QQUIP

Quest for Quality and Improved Performance

Organisational interventions for stroke

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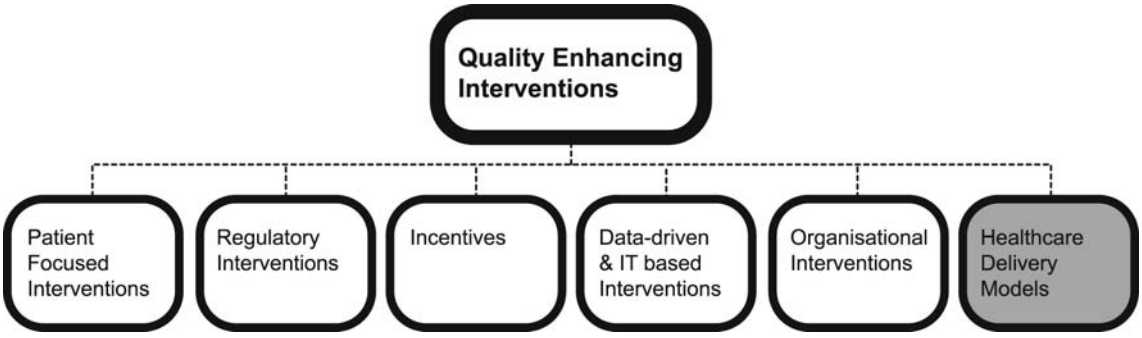
QQUIP and the Quality Enhancing Interventions project

QQUIP (Quest for Quality and Improved Performance) is a five-year research initiative of The Health Foundation. QQUIP provides independent reports on a wide range of data about the quality of healthcare in the UK. It draws on the international evidence base to produce information on where healthcare resources are currently being spent, whether they provide value for money and how interventions in the UK and around the world have been used to improve healthcare quality.

The Quality Enhancing Interventions component of the QQUIP initiative provides a series of structured evidence-based reviews of the effectiveness of a wide range of interventions designed to improve the quality of healthcare. The six main categories of Quality Enhancing Interventions for which evidence will be reviewed are shown below.



For more information visit www.health.org.uk/qquip

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Executive summary

Stroke is a major cause of death and disability among older adults. It is one of the top three causes of death in England and Scotland and a leading cause of disability among older adults. Approximately 130,000 strokes and an additional 20,000 transient ischaemic attacks (TIAs) occur in England every year, and at least 300,000 people live with moderate or severe disability resulting from a stroke (National Audit Office, 2005). In addition to stroke's impact on mortality and morbidity, it is also costly: stroke care costs the National Health Service (NHS) about £2.8 billion a year in direct costs, with an additional £1.8 billion in lost productivity and disability (National Audit Office, 2005).

A stroke, also known as a cerebrovascular accident, is 'the brain equivalent of a heart attack' (National Audit Office, 2005). A stroke occurs when a blood vessel that carries oxygen and nutrients to the brain either gets blocked by a clot or, less commonly, bursts and bleeds. As a result, the part of the brain affected becomes damaged or dies. The severity of strokes varies from one that gets better within 24 hours, known as transient ischaemic attack (TIA), or a 'mini stroke', to one that can cause severe brain damage or even death.

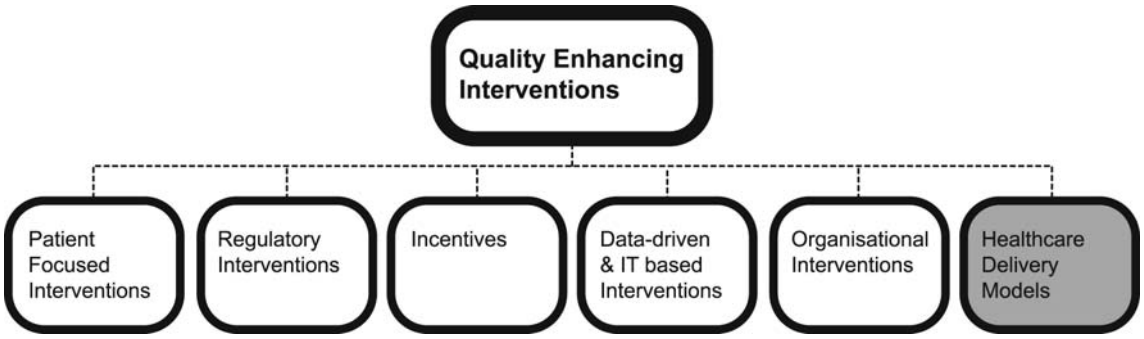
The underlying causes of and effective treatments for strokes and TIAs are well understood. This information has underpinned the development of multiple evidence-based guidelines for the treatment of this serious condition. These include guidelines concerning prevention, acute care and post-acute care (Intercollegiate Stroke Working Party, 2004). Nevertheless, patients with TIAs continue to suffer strokes in high proportions, and the condition continues to cause significant morbidity and mortality. The imbalance between our knowledge of stroke care and effective delivery of guideline-concordant care suggests a lack of fidelity in the stroke care system. Fidelity in this context refers to the 'extent to which the system provides patients the precise interventions they need, delivered properly, precisely when they need them' (Woolf and Johnson, 2005, p 545).

In this review, we focus on the evidence related to health care delivery models that can support timely diagnosis, treatment and rehabilitation of stroke. Evidence is also presented on delivery models for the treatment of TIAs to reduce the risk of stroke. The emphasis, therefore, is not on amassing evidence about effective clinical treatments per se, but rather on health system delivery modalities related to the care of stroke patients.

Project overview

What works to improve quality in health care is a perennial issue. Health services research, clinical medicine and social science literature all contain a huge number of articles that discuss interventions designed to improve quality. The interventions vary widely in terms of design, underlying assumptions, and the context in which they have been implemented. However, although the number of publications that discuss quality improvement is unwieldy and ever-increasing, the empirical evidence about the effects such interventions have on health care processes and outcomes is sparse and difficult to access. The Quality Enhancing Interventions (QEI) project seeks to address these difficulties and will gather available evidence on a range of interventions designed to improve quality of care (see Figure 1).

Figure 1: Quality Enhancing Interventions (QEIs): major themes



Our findings will form the basis of a searchable resource that will allow decision-makers to find relevant research evidence on particular interventions to improve quality and the context in which those interventions have been implemented, as well as access to information on different approaches applied to a particular disease or population group.

Within each of the major themes, sub-categories and clusters of specific interventions are developed, building a taxonomy of QEIs. Clinical healthcare deliverymodels are the focus topics for this report.

Clinical care delivery models vary for different diseases. Effective care processes will reflect the predisposing factors, the cause (aetiology), course and consequences of a particular disease, as well as available therapy options and their cost. Depending on the nature of the disease, care may most appropriately be delivered in primary, emergency or palliative care settings; it may be focused to different extents on prevention as well as management or cure; it may be characterised by an acute episode or by chronic symptoms. The focus of this report is on the care for stroke patients in three settings – emergency, acute and post-acute. In addition, we examine evidence of care delivery models for TIAs, or ‘mini strokes’. This falls under the topic of preventive care for stroke, since a large portion of TIAs are followed by strokes, and care often takes place in the primary care setting.

Methods

We used a ‘best evidence’ approach to conduct our literature review. We focused primarily on evidence from review articles and guidelines issued by national professional organisations. We conducted electronic searches of MEDLINE®, focusing on articles classified as ‘review articles’, and included systematic evidence reviews issued by the Cochrane Collaboration. We conducted our searches using a series of steps to identify articles related to the following four main topic areas: stroke, health systems, health care quality, and health care outcomes. Search strategies are provided in the full report. The review includes a range of research designs: systematic reviews, randomised controlled trials, and quasi-experimental and observational studies. Broad inclusion criteria were adopted owing to the methodological challenges inherent in assessing organisational and delivery models for chronic illness in general and stroke in particular.

Findings

In this review we focused primarily on the following areas related to the organisation and delivery of health care for patients with stroke:

- stroke risk reduction: treatment of TIA
- adequate access to emergency services for diagnosis and timely initiation of appropriate treatment
- inpatient treatment for acute care
- post-acute rehabilitation services.

The evidence is summarised in Table 1.

Table 1: Summary of evidence: health care delivery models for stroke

Area of focus	Summary of evidence
Emergency care	• Some evidence suggests that a multipronged approach to community education for stroke symptom recognition can increase awareness and decrease time to intervention for stroke patients. • When patients use emergency transportation to the emergency department, they experience a reduction in the amount of time between stroke onset and initiation of treatment. • Some evidence supports the use of education programmes for emergency medical services (EMS) dispatchers and paramedics to increase their recognition of stroke signs and symptoms and to decrease time to initiation of treatment. • Establishing standard operating procedures in the emergency department that include a care pathway plan for assessing and implementing emergency stroke care can decrease the time between arrival at the emergency department and start of treatment. • In the event that a neurologist is not available in emergency situations, some evidence supports the ability of emergency service physicians to diagnose a stroke correctly. • Some evidence supports the use of telemedicine to provide a safe, effective alternative model of acute stroke care in rural areas with limited access to neurologists or radiologists.
Stroke risk reduction: treatment of TIA	• The risk of stroke following a TIA is high. For prevention to be effective, the public needs to be educated to seek medical attention urgently and service delivery needs to be organised to provide immediate care. However, there is insufficient evidence to identify the most effective strategy to achieve these goals.

Area of focus	Summary of evidence
Acute care	• Evidence supports a stroke care delivery model that includes coordinated stroke unit care or stroke centre, provided this approach includes multidisciplinary teams. • Evidence shows that a multidisciplinary coordinated care model results in significantly better patient outcomes compared to alternative forms of care, such as care delivered in a general medical ward. • There is a lack of good evidence to identify specific in-hospital care pathways for the treatment of acute stroke. • Treatment at home with supportive services for acute stroke is an option for some elderly patients.
Post-acute care	• Evidence supports stroke rehabilitation units as effective settings in which to treat stroke patients who need rehabilitation. • Rehabilitation can improve functional outcomes when given in the community, provided that it is therapy-based, meaning that the services are carried out by a multidisciplinary and task-oriented team. • There is evidence, albeit weak, to suggest that setting of rehabilitation less important than when therapy is initiated, how intensive the therapy is, how long the therapy lasts, and whether the therapy is administered by appropriate therapists (eg occupational, speech or physical therapists). • Evidence supports selective use of early supported discharge (ESD) as an effective alternative to longer inpatient stays. • A stroke team is an effective means of delivering rehabilitation services when the team includes specialists from disciplines such as nursing, rehabilitation medicine, social services, occupational therapy, physiotherapy, speech and language therapy, and mental health. • There is a lack of good evidence to warrant specific interventions to improve the quality of life for stroke patients' caregivers.

1. Introduction and methods

Background

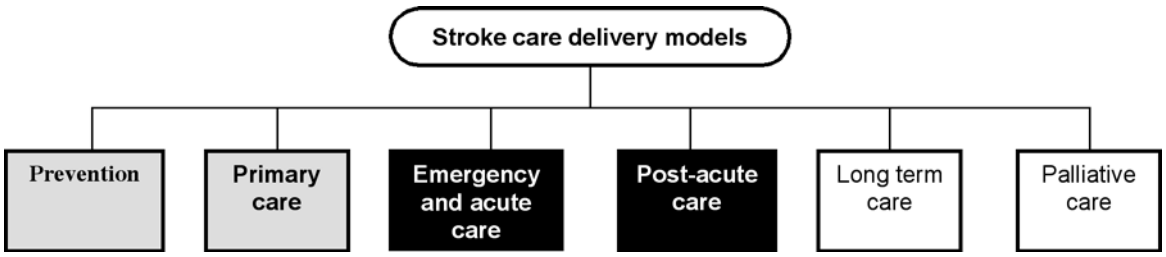
> 'The NHS will take action to prevent strokes, working in partnership with other agencies where appropriate. People who are thought to have had a stroke have access to diagnostic services, are treated appropriately by a specialist stroke service, and subsequently, with their carers, participate in a multidisciplinary programme of secondary prevention and rehabilitation. The milestones focus on the development of specialised stroke services, clinical audit systems, and primary care protocols for risk management, TIA referrals, and risk management.'
>
> (Department of Health, 2006)

In the United Kingdom, about 130,000 people suffer a stroke each year. The impact of a stroke is significant: one year after a stroke, about 33 per cent of these people will be dead and another 40 per cent will be disabled. Stroke is a disease that affects mainly older people; nearly half of all strokes occur among individuals over the age of 75. In the coming decades, as the population ages, the prevalence and burden of the disease will increase. In England, the National Service Framework for Older People highlights the importance of prevention and treatment of stroke among older people (Department of Health, 2001). Recently the term 'brain attack' has come into use in emergency medicine to describe an acute neurological problem, particularly during the early hours of assessment when it is not clear whether the underlying cause for the symptoms is a stroke, a TIA, or something else. This is a useful term for the public because it highlights the similarities between a stroke and a heart attack in that both require immediate medical attention.

Clinical care delivery models differ for different diseases. Effective care processes will reflect the predisposing factors, the cause (aetiology), course and consequences of a particular disease, and the available therapy options and their cost. Depending on the nature of the disease, care may most appropriately be delivered in primary, emergency or palliative care settings; it may be focused to different extents on prevention, management, or cure; and it may be characterised by remission states with flare-ups.

Figure 3 shows the main types of health care delivery settings. These are not mutually exclusive. For each of the clinical conditions we focus on, we will use the schematic shown to indicate the relative concentration of care processes within these settings. Care for stroke spans several settings – emergency, acute and post-acute – that we address in this report. In addition, we discuss care for TIAs, or 'mini strokes', which are typically managed in the outpatient setting by either a primary care or specialist physician. Patients with TIA are at high risk for stroke, with a significant proportion of TIA events followed by stroke. Treatment of TIA therefore has the potential to reduce risk of stroke.

Figure 2: Continuum of health care delivery



Service models for stroke

Major advances have been made during the past several decades in stroke prevention, treatment and rehabilitation. However, obstacles remain to ensuring that scientific advances are consistently translated into effective clinical practice. In this review, we focus primarily on four areas related to the organisation and delivery of health care for patients with stroke:

- adequate treatment of TIAs to reduce the risk of stroke
- timely access to emergency services to differentiate a haemorrhagic stroke from an ischaemic stroke so that adequate treatment can be initiated
    - improve public knowledge with regard to stroke risk factors, the signs and symptoms of stroke and the availability of time-sensitive therapy is generally poor (Schwamm et al, 2005)
    - improve recognition of stroke by emergency personnel is needed, enabling transportation of patients to the most appropriate facility and the initiation of stroke-specific care
- care for the acute phase
- post-acute rehabilitation phase.

Methods

The organisation and delivery of health care services are complex concepts that are challenging to define. The delivery system includes a variety of personnel, processes and infrastructure elements. Neither the organisation nor the delivery of health care is well indexed in existing reference databases of medical literature, such as MEDLINE. Therefore, our strategy relied on using a variety of terms to locate literature containing evidence of effective models of health care delivery for addressing stroke.

Literature search strategy

We used a ‘best evidence’ approach to conduct our literature review, focusing primarily on evidence from review articles, randomised controlled trials (RCTs) and guidelines issued by national professional organisations. With respect to databases, we conducted electronic searches of MEDLINE, focusing on articles classified as ‘review articles’, included systematic evidence reviews issued by the Cochrane Collaboration, and searched CINAHL® for materials more directly related to nursing and allied health. We limited our searches to articles published since 1998 in English that focused on adults aged 19 and older.

Article selection and review

Two report authors independently reviewed article titles and abstracts for 481 review articles and 182 RCTs. Based on the title/abstract review, we retained approximately 200 articles obtained electronically or by interlibrary loan. After independently reviewing these articles, the report authors selected 40, abstracted their findings, and have included them in this review.

Because medical literature databases do not index the health care delivery literature comprehensively, clearly or intuitively, our search strategy evolved during the project. We implemented an iterative process to identify relevant studies to inform models of health care service delivery for stroke.

We began by using lengthy search strings to identify all articles related to health systems, quality, outcomes and cerebrovascular accident, as shown in Table 2. This search yielded 251 review articles. Two authors examined the titles and abstracts of these studies and found that the literature from this search was generally not relevant to the goal of this report.

We also began by conducting searches of MEDLINE, the Cochrane Database of Systematic Reviews and the internet to find guidelines for the provision of stroke care. Once we identified several seminal reports, we used the MeSH terms that had been used to index these publications to inform additional search strategies. For example, a highly relevant American Stroke Association Taskforce report about the establishment of stroke systems was indexed only as ‘cerebrovascular accident’ and ‘health planning guidelines’ (Schwamm et al, 2004). Combining those terms, we obtained the following numbers of candidate publications:

- Search #10: health planning guidelines=2,091
- Search #11: cerebrovascular accident=38,702
- Search #10 AND #11=12.

Table 2: Initial strategy to identify literature related to health care delivery for stroke

Search strategy	Results
Health systems 'disease management' [MeSH] OR 'national health programs' [MeSH] OR ('community health planning' [MeSH] OR 'community health services' [MeSH] OR 'community networks' [MeSH] OR 'delivery of health care' [MeSH]) OR 'center of excellence' [tw] OR 'regionalisation' [tw] OR 'regionalization' OR 'referral management' [tw] OR 'triage' [MeSH] OR ('case management' [MeSH] OR 'organisational case studies' [MeSH]) OR 'risk management' [MeSH] OR 'service lines' [tw] OR 'program evaluation' [MeSH] OR 'regional health planning' [MeSH] OR 'emergency treatment' [MeSH] OR 'emergency medical services' [MeSH] OR 'emergency service, hospital' [MeSH] OR 'emergency medicine' [MeSH] OR 'timeliness' [tw] OR 'rehabilitation' [MeSH]	1,032,048
Quality 'quality assurance, health care' [MeSH] OR 'quality indicators, health care' [MeSH] OR 'quality-adjusted life years' [MeSH] OR 'quality of health care' [MeSH] OR 'health care quality, access, and evaluation' [MeSH] OR 'quality of life' [MeSH] OR 'cost of illness' [MeSH] OR 'appropriate'* [tw] OR 'safety management' [MeSH] OR 'patient safety' [tw] OR 'process assessment (health care)' [MeSH] OR 'performance measures' OR 'cost-benefit analysis' [MeSH] OR ('patient compliance' [MeSH] OR 'guideline adherence' [MeSH]) OR 'continuity of patient care' [MeSH] OR ('efficiency' [MeSH] OR 'efficiency, organizational' [MeSH]) OR 'patient compliance' [MeSH] OR 'information systems' [MeSH] OR 'hospital information systems' [MeSH] OR 'management information systems' [MeSH] OR 'clinical pharmacy information systems' [MeSH] OR 'ambulatory care information systems' [MeSH] OR 'telemedicine' [MeSH] OR 'care pathway' [tw] OR 'care protocol' [tw] OR 'practice guideline' [tw]	3,433,065
Outcomes 'health status' [MeSH] OR 'outcome assessment (health care)' [MeSH] OR 'mortality' [MeSH] OR 'hospital mortality' [MeSH] OR 'ambulatory care sensitive conditions' [tw] OR 'morbidity' [MeSH] OR 'complications' [subheading] OR 'Sentinel surveillance' [MeSH] OR 'fatal outcome' [MeSH] OR 'self care [MeSH] OR 'activities of daily living' [MeSH] OR 'outcome' [tw]	2,036,813
'cerebrovascular accident' [MAJR]	26,725 –
'health systems' AND 'quality' AND 'outcomes' AND 'cerebrovascular accident' [MAJR]	2,067
'health systems' AND 'quality' AND 'outcomes' AND 'cerebrovascular accident' [MAJR]. Limits: English, publication date from 1998, review, humans	251

Best papers search strategy

A discussion of articles thought to be relevant yielded several 'best' articles that we used to develop a larger pool of applicable search terms. We found no common terms among the 'best' papers identified (ie Phase I), so we examined the MeSH indexing of a larger pool of representative papers during Phase II of the strategy. The Appendix contains the specific citations examined and their associated MeSH indexing. The pertinent MeSH descriptors selected from each paper are in bold typeface.

Guidelines search strategy

Working from the inventory of articles identified by the two reviewers (Dr Bernard and Ms Brody), and their specific indexing terms, we developed an overall pool of terms. Many of the highlighted terms had appeared in the initial search already examined. We limited 'cerebrovascular accident' to 'therapy' OR 'rehabilitation', then added 'practice guidelines' OR 'health planning guidelines' (see Table 3 for results of this iteration). This search, however, did not yield citations relevant to delivery systems for stroke.

Table 3: Results of guidelines search strategy

Search #	Search strategy	Results
#1	Search ('cerebrovascular accident/rehabilitation' [MAJR] OR 'cerebrovascular accident/therapy' [MAJR])	8,335
#3	Search ('health planning guidelines' [MeSH] OR 'practice guidelines' [MeSH]). Limits: English, publication date from 1998, review, humans	7,394
#4	Search #1 AND #3. Limits: English, publication date from 1998, review, humans	65

Models search strategy

We reviewed those citations and determined that the earlier search ('cerebrovascular accident', 'therapy' OR 'rehabilitation', AND 'practice guidelines' OR 'health planning guidelines') was closer to but not right on our target literature base. So, as a next step, we expanded the pool by adding 'health services research' OR 'evidence-based medicine' OR 'patient care team' OR 'delivery of health care', and then limited that search with 'models' as a text word (see Table 4 for results of this search). This set was closer, but still not focused enough. Also, these terms did not yield articles that were relevant to the delivery system focus of this report.

Table 4: Results of models search strategy

Search #	Search strategy	Results
Step 1		
#3	Search ('cerebrovascular accident/rehabilitation' [MAJR] OR 'cerebrovascular accident/therapy' [MAJR])	8,317
#12	Search 'health services research' [MeSH] OR 'evidence-based medicine' [MeSH] OR 'patient care team' [MeSH] OR 'delivery of health care' [MeSH]. Limits: English, publication date from 1998, humans	221,522
#13	Search #3 AND #12. Limits: English, publication date from 1998, humans	838
#14	Search models. Limits: English, publication date from 1998, humans	231,033
#15	Search #13 AND #14. Limits: English, publication date from 1998, humans	82
Step 2		
#1	Search ('cerebrovascular accident/rehabilitation' [MAJR] OR 'cerebrovascular accident/therapy' [MAJR])	8,317
#3	Search 'health services research' [MeSH] OR 'evidence-based medicine' [MeSH] OR 'patient care team' [MeSH] OR 'delivery of health care' [MeSH]	545,131
#4	Search models	817,468
#5	Search #1 AND #3 AND #4	85
#6	Search #1 AND #3 AND #4. Limits: English, publication date from 1998, review, humans	11

Manpower search strategy

We next tried to focus on 'manpower' issues ('manpower' [subheading] OR 'health manpower' [MeSH] OR 'health care facilities, manpower, and services' [MeSH]) in MEDLINE. Combining this with 'cerebrovascular accident' yielded the best set yet. However, it still identified too many 'prevention' articles, along with the target 'intervention' articles. Thus, we reran the search, removing 'prevention' articles (see Table 5 for results). The result was a list of articles that included both the target articles that had been suggested for inclusion and pertinent, previously unidentified articles. This set of articles, supplemented by analogous searches in the Cochrane Library and CINAHL, formed the basis for our review.

Further, we conducted additional searches of MEDLINE, employing study design as a restriction to select only RCTs, to gather additional evidence about emergency medical services for stroke and knowledge of signs and symptoms of stroke.

Table 5: Results of manpower search strategy

Search #	Search strategy	Results
#1	Search ('cerebrovascular accident/rehabilitation' [MAJR] OR 'cerebrovascular accident/therapy' [MAJR])	8,335
#3	Search ('manpower' [subheading] OR 'health manpower' [MeSH] OR 'health care facilities, manpower, and services' [MeSH])	1,481,959
#4	Search #1 AND #3	2,059
#5	Search #1 AND #3. Limits: English, publication date from 1998, review, humans	254
#6	Search #1 AND #3 Limits: English, publication date from 1998, review, humans, core clinical journals	28
#7	Select 28 document(s) for review	28
#9	Search prevention	756,530
#10	Search #5 NOT #9	162
#11	Search #10 NOT #6 (removed 28 items already reviewed to eliminate duplicate citations)	148
#12	Select 148 document(s)	148

The search strategies conducted to identify articles related to the delivery of stroke care did not yield sufficient evidence for the care delivery models for TIA. Therefore, we conducted a series of additional literature searches to find evidence for this topic. Initially, we conducted a comprehensive search of TIA using health systems, quality and outcomes terms used for the initial stroke search. We also replicated the manpower strategy described above with TIA and searched for articles related to the health personnel who conduct endarterectomies. The results of these searches are presented in Table 6. Examination of all review articles identified revealed limited evidence about health care delivery models for care of TIA. We identified one review article that was obtained from both the initial search and the manpower search which provided relevant information for this report. We examined the MeSH terms associated with this article to inform us of additional relevant search terms and found that the article was indexed with very few MeSH terms and was limited to multicentre studies. We therefore conducted one additional search of TIA limited to English articles published since 1998 that involved multicentre studies of humans. This search yielded 53 articles. However, no additional evidence for this report was found based on the review of the titles and abstracts of these articles.

Table 6: Results of TIA search strategy

1	'ischemic attack, transient' [MeSH]	14,266
2	**Health systems** 'disease management' [MeSH] OR 'national health programs' [MeSH] OR ('community health planning' [MeSH] OR 'community health services' [MeSH] OR 'community networks' [MeSH] OR 'delivery of health care' [MeSH]) OR 'center of excellence' [tw] OR 'regionalisation' [tw] OR 'regionalization' OR 'referral management' [tw] OR 'triage' [MeSH] OR ('case management' [MeSH] OR 'organizational case studies' [MeSH]) OR 'risk management' [MeSH] OR 'service lines' [tw] OR 'program evaluation' [MeSH] OR 'regional health planning' [MeSH] OR 'emergency treatment' [MeSH] OR 'emergency medical services' [MeSH] OR 'emergency service, hospital' [MeSH] OR emergency medicine' [MeSH] OR 'timeliness' [tw] OR 'rehabilitation' [MeSH]	1,042,865
3	**Quality** 'quality assurance, health care' [MeSH] OR 'quality indicators, health care' [MeSH] OR 'quality-adjusted life years' [MeSH] OR 'quality of health care' [MeSH] OR 'health care quality, access, and evaluation' [MeSH] OR 'quality of life' [MeSH] OR 'cost of Illness' [MeSH] OR 'appropriate'* [tw] OR 'safety management' [MeSH] OR 'patient safety' [tw] OR 'process assessment (health care)' [MeSH] OR 'performance measures' OR 'cost-benefit analysis' [MeSH] OR ('patient compliance' [MeSH] OR 'guideline adherence' [MeSH]) OR 'continuity of patient care' [MeSH] OR ('efficiency' [MeSH] OR 'efficiency, organizational' [MeSH]) OR 'patient compliance' [MeSH] OR 'information systems' [MeSH] OR 'hospital information systems' [MeSH] OR 'management information systems' [MeSH] OR 'clinical pharmacy information systems' [MeSH] OR 'ambulatory care information systems' [MeSH] OR 'telemedicine' [MeSH] OR 'care pathway' [tw] OR 'care protocol' [tw] OR 'practice guideline' [tw]	3,474,142
4	**Outcomes** 'health status' [MeSH] OR 'outcome assessment (health care)' [MeSH] OR 'mortality' [MeSH] OR 'hospital mortality' [MeSH] OR 'ambulatory care sensitive conditions' [tw] OR 'morbidity' [MeSH] OR 'complications' [subheading] OR 'sentinel surveillance' [MeSH] OR 'fatal outcome' [MeSH] OR 'self care' [MeSH] OR 'activities of daily living' [MeSH] OR 'outcome' [tw]	2,058,491
5	'health systems' OR 'quality' OR 'outcomes'	4,811,139
6	'ischemic attack, transient' AND 'health systems' OR 'quality' OR 'outcomes'	7,432
7	'ischemic attack, transient' AND 'health systems' OR 'quality' OR 'outcomes'. Limits: English, humans	4,752
10	Manpower 'health personnel' [MeSH] OR ('manpower' [subheading] OR 'health manpower' [MeSH] OR 'health care facilities, manpower, and services' [MeSH]). Limits: English, humans	949,833

11	(‘ischemic attack, transient’ AND ‘health systems’ OR ‘quality’ OR ‘outcomes’) AND ‘manpower’. Limits: English, humans	401
12	(‘ischemic attack, transient’ AND ‘health systems’ OR ‘quality’ OR ‘outcomes’) AND ‘manpower’. Limits: English, humans, review articles	39
15	’endarterectomy’ [MeSH]	9,660
16	‘manpower” AND ‘endarterectomy’	923
17	‘manpower’ AND ‘endarterectomy’. Limits: English, humans, review articles	87

Quality and strength of evidence

The quality of the evidence reviewed was generally acceptable. Many of the major issues in stroke care were the topic of systematic literature reviews published by the Cochrane Collaboration. We searched for assessments of the quality of other review articles included in the database of abstracts of reviews of effects published by the Centres for Research and Dissemination (CRD). Throughout the report we note whether reviews have been evaluated by the CRD and the findings of those evaluations.

Because research that tests health care delivery models is often carried out with designs other than those used for RCTs, we discuss findings from reviews that included a variety of study designs, that is, RCTs, observational studies, or both. Most review articles documented their literature search strategies and inclusion and exclusion criteria. Several review articles employed multiple independent reviewers and grading systems to characterise the quality of studies reviewed.

The evidence base for health care delivery models to address stroke is evolving, as indicated by the significant challenges we outlined above and the limitations that will be discussed in the conclusion of this report. Most notably, additional research that includes larger, more diverse populations and health care settings is required. In addition, that research should be supported by sophisticated information systems that can accurately capture specific details of the interventions delivered which can be replicated. Finally, investigators must provide rigorous documentation of ‘usual care’ received by comparison groups.

2. Health care delivery models for stroke

Guidelines for the care of stroke patients are available in abundance. The challenge is for all stroke patients to receive guideline-concordant care in every setting. Efficient and effective management of patients requires a delivery system that can respond to the needs of each patient. In this report we present evidence on health care delivery models for stroke that encompass a continuum of stroke care. These explicitly include emergency care that enables clinicians to recognise and promptly diagnose the condition and to orchestrate appropriate access to effective treatment. When care providers determine that stroke symptoms are transient, then the delivery model focuses on the prevention of TIA recurrence and stroke risk reduction by appropriate treatment of the TIA, which can consist of either medical or surgical interventions and follow-up in the primary care setting. In cases where a stroke has occurred, acute care management generally takes place in the inpatient setting, and post-acute care often begins in the inpatient setting and includes rehabilitation.

Stroke guidelines emphasise the need for people suspected of having a stroke to be assessed and treated in a timely manner by clinicians with the appropriate neurological skills and in institutions with appropriate facilities. People who have suffered a stroke and its aftermath benefit from rehabilitation that is timely, ongoing, of high quality, and provided in hospitals, community care and other specialist settings to meet their continuing and evolving needs. The focus of this review is on aspects of the organisation and delivery of services that enable stroke patients to access guideline-concordant care:

- TIA treatment and stroke risk reduction
- emergency – prehospital and in hospital
- acute – in hospital
- post-acute – rehabilitation in various settings.

Emergency care

Background

Ischaemic stroke versus haemorrhagic stroke

Ischaemia is a reduction of blood flow most commonly due to an obstruction such as a clot blocking a blood vessel. An ischaemic stroke results when the obstruction blocks the flow of blood to or within the brain. A haemorrhagic stroke occurs when a blood vessel in the brain ruptures and blood leaks into the surrounding brain tissue. These are different causes of stroke and require very different treatment approaches.

A stroke is a medical emergency. Intervention in the hours immediately following the onset of a stroke can avert significant damage. The goal of emergency stroke care is to identify symptoms of a stroke and to transport acutely ill patients to a hospital emergency department. Upon arrival at the hospital, prompt assessment of the nature of the event is important so that appropriate interventions can be initiated in a timely way. For example, a brain scan can help the physician diagnose an ischaemic stroke. After diagnosis, the physician can initiate thrombolytic treatment that can decrease damage caused by the blockage. Such timely treatment can lead to less brain damage and, subsequently, to better patient outcomes.

Thrombolysis

'The majority of strokes are caused by a clot that blocks a blood vessel in the brain. Thrombolysis is the use of a drug to cause the clot to dissolve and blood flow to resume. While thrombolysis has the potential to improve outcomes for patients with stroke caused by ischaemia, it is a high-risk treatment and must be administered by trained personnel in a setting where the underlying cause of the stroke can be determined and patients can be appropriately monitored' (Intercollegiate Stroke Working Party, 2004).

A substantial body of research demonstrates the value of thrombolytic therapy administered within 3 hours of stroke symptom onset, once haemorrhage has been definitively excluded. The aim of immediate therapy is to prevent death and reduce the damage the stroke can cause; the aim of longer term therapy is to help stroke victims to recover and maintain independence (Wardlaw, del Zoppo and Yamaguchi, 2000; Marler et al, 2000; Hacke et al, 2004; Koennecke et al, 2001). The US National Institute of Neurological Disorders and Stroke (NINDS) conducted the seminal study demonstrating the efficacy of tissue plasminogen activator (tPA) for acute ischaemic stroke. Evidence from 333 stroke patients participating in a randomised, placebo-controlled trial in the United States showed that patients treated with tPA were 30 per cent more likely to have minimal or no disability at 3 months as measured by the National Institutes of Health (NIH) stroke scale, the Barthel index, the modified Rankin scale, and the Glasgow outcome scale than patients receiving only placebo (Tissue Plasminogen Activator for Acute Ischemic Stroke. National Institute of Neurological Disorders and Stroke Rt-PA Stroke Study Group, 1995).

Further, a meta-analysis of data on 2,775 patients treated during six studies conducted in more than 300 hospitals in 18 countries demonstrated that the benefits of tPA were greatest when it was started within 90 minutes of symptom onset. Using data from two NINDS trials, two European Cooperative Acute Stroke Study (ECASS) studies, and two Acute Noninterventional Therapy in Ischemic Stroke (ATLANTIS) studies, in which all thrombolytic treatment was delivered within 6 hours of symptom onset, investigators found that the odds of a favourable outcome at 3 months were related to the time between stroke onset and start of treatment: that is, better outcomes were associated with shorter delays in treatment. The probability of one adverse outcome, ie haemorrhage, was related to increased age and provision of tPA treatment. However, this outcome was not related to the amount of time between symptom onset and thrombolytic treatment (Hacke et al, 2004).

Because thrombolytic treatment must be administered within 3 hours of symptom onset, stroke victims must receive medical attention promptly. Therefore, the health care delivery goal during this acute, emergency phase is to provide stroke victims with access to timely emergency care where they can receive evidence-based therapy within the time specified by guidelines.

Thrombolytic treatment for stroke has been available in the United States and Europe for several years. The US Food and Drug Administration (FDA) approved thrombolytics for this purpose in 1996 (Kaste, 2005). In 1999, use of thrombolytics was approved in Canada (Hill et al, 2000). Following that, in 2002, the European Agency for the Evaluation of Medicinal Products (EMEA) approved it for stroke therapy on condition that patients treated with thrombolytics were included in a registry, the Safe Implementation of Thrombolysis in Stroke: a Multinational, Multicenter Monitoring Study of Safety and Efficacy of Thrombolysis in Stroke (SITS-MOST) (Kaste, 2005).

Why do so few people receive thrombolytic therapy?

Although the efficacy of thrombolytic therapy has been established, only a small percentage of ischaemic stroke victims receive this intervention. Research has documented numerous reasons why patients often do not get to the hospital in time to receive hyperacute stroke treatments, ie thrombolysis. In many cases, patients delay seeking care during or following stroke and do not access emergency care for 3 to 14 hours or more following onset of stroke symptoms (Gil Nunez and Vivancos Mora, 2004; Moser et al, 2006).

The need to increase public awareness of signs and symptoms of a stroke is obviously critical, as is the need to inform the public about the urgency of obtaining timely assistance for people showing symptoms of TIA or stroke. A population-based study conducted in the United States found that, although campaigns to increase public knowledge of stroke symptoms can raise awareness, individuals at highest risk (for example, men, African Americans and persons older than 75 years) are least likely to know the signs and symptoms of stroke. These findings suggest that public education efforts about stroke warning signs need to target those at greatest risk (Schneider et al, 2003; Pancioli et al, 1998). Similar findings have been obtained in studies of public knowledge of stroke symptoms conducted in Australia, India, Spain, the United Kingdom, and additional states in the United States (Sug Yoon et al, 2001; Das et al, 2007; Pandian et al, 2005; Segura et al, 2003; National Audit Office, 2005; Reeves, Hogan and Rafferty, 2002; Blades et al, 2005).

Both individual and situational characteristics are associated with delays in seeking emergency care for stroke symptoms. These include: living alone; being from a minority ethnic group; being of lower socioeconomic status; having gradual as opposed to abrupt onset of symptoms; and consulting family or friends or attempting to contact a general practitioner (GP) in lieu of or before obtaining emergency medical services (EMS) assistance (Kennedy, Ma and Buchan, 2004; Moser et al, 2006; Gil Nunez and Vivancos Mora, 2004; Brice et al, 2002) In addition, a study conducted in Germany found that the length of time from being admitted to an emergency department to having a brain scan varied by non-clinical factors such as gender and health insurance. Specifically, men and those with private health insurance had shorter delays between arrival at the emergency department and performance of a brain scan (Jungehulsing et al, 2006).

Sandercock et al (2002) conducted a systematic review of the challenges involved in delivering thrombolysis to acute stroke patients, which the National Health Service (NHS) published as a Health Technology Assessment (HTA) report in 2002. The 54 observational studies reviewed had been conducted between 1990 and 2001 and varied greatly in size (from 30 to 17,324 patients). The studies were conducted around the world – including in Australia, Canada, China, Denmark, Finland, France, Italy, Israel, New Zealand, the United Kingdom and the United States – and included information from 39,030 patients. The authors identified three major categories of barriers to timely stroke treatment:

- lack of knowledge by family or patient about what to do
    - patient or family not recognising stroke warning signs or not seeking immediate medical attention (21 studies)
    - patient or family contacting GP (23 studies), which increases time elapsing before receipt of appropriate emergency care
    - patient or family choosing not to give consent for thrombolysis owing to risks or patient being unable to give consent due to language impairment (two studies)

- lack of adequate emergency service response
    - EMS (eg call handlers) classifying stroke as non-urgent, leading to delays reaching patient and during transport to the hospital (seven studies)
    - emergency departments classifying stroke as non-urgent, which leads to further delays in obtaining appropriate care such as a neurologist's assessment or neuroimaging needed for diagnosis and treatment decisions (27 studies)
- lack of availability of diagnostic equipment or place of service
    - neuroimaging services not being immediately available (22 studies), often because computerised tomography (CT) or magnetic resonance imaging (MRI) scans are rarely available outside typical business hours
    - many patients being cared for on general medical wards (GMWs) rather than in stroke units (18 studies)
    - physicians being concerned about risks of thrombolysis and difficulty of administering treatment within 3 hours of onset (four studies).

Evidence from nine studies showed that a relatively small proportion of stroke patients, 0 to 22 per cent, were eligible for thrombolytic therapy. The HTA found that the common reasons that patients were not eligible for tPA were the following:

- delay to treatment of >3 hours
- symptom onset unknown
- haemorrhage found on CT scan
- stroke too mild or resolving rapidly
- refusal to consent to treatment (Kwan and Sandercock, 2002).

To examine the process of delivering thrombolytic therapy and identifying strategies for increasing access to this effective stroke treatment, the American Stroke Association created the 'chain of recovery', a construct that organises the activities leading up to stroke treatment into the following five stages (Kennedy et al, 2004):

- recognition – the ability of patients and caregivers to recognise the signs and symptoms of stroke and the need to obtain care immediately by contacting EMS
- EMS's reaction to a call, such as prioritising stroke cases to receive rapid transport to a hospital
- the hospital's response to begin medical assessment upon receiving a patient suspected of having had a stroke
- the time needed to conduct and interpret results of brain imaging to reveal the cause and type of stroke to inform treatment
- rx (treatment) – the final stage, consisting of the time needed to begin treatment for the stroke.

Two phases of the continuum of care are involved in getting patients treatment as described in the chain of recovery: prehospital care and emergency care in hospital. In the next section, we summarise current evidence-based guidelines for stroke emergency care and current practice in emergency care for stroke. Following that, we

present evidence of the effectiveness of health care delivery models for the first three stages of the chain of recovery (recognition, reaction and response) under the topic of prehospital care, that is, patient recognition of stroke symptoms and transportation and care provided by call handlers and paramedics, and emergency care provided in the hospital setting.

Guidelines: emergency care

The American Heart Association, NINDS, the Brain Attack Coalition and the European Stroke Initiative have all issued guidelines related to prehospital care for stroke (Schwamm et al, 2005; Moser et al, 2006; Scott et al, 2003; Alberts et al, 2000; European Stroke Initiative Executive Committee and the EUSI Writing Committee, 2000). In particular, Schwamm et al (2005) developed recommendations for the establishment of stroke systems of care. Overall, the American Heart Association recommends creating a regional system response to stroke care that involves all health care resources that may be used to support stroke victims, for example, EMS workers, hospital staff, etc. (Moser et al, 2006). Elements of a stroke system as identified by guidelines include the following points:

- A stroke system should include 24-hour access to emergency transport, initiated by telephone (Schwamm et al, 2005).
- Once stroke symptoms are identified, patients, family members or bystanders should call EMS for transportation to the hospital (European Stroke Initiative Executive Committee and the EUSI Writing Committee, 2000).
- The stroke system should support efforts to educate high-risk populations and their families (for example, older adults, patients with previous stroke or transient ischaemic attack) about stroke signs and symptoms and the need to call EMS (Schwamm et al, 2005).
- Educational initiatives as part of a stroke system should include community-based organisations, policymakers and other stakeholders who might help communicate with local populations, including reaching ethnic and racial minorities (Schwamm et al, 2005). In addition, the American Heart Association issued a scientific statement that recommends conducting additional research on effective ways to educate the public about the warning signs of stroke. Such research should consider educational interventions that target high-risk individuals (for example, those with a history of hypertension or previous stroke) and that emphasise the message of urgency of immediate medical transport and benefits of reducing delay in seeking care (Moser et al, 2006).

Timing of emergency department services for stroke

The US National Institute of Neurological Disorders and Stroke (NINDS) has issued recommendations relating to the timing of emergency department services for stroke to facilitate administration of thrombolytic therapy (Bock, 1996). The guidelines are as follows:

- initial physician evaluation – within 10 minutes of arrival at emergency department
- notification of stroke team – within 15 minutes of arrival
- CT scan initiation – within 25 minutes of arrival
- CT scan interpretation – within 45 minutes of arrival
- administration of thrombolytic drug therapy – within 60 minutes
- transfer to inpatient setting – within 3 hours of arrival

There may be instances, particularly in rural areas, where a patient may not have direct access to a neurologist who is qualified to diagnose stroke. In these cases, NINDS recommends the use of telemedicine technology to increase access to stroke care (Jagoda 2003).

- A stroke system should encourage EMS dispatchers and responders to use diagnostic algorithms and protocols to identify persons with stroke and alert the hospital that a stroke patient is coming.
    - EMS personnel should perform and document results of assessments and screening for thrombolysis and other relevant interventions (Schwamm et al, 2005; Moser et al, 2006; Scott et al, 2003)
    - the EMS system should be integrated with the local stroke centre via educational initiatives conducted by the stroke centre (Alberts et al, 2000). Specifically, emergency physicians and stroke experts should be involved in the development of educational materials and transport protocols for EMS personnel (Schwamm et al, 2005)
    - EMS should be dispatched with the same level of priority received by other acute events (for example, myocardial infarction and trauma) (Schwamm et al, 2005; Alberts et al, 2000; Moser et al, 2006)
    - Candidates for hyperacute interventions (ie thrombolyis) should be transported to the nearest primary stroke centre, using air transport if appropriate. Patients for whom these interventions are not appropriate should be transported to local hospitals for evaluation (Schwamm et al, 2005; Scott et al, 2003).

Current practice in the United Kingdom

The National Stroke Audit prepared by the clinical effectiveness and evaluation unit of the Royal College of Physicians provides information about the current practice of stroke care in England, Wales and Northern Ireland (Hoffman et al, 2006). The report indicates that various opportunities exist to improve the UK health system to manage stroke as a medical emergency.

- Thrombolysis services are developing slowly in the United Kingdom; only 75 per cent of the 40 hospitals that offer thrombolysis services actually delivered this service during the previous year.
- A total of 218 patients received thrombolysis in the past year, a small proportion of the patients who could have received benefit from this treatment.
- Only 10 per cent of patients are directly admitted to a specialist acute stroke unit, despite the fact that 50 per cent of hospitals operate such units. Not all of these stroke units have all five of the following key characteristics of stroke units identified by the Stroke Unit Trialists' Collaboration (2007):
    - consultant physician with responsibility for stroke
    - formal links with patient and caregiver organisations
    - weekly multidisciplinary meetings to plan patient care
    - patient education about stroke
    - continuing education programmes about stroke for staff (Hoffman et al, 2006).

The Scottish Stroke Care Audit provides information about the quality of care delivered to stroke victims in Scotland. According to data collected during 2004-2005, 70 per cent of all individuals receiving care at a hospital with stroke were admitted to a stroke unit at some point during their stay, while only 47 per cent of stroke victims were admitted to a stroke unit within one day of admission. Approximately three out of every four persons admitted for stroke had CT/MRI imaging within 2 days of admission (Dennis, 2006).

Evidence

What is the most effective way to educate the public about stroke signs and symptoms?

Summary of evidence

There is some evidence that a multipronged approach to community education for stroke symptom recognition can increase awareness and decrease time to intervention for stroke patients.

Efforts to date have not yielded effective strategies for decreasing the amount of time between symptom onset and accessing medical care. A scientific statement issued by the American Heart Association advises that additional research should be conducted to identify effective interventions for educating the public about the signs and symptoms of stroke and the urgency of obtaining care for stroke (Moser et al, 2006). Two studies (reviewed below) provide preliminary evidence of the effectiveness of educational campaigns to increase use of tPA therapy, to improve patient knowledge of stroke symptoms, and to train caregivers in how to evaluate symptoms of stroke using the Cincinnati Prehospital Stroke Scale (CPSS) under the direction of an EMS dispatcher.

Silver et al (2003) conducted a quasi-experimental study in three test communities and one control community in Ontario, Canada, to evaluate the impact of advertising strategies intended to increase public knowledge of the warning signs of stroke. The interventions varied across the test communities with regard to the way the messages were delivered: print; low-level, intermittent television messages; and high-intensity, continuous messages. The print and 30-second black-and-white television advertisements contained information

about the warning signs of stroke. Investigators conducted telephone interviews with approximately 400 members in each of the four communities both before the initiation of the advertising campaigns and 3 months following the end of the advertising campaign. The mean number of warning signs named and the percentage of people able to name at least two warning signs of stroke were significantly higher during the post-intervention period for the two communities exposed to television campaigns ($p<0.01$). This significant improvement was observed among men and women and among those who had not completed high school. In contrast, these results were not observed among individuals aged 65 and over (Silver et al, 2003).

Morgenstern et al (2004) conducted the Temple Foundation Stroke Project to evaluate whether a community communication campaign combined with professional education and organisational change initiatives are effective in reducing stroke-related disability and mortality. Public service announcements aired on radio and television were used to educate community members. To target physicians, the intervention conducted systems change programmes in hospitals, changed perceived norms in the medical community, and reinforced messages through publishing success stories in the newspaper and newsletters distributed to health care personnel. The authors compared the use of tPA during the pre- and post-intervention periods in the intervention community who received the educational messages and a comparison community who did not receive the intervention (n=108 for each study group during the post-intervention period).

In the intervention group, the proportion of patients with ischaemic stroke treated with tPA was significantly lower during the pre-intervention period than during the 6 months following the end of the intervention period (2.2 per cent versus 11.2 per cent; $p<0.01$). Further, among patients eligible to receive tPA, 69.2 per cent received treatment during the 6 months following the intervention; the rate in the pre-intervention period had been 13.6 per cent ($p<0.01$). As expected, in the comparison group, the percentages of patients treated with tPA in the pre- and post-intervention periods did not differ. Similarly, physician reluctance to use tPA decreased over time in the intervention group and not in the comparison group (Sharma et al, 2005).

Liferidge et al (2004) conducted an observational study of 70 individuals to determine whether laypersons could be trained to use the Cincinnati Prehospital Stroke Scale (CPSS) to convey stroke symptoms by telephone to an EMS dispatcher. The CPSS evaluates individuals for facial palsy, arm weakness and speech abnormalities. Seventy visitors to a tertiary care clinic in North Carolina recruited to participate in the study were exposed either to a healthy patient or a patient with stroke symptoms. The three components of the CPSS were administered and interpreted with 94 per cent sensitivity and 83 per cent specificity, indicating that the CPSS may be a useful tool for early prehospital detection of stroke. The investigators did not report on community-based testing of the use of this instrument or its impact on time to care for stroke patients (Liferidge et al, 2004).

How should stroke victims seek medical care?

Summary of evidence

When patients use emergency transportation to the emergency department, they experience a reduction in the amount of time between stroke onset and initiation of treatment.

Harraf et al (2002) conducted a multicentre prospective observational study that found that use of emergency transportation significantly reduces the amount of time between stroke onset and arrival at the hospital. Information from 739 stroke patients presenting to one

of 22 hospitals in Dublin, Ireland, and other areas in the United Kingdom showed that the median delay between symptom onset and arrival at the hospital for patients who used the emergency service was 2 hours and 3 minutes; the time for patients who were referred to the hospital by a GP was 7 hours and 12 minutes ($p<0.0001$). This study also found that symptom onset between midnight and 6am or admission to a teaching hospital (compared with a general hospital) was associated with delays of greater than 6 hours between symptom onset and arrival at the hospital (Harraf et al, 2002).

Morris et al (2000) conducted the Genentech Stroke Presentation Survey, a multicentre prospective registry of patients, intended to describe the length of delays in obtaining acute stroke care and the factors related to quicker access to stroke care. Investigators collected data from 721 patients with stroke symptoms who presented to 48 emergency rooms throughout North Carolina. On average, patients arrived at the emergency room 5.4 hours after their stroke symptoms began. More than half of patients (56 per cent) reached the hospital within 3 hours of symptom onset. Once at the hospital, patients waited an average of 1.9 hours to receive a CT scan. Compared with patients who did not contact EMS for help, patients who travelled by ambulance had a 50 per cent shorter time between symptom onset and arrival at the hospital ($p<0.001$) and a 25 per cent shorter time between hospital arrival and CT scan ($p<0.01$). Logistic regression of a variety of factors related to delay in receipt of stroke care revealed that patients who awakened with symptoms were less likely to arrive at the hospital within 2 hours than those who had a stroke while awake ($p<0.01$) (Morris et al, 2000).

An alternative means of providing emergency services

In environments where stroke centres (ie hospitals prepared to treat patients with stroke) are sparsely located, helicopter transport may be needed to get patients to the hospital quickly enough to obtain effective treatment. The studies described below report on the safety of air transport for transporting stroke victims.

Silliman et al (2003) conducted a prospective study of helicopter transport to a hospital from an 11-county region in the south-eastern United States to examine use of helicopter transport to provide rural residents with access to thrombolytic therapy. During the 3-year study period, 111 helicopter transports were conducted. Approximately 75 per cent of the 111 patients transported had a diagnosis of stroke or TIA. Seventy-one per cent arrived within 3 hours of symptom onset. Forty-seven patients had an ischaemic stroke, 18 of whom received thrombolytic therapy. The authors suggest that introducing a validated stroke scale may help EMS to improve their recognition of stroke victims, thus increasing the percentage of helicopter transports for patients who can benefit from thrombolytic treatment (Silliman et al, 2003).

Conroy et al (1999) conducted a retrospective case series of all patients transferred by helicopter to a university hospital in the United States within 24 hours of symptom onset during a 2-year period. A total of 75 patients were transported by helicopter during the study period; eight received tPA before transfer, 38 enrolled in acute stroke study drug protocols, and 35 received no special therapy. Flights lasted from 6 to 45 minutes, covering distances that require 30 to 150 minutes of driving time.

Of the 45 patients who responded to a survey, 84 per cent were transferred by a physician at originating hospital and 76 per cent of patients were transferred because a possible treatment was not available at the originating hospital. Ninety-three per cent of patients reported that they felt they benefited from air transport, despite the fact that 40 per cent of them received no specific therapy as a result of the intervention. The authors conclude that

air transport has the potential to provide stroke patients with access to therapies that would be unavailable otherwise (Conroy et al, 1999).

How to increase awareness of signs and symptoms of stroke by EMS dispatchers and paramedics?

Summary of evidence

There is some evidence that supports the use of education programmes for EMS dispatchers and paramedics to increase their recognition of stroke signs and symptoms and decrease time to initiation of treatment.

As cited above, stroke care guidelines recommend that EMS providers should use a diagnostic algorithm to recognise stroke signs and symptoms (Schwamm et al, 2005; Moser et al, 2006; Scott et al, 2003). In this section, we describe several studies that examined the validity of paramedic diagnosis of stroke using the Los Angeles prehospital stroke screen (LAPSS), as well as a case-based approach to train paramedics to recognise signs of stroke.

Kidwell et al (2000) conducted a prospective observational study to examine the accuracy of paramedic diagnoses of stroke using the LAPSS. The LAPSS is a stroke screening instrument that was developed specifically for use by prehosptial personnel. The 1-page instrument requires less than 3 minutes to complete and includes the following:

- patient history (age >45, history of seizures or epilepsy absent, symptom duration less than 24 hours, patient not wheelchair bound or bedridden)
- blood glucose measure
- three examination items to detect unilateral motor weakness (facial droop, strength of hand grip and arm strength).

Paramedics were trained during a 1-hour stroke educational session that included use of the LAPSS and general emergency stroke care knowledge. Paramedics were certified to use the LAPSS if they could correctly complete the instrument for five patients shown in video vignettes. A total of 18 paramedics completed the training for this prospective validation study. During an 8-month period, 446 EMS runs were made for patients with neurological symptoms relevant to stroke. Paramedics completed LAPSS forms on 206 of these patients, and none of the remaining 240 patients had a final diagnosis of stroke. Based on LAPSS results from 34 patients with a target diagnosis of stroke, paramedics demonstrated 91 per cent sensitivity and 97 per cent specificity in identifying stroke victims (Kidwell et al, 2000).

Wojner-Alexandrov et al (2005) examined the effectiveness of a multilevel educational intervention that targeted paramedics, hospital staff and community members in Texas. During the year-long intervention, monthly educational sessions were presented to paramedics and hospital personnel. These sessions included competitive benchmarking of hospital and paramedic performance, implementation of the LAPSS and public announcement of stroke centre designation. In addition, community education about the identification of stroke warning signs via print, radio and television was implemented, and community stroke screening events were coordinated.

The study compared the following outcomes between the 6 months before the educational intervention and the 12 months during the intervention: accuracy of paramedic diagnosis,

thrombolysis rates, and rates of post-thrombolysis haemorrhage. EMS transported an average of 74 patients suspected of stroke each month during the pre-intervention period, and 89 patients during the active intervention period. Based on data from 1,039 patients, a small but statistically significant increase in the percentage of patients presenting at the emergency department within 120 minutes was observed (58 per cent pre-intervention versus 62 per cent active intervention, $p<0.01$). Accuracy of paramedic diagnosis of stroke increased from 61 per cent before the education intervention to 79 per cent during the active intervention phase. The time that paramedics spent on scene with patients and in transport from the scene to the hospital increased slightly between the two study periods ($p<0.01$). One of six hospitals significantly increased its rate of tPA use from 4.7 per cent to 17.3 per cent during the active intervention period ($p<0.05$). This study provides evidence that community and professional education can improve paramedic stroke diagnosis accuracy (Wojner-Alexandrov et al, 2005).

Crocco et al (2003) evaluated the impact of a case-based education approach to increase stroke knowledge among prehospital care providers in the United States. This 45-minute educational module was designed to be delivered in the context of a 2-day advanced cardiac life support (ACLS) course. Two case-based scenarios were presented to 206 EMS personnel in 12 EMS agencies in metropolitan areas. Scores on a 25-item test about stroke care were 32 per cent higher immediately following the session than those obtained before the session ($p<0.001$). When 74 EMS personnel were retested 6 months later, their scores were 18 per cent higher than those obtained before the intervention ($p<0.001$). These results were obtained whether the training was provided by a physician or an ACLS instructor (Crocco et al, 2003).

Behrens et al (2002) found that an educational programme for EMS professionals in Germany improved the quality of stroke care delivered based upon patient outcomes observed among a pre-intervention cohort of stroke patients (n=83) compared with the outcomes observed among those treated following the educational programme (n=113). During a period of 3 months, 345 EMS professionals (ie paramedics, dispatchers, emergency doctors and neurologists) each received at least 2 hours of training. Specific issues addressed by the training included:

- stroke signs and symptoms
- challenges in differentiating ischaemic from haemorrhagic lesions during the prehospital phase
- appropriate treatment or non-treatment of abnormal vital signs (for example, avoidance of rapid treatment of high blood pressure) in the field
- use of standardised protocols to obtain medical history information from friends and family
- logistics related to family transport to hospital
- advance notice to hospital about incoming stroke patient
- prioritisation of stroke patient care in emergency department (for example, immediate blood sampling) on par with that of myocardial infarction.

T-tests were used to compare patient outcomes during the period before the educational programme with those following the programme. The time between symptom onset and hospital arrival among patients with a final diagnosis of stroke or TIA decreased by 2 hours between the pre- and post-intervention periods (before: mean=5.22 hours; after: mean=3.28 hours; $p<0.05$). Whereas the time between emergency department arrival and completion of neurological examination was unchanged, the time between diagnosis and initiation of

therapy was significantly shorter in the post-intervention period than before the educational programme (before: mean=2.58 hours; after: mean=1.57 hours, p<0.001). These decreased delays resulted in a significantly higher percentage of patients receiving tPA treatment during the post-intervention period (1.8 per cent) than before the educational programme (10.5 per cent; p<0.01) (Behrens et al, 2002).

How should stroke care be delivered in the emergency department?

Summary of evidence

Establishing standard operating procedures in the emergency department that include a care pathway plan for assessing and implementing emergency stroke care can decrease the time between arrival at the emergency department and start of treatment.

Belvis et al (2005) conducted an observational study of 240 stroke patients presenting at an emergency department within 3 hours of symptom onset in Barcelona, Spain, during a 2-year period to evaluate the effectiveness of a prehospital stroke code system in reducing delays associated with stroke care. The stroke code, which was activated for 37 patients, included emergency transport service alerting the attending neurologist of the incoming stroke patients, so that he or she could prepare the patient's admission to the emergency department and coordinate the stroke team members immediately upon the patient's arrival. The proportion of patients treated with thrombolytic agents was higher among patients under the stroke protocol than among those in the comparison group (10 per cent versus 4.5 per cent; p<0.01). Further, the mean times elapsed between arrival at the emergency department and 1) request for a neurological assessment, 2) conduct of a neurological exam and 3) performance of a brain CT were significantly shorter among the treatment group compared with the control group: respectively 1) 4.4 minutes versus 194.7 minutes; p<0.001; 2) 12.6 minutes versus 225.3 minutes; p<0.01; and 3) 35.5 minutes versus 120.3 minutes; p<0.001 (Belvis et al, 2005).

Mehdiratta et al (2006) found that implementation of an acute stroke triage pathway in a Canadian hospital significantly reduced the times between emergency department presentation and CT and emergency department presentation and administration of thrombolytics (ie 'door-to-needle' time). All patients suspected of having a stroke were screened using a 3-item scale assessing facial droop, arm drift and speech. For those with any abnormal finding and onset of stroke within 6 hours, the following acute stroke orders were issued:

- emergency department physician assessment
- page stroke team
- call for head CT STAT
- ECG STAT
- blood tests STAT
- initiate intravenous (IV) access.

A comparison of 62 patients treated before initiation of the pathway and 40 patients treated after development of the care pathway showed that door-to-CT time was reduced by 11 minutes (p<0.05) and door-to-needle time was reduced by 18 minutes (p<0.01) (Mehdiratta et al, 2006).

What types of physicians should diagnose stroke in the emergency department?

Summary of evidence

In the event that a neurologist is not available in emergency situations, some evidence supports the ability of emergency services physicians to diagnose a stroke correctly.

Ferro et al (1998) conducted a validation study in Portugal to examine the accuracy of diagnoses made by GPs and hospital emergency service physicians. Compared with 'gold standard' diagnoses made by neurologists, stroke diagnosis by GP was accurate in 85 per cent of 52 stroke cases, and hospital emergency physicians correctly diagnosed 91 per cent of 186 stroke cases. Data were obtained from records of GPs' referrals to a stroke outpatient clinic and from case notes and neurology referrals made by emergency service physicians, (Ferro et al, 1998).

Another study conducted by Morgenstern et al (2004) examined the validity of stroke diagnoses made by emergency department physicians and found that these providers are skilled at recognising and diagnosing strokes. The investigators analysed stroke diagnoses of 2,059 stroke victims presenting to seven acute care hospitals in Nueces County, Texas, during a 30-month period. Compared with a board-certified neurologist using medical record review, emergency department physicians' diagnoses had a sensitivity of 91.5 per cent and a positive predictive value of 89 per cent. Overall, agreement was higher for diagnoses of haemorrhagic stroke than ischaemic stroke. Further, the odds that the emergency department physician would make a false-negative diagnosis were lower in the presence of motor or language deficits (Morgenstern et al, 2004).

Emerging technology – telemedicine

Summary of evidence

Some evidence supports the use of telemedicine to provide a safe, effective alternative model of acute stroke care in rural areas with limited access to neurologists or radiologists.

Some evidence suggests that even though emergency department physicians are able to diagnose a stroke correctly, consulting with experts for reading and interpreting radiologic studies before the delivery of tPA may be indicated. In areas with no practising neurologists, the use of telemedicine can provide access to neurologists and radiologists for patients suspected of having an ischaemic stroke. This health care delivery practice may actually provide more timely access to thromobolytics than helicopter transport.

Wu and Langhorne (2006) conducted a systematic review to examine the feasibility of using telemedicine consultations to improve the delivery of tPA. The authors reviewed findings from four main telemedicine networks operating in the United States, Germany, and France:

- Telemedic Pilot Project for Integrative Stroke Care (TEMPiS)
- Telemedicine in Stroke in Swabia (TESS)
- Telemedicine for the Brain Attack Team (TeleBAT)
- Remote Evaluation for Acute Ischemic Stroke (REACH).

The 17 studies reviewed showed that telemedicine systems for radiological assessment and clinical management of stroke patients were feasible to implement and acceptable to physicians. Specifically, consultations lasted 15 minutes on average, few technical problems were reported, clinician satisfaction with such systems was high, and use of telemedicine consultations increased over time. In addition, telemedicine yields reliable results, based on findings from five studies that found good or excellent agreement between clinical findings of remote and in-person evaluations. Further, use of tPA improved with the introduction of telemedicine strategies compared with use of thrombolytic therapy before telemedicine was adopted (Wu and Langhorne, 2006).[1]

Audebert et al (2006) examined the impact of telemedicine on the administration of tPA therapy for ischaemic stroke by analysing prospectively collected data on 6,616 patients admitted to one of two stroke centres or 12 regional medical clinics in Bavaria during 2004. The regional medical clinics participated in TEMPiS, which employed the following elements for telestroke care:

- Stroke teams provided care on specialised stroke wards in each hospital, with 24-hour access to laboratory examinations and CT scans. Treatment was conducted using standardised stroke protocols.
- All medical staff members had access to comprehensive continuing medical education about stroke care.
- A computerised telemedicine network was available to conduct high-speed data transmission of digital brain images and clinical examinations via video conference.
- Emergency interhospital transfers were centrally organised.

In addition, all participating facilities received a lysis box containing necessary tools and medications for the administration of tPA.

The percentage of patients treated at stroke centres who received tPA (5.8 per cent) was higher than the percentage of patients treated at satellite clinics (2.4 per cent). Time intervals between symptom onset and presentation at the hospital were significantly shorter at community hospitals compared with stroke centres (mean of 64 minutes versus 74 minutes; $p<0.01$). In contrast, the time between presentation at the hospital and the receipt of CT was significantly shorter for patients treated at stroke centres compared with patients at community hospitals (mean of 17 minutes versus 27 minutes; $p<0.01$, respectively). However, the time from CT to administration of tPA was significantly longer (average of 68 minutes) at community hospitals than at stroke centres (average of 61 minutes). This delay can probably be attributed to the extra time needed to conduct a telemedicine consultation. The rate of complications after tPA (ie death or haemorrhage) was similar among those treated in both settings, suggesting that telemedicine provides a safe and effective alternative model of acute stroke care in rural areas (Audebert et al, 2006). Similar results were obtained from several smaller observational studies of telemedicine (Schwamm et al, 2004; Waite et al, 2006; Choi et al, 2006; Wang et al, 2004).

Handschu et al (2003) examined inter-rater agreement in remote video examination using a multimedia system in Germany. For each of the 41 patients examined, two neurologists conducted the National Institutes of Health stroke scale (NIHSS) (German version) during the first hours after symptom onset. One conducted the examination remotely, using real-time video sequences and audio data delivered through a computerised telesupport system, and the other conducted the exam at bedside. Inter-rater agreement was good to excellent on all items; weighted κ coefficients ranged from 0.85 to 0.99 on the 13 items that comprise the NIHSS. Examinations were conducted efficiently. However, remote examination took

slightly longer than bedside evaluation (11.4 minutes versus 10.8 minutes; $p<0.05$). This study indicates that telemedicine is a feasible and reliable method to evaluate stroke patients. The authors suggest that technological improvements, such as determining the optimal camera position and improving image brightness and audio quality, are needed (Handschu et al, 2003).

Schwamm et al (2004) conducted a small retrospective observational study that provides additional evidence of the benefits of telemedicine for increasing access to thromobolytic therapy for stroke patients. The authors reviewed records of 106 stroke patients treated on an island off the United States during a 27-month period; 24 of these patients were treated using a TeleStroke intervention, which consisted of a 'virtual' stroke consultation for emergency physicians. The stroke radiologist who received information by video conference and the neurologist on-site at the hospital had very good agreement about the one patient who was not an appropriate recipient of tPA due to subtle subdural haematoma. Agreement regarding detection of early ischaemic changes ranged from very good to fair, whereas agreement about chronic ischaemic changes was good to very good.

Six of 106 patients with ischaemic stroke received tPA during the 27-month study period, compared with none of the 100 stroke patients treated during the 24 months before the telemedicine intervention when the emergency department had tPA and a written protocol ($p<0.05$). The telemedicine intervention prevented transfers for 11 patients. On average, the time between telemedicine consultation and tPA therapy was 36 minutes; the time between presentation at the emergency department and tPA therapy was 106 minutes. Further, emergency physicians, stroke neurologists and patients were highly satisfied with the telemedicine service. In particular, more than 95 per cent of physicians believed that the video conferencing provided more information than would have been transmitted by telephone (Schwamm et al, 2004).

Transient ischaemic attack: treatment and reduction of stroke risk

Transient ischemic attack (TIA)

'A brief episode of neurological dysfunction caused by a focal disturbance of brain or retinal ischaemia with clinical symptoms typically lasting less than 1 hour and without evidence of infarction' (Sacco et al, 2006).

A transient ischemic attack (TIA) is described as a 'warning event' or minor stroke that resolves quickly. Although the symptoms of a TIA typically disappear quickly, patients who experience a TIA are at considerable risk for a subsequent stroke. The estimated risk of stroke after TIA is 8 to 12 per cent at 7 days and 11 to 15 per cent at 1 month (Coull, Lovett and Rothwell, 2004). According to another data source from the United States, there is a 10.5 per cent chance of a stroke within 90 days of a TIA (Sacco et al, 2006). Guidelines issued by the Royal College of Physicians indicate that up to one in five people who experience a TIA have a stroke within 30 days (Intercollegiate Stroke Working Party, 2004).

In this section we discuss guidelines that address appropriate service delivery for patients experiencing a TIA.

Guidelines: transient ischemic attack

The US National Stroke Association sponsored the development of guidelines for the management of TIA based on expert review of previously published guidelines. A panel of 15 experts reviewed and rated the quality of recommendations from an evidence base of 257 guideline documents. Of these, 13 documents, including 137 recommendations, were used to develop a set of 53 consensus guidelines using a Delphi approach. This comprehensive set of evidence-based guidelines was published in 2006 (Johnston et al, 2006). The Royal College of Physicians, the American Heart Association, and the American Stroke Association have also published guidelines related to the treatment of TIA (Intercollegiate Stroke Working Party, 2004; Johnston et al, 2002; Sacco et al, 2006).

Because the risk of stroke is greatest during the week following a TIA, all guidelines reviewed recommend medical evaluation soon after a TIA to determine the cause and develop a care plan. Specifically, the Royal College of Physicians recommend that patients diagnosed with a TIA by a GP should be evaluated in a specialist stroke service (ie a neurovascular clinic) within 7 days of the event and that treatment for risk factors (for example, hypertension) should be initiated (Intercollegiate Stroke Working Party, 2004). The American Heart Association recommends 'prompt' evaluation following a TIA, and the National Stroke Association in the United States suggests that patients are evaluated within hours of TIA symptom onset (Johnston et al, 2002). Medical evaluation may include laboratory testing based on patient history, brain imaging, carotid imaging and electrocardiogram (Johnston et al, 2006).

Treatment following TIA should focus on managing risk factors for future TIAs or stroke. Antiplatelet therapy (for example, aspirin) is recommended following most TIA events to decrease the risk of future blood clots that could lead to additional TIAs or strokes (Sacco et al, 2006; Johnston et al, 2006; Intercollegiate Stroke Working Party, 2004) Similarly, risk factor management should include interventions that address cardiovascular risk, lipid levels and hypertension. Smokers should be encouraged to stop smoking and heavy drinking should be discouraged. Lifestyle changes related to maintaining a healthy weight, including physical activity, are recommended for those who experience TIA. Among people with diabetes who have a TIA, a fasting blood glucose level of less than 126 mg/dl is recommended (Johnston et al, 2006; Sacco et al, 2006).

Hospitalisation is recommended for patients who experience multiple TIAs during a 7-day period (Intercollegiate Stroke Working Party, 2004). Hospitalisation is also advised if symptoms persist for longer than 1 hour in the event of crescendo TIAs, or in the presence of a symptomatic internal carotid stenosis greater than 50 per cent. The National Stroke Association recommends that hospitals and physicians have a consensus-based protocol that includes the conditions under which patients with TIA are to be referred or admitted to the hospital (Johnston et al, 2006).

Current practice in the United Kingdom

According to the National Sentinel Stroke Audit (2007), neurovascular services for TIA are improving in the United Kingdom. The percentage of health care trusts with a neurovascular clinic has increased from 65 per cent in 2004 to 78 per cent in 2006. The median waiting time for a clinic appointment in 2006 was 12 days, down from 14 days in 2004. In 2006, 35 per cent of patients who experienced a TIA were able to be seen at a neurovascular clinic within 7 days as recommended by the Royal College of Physicians (Hoffman et al, 2006). In Scotland, 19 per cent of patients with a definite cerebrovascular diagnosis seen in the outpatient setting were seen within 7 days of receipt of referral to a neurovascular

clinic, and this figure increases to 43 per cent for those seen within 14 days of referral to a neurovascular clinic (Dennis, 2006). Based on these statistics, health care delivery for TIA in the United Kingdom is improving; but opportunities for improvement that will help ensure that all patients can receive appropriate care to decrease their risk of stroke after a TIA remain.

Evidence

Summary of evidence

The risk of stroke following a TIA is high. For prevention to be effective, the public should be educated to seek medical attention urgently and service delivery needs to be organised to provide immediate care. However, there is insufficient evidence to identify the most effective strategy to achieve these goals.

Coull, Lovett and Rothwell (2004) report on the findings of the Oxford Vascular Study, a population-based study of the incidence and prognosis of TIA and stroke. The study covers 63 GPs in nine family health centres in Oxfordshire, England, which include a patient population of 90,542. Their findings showed a high risk of stoke after a first ever TIA. More important, the British guidelines recommend that patients with TIA should be seen in clinics within 2 weeks of the episode. However, their data show that a substantial number of patients will have a stroke before being seen in such clinics if they wait 2 weeks to be seen. For stroke prevention to be effective, they conclude that patients will need to be seen within the first few hours or days. For stroke prevention to be effective, the public would need to be made aware of the need to seek immediate attention and the care delivery would need to be organised so that patients with TIA are seen immediately, (Coull, Lovett and Rothwell, 2004).

Acute care

Background

Acute care for stroke patients focuses on interventions for symptoms, supporting basic functions while the stroke is resolving (for example, breathing or nutrition), and initiating therapeutic activities that support rehabilitation. Because a stroke can affect physiologic function, physical function, cognition and communication, patients require assessment and intervention from a variety of clinical specialties, including physicians, nurses and therapists. Evidence reviewed for delivering acute care to stroke patients focused on type of facility and personnel.

Guidelines: acute care

Guidelines for the delivery of acute care for stroke have been published by a variety of organisations in the United Kingdom, the United States and Europe. Many of these guidance documents draw from a common body of research evidence anchored by reviews published by the Cochrane Collaboration; the recommendations issued by the various organisations are therefore quite similar. For example, there is broad consensus that initial care and treatment for stroke should be delivered in a hospital setting on a stroke unit (Intercollegiate Stroke Working Party, 2004; Scottish Intercollegiate Guidelines Network, 2002; European Stroke Initiative Executive Committee and the EUSI Writing Committee, 2000; Schwamm et al, 2005). We summarise below guidelines issued by the following organisations:

- Royal College of Physicians (Intercollegiate Stroke Working Party, 2004)
- Scottish Intercollegiate Guidelines Network (Scottish Intercollegiate Guidelines Network, 2002)
- American Stroke Association (Schwamm et al, 2005)
- The Brain Attack Coalition (Alberts et al, 2000)
- The European Stroke Initiative (European Stroke Initiative Executive Committee and the EUSI Writing Committee, 2000)
- World Health Organization (Kjellstrom, Norrving and Shatchkute, 2006).

As indicated in a previous section, the American Stroke Association issued recommendations for the establishment of stroke systems of care that provide guidance on overarching issues of delivering acute stroke care. In particular, these guidelines suggest that a directory of the acute stroke resources should be available at each hospital in the area and that it should be available to EMS, primary care providers and the public. Further, hospitals that do not operate as stroke centres should have protocols in place for transporting stroke patients to appropriate collaborating facilities via ambulance or air transport, as appropriate (Schwamm et al, 2005). Similarly, the Helsingborg Declaration recommends the establishment of national or international certification of stroke units to ensure that care meets evidence-based and published consensus-based care standards (Kjellstrom, Norrving and Shatchkute, 2006).

The Brain Attack Coalition (BAC) guidelines published in 2000 provide detailed specifications for primary stroke centres, which were based upon established models of care for trauma (Alberts et al, 2000). Many of the provisions in these guidelines have been adopted by other organisations such as the American Stroke Association (Schwamm et al, 2005). In addition, the Joint Commission for the Accreditation of Healthcare Organizations in the United States used these guidelines as the foundation for its programme of certification for primary stroke centres. We describe the BAC guidelines for primary stroke centres below along with citations of other guidance documents that support these recommendations. Stroke centres should operate with the commitment and support of the host medical organisation. Specifically, the stroke centre should be run by a medical director and be staffed with physicians experienced in treating cerebrovascular disease (Alberts et al, 2005).

Guidelines support 24-hour availability of acute stroke care, which includes the following health professionals with an interest in stroke care:

- consultant physicians in stroke medicine
- nurses
- physiotherapists
- occupational therapists
- speech and language therapists
- neuroradiologists
- dietitians
- clinical psychologists
- pharmacists
- social workers

To be most effective, stroke teams should meet weekly to discuss patient progress (Alberts et al, 2000; Kjellstrom, Norrving and Shatchkute, 2006; Intercollegiate Stroke Working Party, 2004; European Stroke Initiative Executive Committee and the EUSI Writing Committee, 2000).

Written care protocols should guide the provision of stroke care, and these should include specifications for the emergency care of stroke patients, such as stabilisation of vital functions, diagnostic tests and use of medications. These protocols should be reviewed and updated on an annual basis (Alberts et al, 2000). The American Stroke Association and Royal College of Physician guidelines also endorse the use of clinical pathways to organise stroke care and ensure that standards of care are followed to optimise clinical outcomes (Schwamm et al, 2005; Intercollegiate Stroke Working Party, 2004). In particular, the emergency department should use written protocols to deliver stroke care (Alberts et al, 2000). The stroke centre should include a stroke unit that provides care following the hyperacute period of illness. (See Box for key elements of stroke unit services.)

Key elements of stroke unit services

- Staff experienced in treating stroke patients
- Dedicated beds for stroke patients
- 24-hour access to neuroimaging services with a physician available to interpret findings. The Helsingborg Declaration suggests that telemedicine technology should be used to access radiologist services, when a specialist is not available on site (Kjellstrom, Norrving and Shatchkute, 2006)
- 24-hour access to laboratory services to obtain complete blood cell counts, blood chemistry and coagulation studies
- 24-hour access to operating rooms and neurosurgical services
- Use of registry for tracking stroke care and evaluating patient outcomes to inform quality improvement (Alberts et al, 2005). Facilities providing thrombolytic treatment should register with the UK Safe Implementation of Thrombolysis in Stroke Monitoring Study (SITS-MOST) programme
- Continuing education for patients, families and caregivers, as well as for health care professionals. Patient education should be tailored to target the individual needs of each individual and include information on relevant local and national services to provide support as needed. Stroke centres should offer at least 8 hours of continuing medical education related to stroke annually (Kjellstrom, Norrving and Shatchkute, 2006; Alberts et al, 2005; Intercollegiate Stroke Working Party, 2004).

In 2005, the BAC created a set of guidelines for comprehensive stroke centres which expand upon those described for primary stroke centres. Table 7 summarises the components of primary and comprehensive stroke centres. The staff of a comprehensive stroke centre include representation from a broader number of medical specialities, such as respiratory therapy, vascular surgery and vascular neurosurgery. Compared with a primary stroke centre, a comprehensive centre offers a broader range of diagnostic techniques, surgical therapies, and educational and research programmes.

mponents12–13

Table 7: Primary stroke centre versus comprehensive stroke centre: key components	
Primary stroke centre	Comprehensive stroke centre
1. Acute stroke teams – multidisciplinary membership, including physician and nurse with stroke expertise (at a minimum) responding within 15 minutes of patient arrival. Additional members per resources available. 2. Written care protocols – tissue plasminogen activator (tPA) protocols, diagnostic work up, treatment preferences, including stabilisation of vital functions and use of medications that are evidence-based. 3. Emergency medical services (EMS) –rapid identification of patient and communication/transport of the patient to a centre capable of dealing with stroke. 4. Emergency department – personnel trained in diagnosing/treating stroke. Protocols for triage and treatment of stroke patients. Participate in educational opportunities twice a year. Written documentation. 5. Stroke unit – staffed/directed by personnel with education in stroke. Infrastructure including continuous cardiac monitoring, written care protocols, continuous monitoring of blood pressure. Documentation of staffing, admission/discharge criteria, care protocols and outcome data. 6. Commitment and support of medical organisation – administrative support evidenced by statement of support from administration, listing of stroke centre in infrastructure of hospital and budget, medical director of stroke centre, physician staffing (trained/ expertise in treating patients with cerebrovascular disease).	1. Personnel: a) Physicians with expertise in vascular neurology, vascular neurosurgery, vascular surgery, diagnostic radiology/ neuroradiology, interventional/ endovascular, critical care medicine, physical medicine/ rehabilitation. b) Multidisciplinary members: advance practice nurse, rehabilitation therapy (physical therapy, occupational therapy and speech therapy), staff stroke nurses, respiratory therapy and swallowing assessment. c) Optional: neuro-intensive care and nursing director 2. Diagnostic techniques: a) MRI with diffusion, MRA, CTA, digital cerebral angiography, transcranial Dopplers, carotid duplex ultrasound, transesophogeal echocardiogram. b) Option: MR perfusion, CT perfusion, Xenon CT, SPECT, PET scans 3. Surgical/interventional therapies: a) Carotid endarterectomy, clipping of intracranial aneurysm, placement of ventriculostomy and ICP monitoring, haematoma removal, endovascular ablation of aneurysms or arteriovenous malformations; intra-arterial thrombolysis, endovascular treatment of vasospasm. b) Option: stenting/angioplasty of extracranial/intracranial vessels.

Table 7 (continued): Primary stroke centre versus comprehensive stroke centre: key components	
Primary stroke centre	Comprehensive stroke centre
7. Neuroimaging – brain imaging studies within 25 minutes of patient arrival/24 hours a day. Interpretation of studies by radiologists within 45 minutes of patient arrival. 8. Laboratory services – services available 24 hours a day with results within 45 minutes. 9. Outcomes and quality improvement – database or registry for tracking patients, types of treatment and outcomes; comparison to benchmarks (ie use of tPA). 10. Educational programmes – a) community: provide 2 educational programmes/ year; b) continuing medical education: at least 8 hours/ year of CME credit for nurses/ physicians caring for stroke patients.	4. Infrastructure: a) Stroke unit, intensive care unit, operating room staffed 24 hours a day, interventional radiologist/ team 24 hours a day, and stroke registry. b) Option: stroke clinic, air ambulance, neuroscience ICU. 5. Educational/research programme: a) Community education and prevention programmes, professional education and patient education. b) Option: clinical and laboratory research, fellowship programme and presentations at national meetings.

Source: Bader and Palmer, 2006

Current practice in England, Wales and Northern Ireland

The National Stroke Audit (2007) conducted in 2006 provides an overview of acute stroke services in England, Wales and Northern Ireland. According to the audit, most hospitals have brain and vascular imaging capabilities. However, access to these services outside typical business hours remains limited. Ninety-five per cent of stroke units have four of the following five features required of stroke units:

- consultant physician with responsibility for stroke
- formal links with patient and caregiver organisations
- weekly multidisciplinary meetings to plan patient care
- patient education about stroke
- continuing education programmes about stroke care for health care professionals.

Despite the increase in the number of stroke beds in the United Kingdom since 2004, the number of hospital beds designated for stroke care remains insufficient as of 2006. On the day of the audit, 6,720 patients were in hospital for stroke and the census revealed only 5,523 stroke beds in the country. Overall, there are 0.82 beds per stroke patient. The audit also found that almost half of stroke units exclude patients based on outdated care standards – further evidence that stroke units do not have sufficient beds to meet the needs of the population (Hoffman et al, 2006).

Overall, staffing levels of stroke care specialists are limited. While 97 per cent of hospitals have a consultant physician responsible for stroke services, the current number of stroke care specialists can provide only about a quarter of the hours of care recommended by the British Association of Stroke Physicians. Hospitals continue to have a low number of positions for consultant stroke nurses, and more than 25 per cent of hospitals have no senior stroke nurse specialist. Further, more than 25 per cent of stroke teams do not have a social worker. In addition, psychological services for stroke and resources for orthotics and foot health are scarce (Hoffman et al, 2006).

All stroke units hold team meetings at least once a week, most of which include representation from a variety of specialties within medicine. Use of standardised measures of disability and impairment following stroke has increased since 2002. For example, in 2006, 90 per cent of stroke patients were evaluated using standardised measures; in 2002, the figure was 59 per cent.

Approximately 90 per cent of stroke units provide educational programmes to their staff compared with less than 75 per cent in 2002. However, additional training schemes are needed for general medical staff because a large number of stroke patients are cared for outside stroke units.

Overall, improvements have been made to provide information to stroke patients. For example, 68 per cent of stroke units are associated with a community user group, compared with only 59 per cent of units in 2004. However, many hospitals still do not have a formal link with a community-based support group (Hoffman et al, 2006).

Evidence

Where should acute stroke care be delivered?

Summary of evidence

Evidence supports a stroke care delivery model that includes coordinated stroke care, provided this approach includes multidisciplinary care teams.

Langhorne et al (2000) conducted a systematic literature review published by the Cochrane Collaboration to evaluate the costs and outcomes associated with services for helping acute stroke patients avoid hospital admission. Conducted in the United Kingdom, the four studies reviewed included three interventions that aimed to prevent inpatient admission and one intervention focused on providing support for early discharge of stroke patients from the hospital. The authors constructed odds ratios and weighted mean differences to pool study results. No significant differences were observed in any of the outcomes measured (ie death, death or institutionalisation, death or dependency, extended activities of daily living, mood status, patient satisfaction, or caregiver stress). Insufficient data were available to evaluate costs associated with the interventions evaluated. Consequently, the authors conclude that the evidence does not support shifting the site of care for the acute care of stroke from the hospital setting to the home (Langhorne et al, 2000).

The Stroke Unit Trialists' Collaboration (2002) conducted a widely cited systematic literature review that provides evidence that stroke care provided in stroke units results in significantly better patient outcomes compared to alternative forms of care, such as care delivered in a general medical ward. Published by the Cochrane Collaboration, the review includes 23

randomised and quasi-randomised studies conducted in a variety of locations (ie United Kingdom (7), Sweden (4), Finland (3), United States (3), Norway (2), Scotland, Australia (1), Canada (1), Denmark (1), Greece (1), and South Africa (1)). Studies ranged in size from 52 to 550 and included a total of 4,911 patients. The authors classified the various types of organised inpatient care into the following categories:

- stroke ward – a discrete ward where care is delivered exclusively to stroke patients by a multidisciplinary team. (Stroke wards include: acute stroke units where patients typically spend a week or less; rehabilitation stroke units, which focus on rehabilitative therapy and typically accept patients at least 7 days after stroke; and comprehensive stroke units, which provide both acute and rehabilitative care.)
- mixed rehabilitation ward – a general rehabilitation ward where patients receive care from a multidisciplinary team
- mobile stroke team – a multidisciplinary team providing stroke care in a variety of settings
- general medical ward (GMW) – an acute medical ward where patients receive care without routine multidisciplinary input.

Compared to patients treated in alternative settings, patients who received organised stroke unit care had a significantly lower risk of the following at 1-year follow-up: 1) death (OR=0.82; $p<0.01$); 2) death or institutionalisation (OR=0.80; $p<0.001$); and 3) death or dependency (OR=0.78; $p<0.001$). Analysis of effects on length of stay were complicated by differing ways of calculating length of stay. A random effects model showed a slight reduction in length of stay among patients treated in a stroke unit compared to alternative settings (standardised mean difference=-0.17; $p<0.05$). Additional analysis stratified by age, gender and stroke severity showed that these factors did not affect patient outcomes observed. Compared to care in a general ward, care in comprehensive units, rehabilitation units and mixed assessment/rehab units all had better outcomes. In addition, one study found that care in a dedicated stroke unit resulted in significantly lower mortality rates and lower risk of death or institutionalisation among patients treated in a comprehensive stroke unit compared with those treated by a mobile stroke team ($p<0.001$) (Stroke Unit Trialists' Collaborative, 2002).

Lattimore et al (2003) found that establishment of a primary stroke centre at a community hospital in Bethesda, Maryland in the United States significantly increased the use of thrombolytic therapy for stroke patients ($p<0.0001$). A community hospital introduced the following services to fulfil the requirements of a primary stroke centre:

- The hospital established an acute stroke team that was available 24 hours a day and was paged to evaluate any patient presenting with stroke symptoms less than 6 hours in duration for eligibility for thrombolytic treatment.
- The stroke team initiated a broad community-based education campaign consisting of lectures and stroke risk assessment screenings conducted at the hospital and local community centres.
- The stroke team and emergency department staff received continuous feedback about their performance, such as time intervals and barriers to treatment.

During the first 2 years of implementation of the stroke centre, 10.5 per cent of stroke patients received tPA, compared with only 1.5 per cent who received this intervention during the 12 months before the establishment ($p<0.0001$) (Lattimore et al, 2003).

Phillips, Eskes and Gubitz (2002) examined stroke patient outcomes during the 3 years before the establishment of an acute stroke unit at a hospital in Nova Scotia (n=1,324) and during the first 3 years of operations of the unit (n=1,324). Patients treated on the stroke unit had a significantly shorter length of stay ($p<0.001$) and lower rate of deep vein thrombosis ($p<0.05$). Further, a non-significant trend of lower odds of mortality or needing long term institutional care after 10-day follow-up was observed among those treated on the stroke unit compared to those who received care before the stroke unit was operational (Phillips, Eskes and Gubitz, 2002).

Camilo and Goldstein (2005) conducted a survey of hospitals in North Carolina that showed that the availability of a stroke centre was associated with stroke-related mortality. Stroke centres were classified into the following categories:

- basic stroke centre – emergency department, rt-PA treatment protocol, brain CT, transthoracic echocardiography, carotid ultrasonagraphy, cerebral angiography, and performing carotid endarterectomy
- advanced stroke centre – all basic services + brain MRI, transesophageal echocardiography, transcranial Doppler ultrasonography, interventional radiologist
- primary stroke centre components (based on BAC recommendations) – emergency department, immediate availability of certain blood studies, blood glucose, immediate availability of a brain scan, prothrombin time/activated thromboplastin time, stroke quality improvement programme, stroke care map, tPA treatment protocol, prewritten stroke care orders.

Of the 128 hospitals in the state, 21 per cent had a basic stroke centre, 12 per cent supported an advanced stroke centre, and 14 per cent had a BAC-type stroke centre. Counties with a stroke centre of any kind had significantly lower stroke mortality rates than those with no stroke centre ($p<0.001$) (Camilo and Goldstein, 2005). Although the methodology is somewhat weak, this study does suggest that the presence of organised stroke care can be beneficial.

How should acute care be organised?

Summary of evidence

There is a lack of good evidence to support the use of in hospital care pathways for the treatment of acute stroke.

A Cochrane systematic literature review conducted by Kwan and Sandercock (2004) yielded insufficient evidence to support the use of in-hospital care pathways for acute stroke care. The authors used random effects models to examine outcomes from three randomised and 12 non-randomised studies of 4,421 patients conducted in the United States (10), the United Kingdom (2), Australia (1), Singapore (1) and Sweden (1). To be included in the review, study interventions had to meet the following criteria:

- have at least two of the following features: assessment, investigation, diagnosis, or treatment
- involve a multidisciplinary staff representing at least two types of medical care (for example, medical, nursing, physiotherapy, occupational therapy, speech and language therapy, dietitian).

Care pathways had both positive and negative effects upon patient outcomes compared with usual care provided to comparison groups. Specifically, patients receiving care organised by a care pathway had significantly fewer urinary tract infections ($p<0.05$), significantly fewer readmissions or emergency department visits ($p<0.001$), were significantly more likely to receive a first or second CT brain scan ($p<0.05$), and were significantly more likely to receive a brain scan within 24 hours ($p<0.01$). In contrast, the care pathway intervention was associated with significantly greater dependence at discharge ($p<0.05$) and lower patient satisfaction ($p<0.01$). There were no statistically significant intervention effects related to mortality or discharge destination.

The authors concluded that available evidence is insufficient to support recommendations for the use of care pathways for inpatient care of acute stroke due to the mixed results of the studies reviewed and the quality of evidence available. The care provided to members of control and comparison groups was poorly defined for many of the studies reviewed. Care pathway interventions varied across studies. In addition, since care pathways are multicomponent interventions, it is difficult to discern which components of care pathways had an effect upon outcomes observed (Kwan and Sandercock, 2004).

Alternatives to hospitalisation for select acute care patients

Summary of evidence

Treatment at home with supportive services for acute stroke is an option for some elderly patients.

Shepperd and Iliffe (2005) prepared a Cochrane Collaboration systematic review to assess the effects of hospital at home compared with inpatient hospital care. The review examined studies of several conditions, including five randomised controlled trials recruiting patients recovering from stroke in Europe (the United Kingdom, Sweden, Norway and Italy), which ranged in size from 40 to 331 subjects. The authors define hospital at home as a 'service that provides active treatment by a health care professional in the patient's home for a condition that otherwise would require acute hospital inpatient care' (Shepperd and Iliffe, 2005). The five studies of patients with stroke actually examined the impact of early supported discharge (ESD) from the hospital, rather than home hospitalisation in lieu of an inpatient admission. Various patient outcomes were examined, including mortality, hospital readmission, patient satisfaction with care, and patient-reported functional status, psychological wellbeing and quality of life.

Results from the meta-analysis using odds ratios created using Peto fixed effects and weighted mean differences indicated no significant difference in mortality or readmission rates between patients receiving inpatient care or hospital at home care (OR 0.78; 95% CI 0.52 to 1.19; OR 0.96; 95% CI 0.63 to 1.45). However, patients allocated to hospital at home reported significantly higher levels of satisfaction. In addition, three studies reported no differences in the self-reported outcomes of functional status, psychological wellbeing and quality of life, whereas one study reported significantly higher functioning among patients hospitalised at home compared with those in the control group at 6 months (Rankin scale: difference 17.7%; $p<0.05$; Barthel index: difference 13.5%; $p<0.05$). The fifth study showed worse outcomes related to psychological wellbeing, communication and emotional behaviour compared to the control group at 3 months. However, these differences were not present at 6-month follow-up (Shepperd and Iliffe, 2005).

Ricauda et al (2004) conducted a randomised controlled, single-blind trial of 120 patients admitted to the emergency department with acute ischaemic stroke to evaluate whether

home hospitalisation of elderly patients with ischaemic stroke is associated with different mortality rates and clinical outcomes than those of patients treated on a GMW in Italy. The main outcome of interest was cumulative survival at 6 months, and secondary outcomes included residual functional impairment, neurological deficit, depressive symptoms and admission to rehabilitation and long term care facilities. Functional outcomes were measured using the functional independence measures (FIM™) instrument and the activities of daily living (ADL) scale while mental status was measured using the Canadian neurological scale and the NIH stroke scale. The geriatric depression scale was used to evaluate depression. Home rehabilitation consisted of one visit by a physician, nurse or physical therapist each day and stressed guided, supervised and self-directed activities.

Results indicate that patients managed at home had a significantly longer mean length of treatment than patients in a GMW (38.1 versus 22.2 days; $p<0.001$). However, there was no statistically significant difference in 6-month mortality rates or FIMs between the two groups. Depression scores were significantly better in home-treated patients than in-hospital treated patients ($p<0.001$). In addition, at-home patients were less likely to be admitted to rehabilitation or nursing facilities than patients in the GMW ($p<0.001$). The authors conclude that home-treated elderly patients with ischemic stroke have better depression scores and lower rates of admission to nursing homes (Ricauda et al, 2004).

Post-acute care

The goals of post-acute care for stroke patients are 1) to prevent additional strokes from occurring and 2) to enable the patient to reach his or her optimal physical, cognitive and social functional level. A large proportion of stroke patients experience an impairment of some kind following stroke. Those with severe stroke may not recover as fully as those less severely affected; however, rehabilitation can still be of significant value. There are a number of settings in which a patient can receive rehabilitative services, including inpatient rehabilitation units and in the community. Below we examine the evidence for service delivery of post-acute care for stroke patients.

The duration of the post-acute period for stroke patients can last more than several months, with family and caregivers providing a great deal of support for the stroke patient. A review of 27 UK-based studies found that stroke patients and their caregivers experience chronic problems following stroke that can last more than 1 year following stroke. The review, which included survey results from more than 6,000 patients and 3,000 caregivers, determined that stroke patients face the following long term challenges: anxiety, depression, sexual dysfunction and social isolation. Caregivers reported long term anxiety, limitations on their social life and the stroke's negative impact upon sex life. Patients and caregivers experienced long term strain on their relationship. In addition, patients and carers reported dissatisfaction with rehabilitation services and social services delivered both immediately following hospital discharge and in the months and years following (Murray et al, 2003).

Guidelines: post-acute care

The US Veterans Affairs and Department of Defense (VA/DOD) developed a clinical practice guideline that specifically addresses stroke rehabilitation and was endorsed by the American Heart Association and American Stroke Association. The purpose of the guideline is to help facilities, particularly those without rehabilitation bed units, provide evidence-based rehabilitation services that maximise patient functionality, independence and quality of life. Further, the guidelines are intended to support clinicians in decisions regarding the timing of rehabilitation care, decrease readmissions, and optimise healthcare utilisation.

While not prescribing specific standards and protocols, this set of comprehensive guidelines provides algorithms for three different aspects of rehabilitation service delivery: assessment, inpatient rehabilitation, and community-based rehabilitation. Since every stroke patient has a unique set of physical and emotional issues and support, rehabilitation services need to be targeted specifically to the needs of each patient. Overall, the primary goals of rehabilitation are to prevent complications, minimise impairments and maximise patient functioning (Duncan et al, 2005).

In addition to the rehabilitation guidelines created by the VA/DOD, many of the guidelines about stroke care in general contain recommendations about post-acute care, including statements issued by the following organisations:

- Royal College of Physicians
- American Stroke Association
- European Stroke Initiative
- Helsingborg Declaration on European Stroke Strategies, and
- Scottish Intercollegiate Guidelines Network.

First, we summarise overarching recommendations regarding the organisation of post-acute stroke care, and we follow that with a description of recommendations for specific elements of stroke rehabilitation.

During the initial hospitalisation, it is important to conduct a standardised screening of neurological deficits, functional status, cognitive and psychological status, previous functional status and medical comorbidities, level of family/caregiver support, and ability to participate in rehabilitation services (Schwamm et al, 2005; Brainin et al, 2004; Kjellstrom, Norrving and Shatchkute, 2006). Further, assessment should be performed using valid tools that all rehabilitation team members have been trained to use, such as the National Institutes of Health stroke scale (Intercollegiate Stroke Working Party, 2004; Duncan et al, 2005; Rodin, Saliba and Brummel-Smith, 2006).

Rehabilitation services should be provided in a setting that meets the specific needs of each patient (ie inpatient, outpatient, or home care) and the care should be tailored to the resources and challenges faced by each patient and his or her caregivers (Schwamm et al, 2005; Duncan et al, 2005; Rodin, Saliba and Brummel-Smith, 2006). For example, patients should receive inpatient rehabilitation services if they need skilled nursing services, regular physician visits and multiple therapeutic interventions (Rodin Saliba and Brummel-Smith, 2006; Duncan et al, 2005). The European Stroke Initiative and the Scottish Intercollegiate Guidelines Network recommend that rehabilitation be provided in a stroke rehabilitation unit if possible (Brainin et al, 2004; Scottish Intercollegiate Guidelines Network, 2002).

For patients obtaining post-acute care in an outpatient setting, there should be close coordination between hospital-based and community-based providers so that patients have sufficient support in the community. Specifically, early supported discharge services provided by a coordinated specialist multidisciplinary team provide a sufficient alternative to a longer stay in a hospital stroke unit (Scottish Intercollegiate Guidelines Network, 2002; Kjellstrom, Norrving and Shatchkute, 2006; Duncan et al, 2005; Rodin Saliba and Brummel-Smith, 2006; Schwamm et al, 2005).

Rehabilitation should begin as soon as the patient is medically stable (Duncan et al, 2005; Rodin, Saliba and Brummel-Smith, 2006; Brainin et al, 2004). In particular, patients should be mobilised as soon as possible after stroke (Kjellstrom, Norrving and Shatchkute, 2006; Scottish Intercollegiate Guidelines Network, 2002). During the first year following stroke, patients living at home should receive therapy-based rehabilitation services as needed (Scottish Intercollegiate Guidelines Network, 2002). Long term support should be provided for patients with chronic symptomatic stroke, including care from a family physician, outpatient rehabilitation services, secondary prevention, and support in psychosocial functioning (Brainin et al, 2004).

Most of the guidelines reviewed recommend that stroke rehabilitation services should be delivered by a multidisciplinary team of professionals trained and experienced in stroke medicine, such as physicians, nurses, physiotherapists, occupational therapists, speech therapists and social workers (Duncan et al, 2005; Rodin Saliba and Brummel-Smith, 2006; Kjellstrom, Norrving and Shatchkute, 2006; Scottish Intercollegiate Guidelines Network, 2002). Rehabilitation providers should work with patients – and their caregivers, if appropriate – to set meaningful, challenging and feasible goals for rehabilitation (Kjellstrom, Norrving and Shatchkute, 2006; Intercollegiate Stroke Working Party, 2004). In addition, providers should educate the patient and family about treatment options so that they are empowered to help determine the best environment and delivery of rehabilitation treatment (Duncan et al, 2005; Rodin Saliba and Brummel-Smith, 2006; Kjellstrom, Norrving and Shatchkute, 2006). Since there is weak evidence of a dose-response relationship between the amount of rehabilitation provided and patient outcomes, Duncan et al recommend providing high-intensity therapy to stroke patients (Duncan et al, 2005; Rodin Saliba and Brummel-Smith, 2006).

Current practice in England, Wales and Northern Ireland

The National Stroke Audit provides an overview of current practice related to ESD in England, Wales and Northern Ireland. The audit shows opportunities for growth in the practice of ESD: only 22 per cent of trusts have organised care for early supported discharge, and only 32 per cent of hospitals have a specialist community stroke team. The audit concluded that there is an ongoing need to monitor the composition of multidisciplinary stroke teams and the quality of care delivered since the specialties of medicine represented on each team are variable. For example, almost all of these teams have physiotherapist and an occupational therapist; however, fewer than half of ESD teams (36 to 44 per cent) have a social worker or dietitian (Hoffman et al, 2006).

In a review of stroke services, the UK National Audit Office drew on the Royal College of Physicians' Sentinel Stroke Audit (National Sentinal Stroke Audit, 2007) and conducted additional investigations to evaluate the current status of stroke care, identifying several areas for improvement in the area of post-acute care delivery. The Sentinel Stroke Audit found that approximately two thirds of patients discussed their prognosis and therapy goals with hospital personnel. Follow-up care plans were discussed with 80 per cent of patients. However, 52 per cent of patients did not receive a name and contact information to reach

someone for help following discharge from the hospital. Before discharge, 30 per cent of patients did not receive a home visit from a health care professional to provide guidance on adapting to the home environment following stroke. A survey of hospitals regarding their perception of patient satisfaction with rehabilitation services showed that half of stroke patients felt that their rehabilitation needs were not met during the first 6 months following discharge. Further, this proportion dropped to 75 per cent of patients during the 6 to 12 months following hospitalisation (National Audit Office, 2005).

Additional coordination with community GPs is beneficial, so that they can effectively support patients with long term care needs resulting from stroke. Only one third of GPs reported receiving information about secondary prevention plans for stroke patients in response to a 2004 survey (National Audit Office, 2005).

Support for caregivers of stroke survivors is another area with opportunities for improvement. In a 2001 survey, 59 per cent of patients with caregivers reported that their caregivers received no support. In addition, caregivers reported having problems with getting advice on benefits (40 per cent), support from social services (49 per cent) and support from local health services (52 per cent) (National Audit Office, 2005).

Evidence

Early supported discharge (ESD) services

Summary of evidence

Evidence supports selective use of early supported discharge as an effective alternative to longer inpatient stays.

Early supported discharge is care that is typically provided by a multidisciplinary team and begins during the inpatient stay. The aim is to help stroke patients prepare for discharge home by coordinating community-based, post-acute health care services. In this way, ESD allows for patients to be discharged earlier than they would otherwise be. The evidence presented below examines this option for patients hospitalised for a stroke.

The Early Stroke Supported Discharge Trialists (2005) published a systematic Cochrane Collaboration review of 11 RCTs examining the effectiveness of ESD services intended to reduce the duration of hospital care for acute stroke patients. Overall, the results of this meta-analysis show that ESD services can be used effectively to decrease length of hospitalisation without compromising patient outcomes. The review shows that ESD is associated with increased satisfaction with services and statistically significant decreases in the risks of death or institutionalisation, death or disability, and in health care costs.

Conducted in Australia, Canada, Norway, Sweden, Thailand, the United Kingdom and the United States, the studies ranged in size from 23 to 331 participants. The authors classified the interventions tested in each study into the following three categories:

- multidisciplinary ESD team that coordinates and delivers community-based care
- multidisciplinary ESD team that coordinates post-discharge care among unaffiliated community-based services
- community-based care provided by a variety community-based services that are not coordinated.

Typically, the ESD intervention started during the inpatient stay, and one of the ESD team members worked with the patient and caregiver (for example, family member, home health personnel) to create a discharge plan, which sometimes included a predischarge home visit. Members of the ESD team provided input to the patient on their care on 4 to 7 days a week, depending on the study and the patient, usually for up to 3 months. In addition, ESD teams often provided patients with a medical record and a discharge summary at the end of service. Members of each control group had access to a variety of discharge planning services, and a small subgroup had access to follow-up arrangements for post-acute care.

On average, across all trials, length of inpatient stay was decreased by 8 days ($p<0.001$) based on an analysis of weighted mean differences. Although mortality did not differ significantly between intervention and control groups, those participating in ESD programmes were significantly less likely to have the combined outcome of death or institutionalisation (OR=0.74; p=0.02) and significantly less likely to incur the combined outcome of death or becoming dependent as measured by the Barthel index or Rankin score (OR=0.79; p=0.02). In addition, patients receiving ESD services were more likely to report being satisfied with health care services in general or outpatient services (OR=1.60; p=0.02). Sensitivity analysis revealed that ESD services had the greatest benefit for individuals with mild to moderate stroke. Studies which involved a coordinated multidisciplinary team were more effective than those without an ESD team (odds of death: 0.70 and 1.23, respectively). Further, four trials that provided cost data indicated that costs at 6 months or 1 year after randomisation were 9 to 20 per cent lower for those in the intervention group than for those receiving usual care (Early Supported Discharge Trialists, 2005).

Larsen, Olsen and Sorensen (2006) conducted a health technology assessment of early home-supported discharge (ie ESD) of stroke patients using 7 of the 11 studies included in the Cochrane review of ESD noted above (Early Supported Discharge Trialists, 2005; Langhorne et al, 2005). The authors included RCTs examining the impact of coordination and delivery of ESD delivered by specialist multidisciplinary teams. A meta-analysis of data on 1,108 patients pooled into an aggregate RCT indicated that ESD is associated with significantly lower risk of death or institutionalisation compared with care provided on conventional stroke rehabilitation units (OR=0.75; CI (95%)=0.46-0.95). In addition, patients participating in ESD had hospitalisations that were, on average, 10 days shorter than the hospitalisations for their peers receiving conventional care, based on calculations of the average difference between study groups relative to their pooled standard deviation (95% CI 2.6-1.8 days) (Larsen, Olsen and Sorensen, 2006).

Anderson et al (2002) conducted a systematic review of seven published RCTs to compare the costs and health outcomes of patients receiving continued rehabilitation in hospital or early discharge and rehabilitation at home. Studies reviewed ranged in size from 92 to 331 patients and were conducted in Australia, Canada, Norway (2), Sweden, and the United Kingdom (2). A meta-analysis was conducted by pooling estimates using Mantel-Haenszel fixed effects models, when possible, and random effects models in the presence of significant heterogeneity between study outcomes.

Results from an analysis of weighted mean differences indicate that early hospital discharge and home-based rehabilitation reduced total length of stay by 13 days (95% CI 19 to -7 days). Shorter hospital stays were not associated in significant increases in mortality (OR=0.95; 95% CI 0.65 to 1.38) or changes in other clinical outcomes, including disability, long term institutional care, or readmission as assessed between 3 and 12 months after discharge. The authors estimated that overall mean costs were approximately 15 per cent lower for early discharge than for standard care. They conclude that early hospital discharge with home-based rehabilitation appears to be a practical and effective alternative

to conventional care for patients with stroke-related disability; it results in a significant reduction in length of hospital stay and produces cost savings (Anderson et al, 2002).[2]

A review of ten studies by Teasell et al (2003) found that ESD services resulted in a significantly shorter length of hospitalisation among mild stroke patients without compromising patient functional outcomes. Specifically, six of eight studies reporting length of stay found that ESD resulted in significantly shorter hospitalisations compared with usual care (that is, rehabilitation on either a stroke or geriatric rehabilitation unit). In addition, three studies compared the costs of ESD with those of usual care and found trends indicating that ESD reduced health care costs; one finding was statistically significant. This narrative review of ten studies encompassed a total of 1,286 participants; each study had a sample size of between 20 and 331 subjects. ESD interventions lasted between 4 weeks and 4 months. Although the authors did not note the location of the studies reviewed, they indicated that the inclusion criteria for most studies resulted in study populations primarily comprising patients with a high level of independence (Teasell, et al, 2003).[3]

Torp et al (2006) conducted a RCT to evaluate the impact of hospital-supported discharge after stroke with 198 stroke victims in Denmark who were hospitalised for at least 1 week. At 6 and 12 months following hospital admission, they observed no differences between the two study groups with respect to length of hospital stay, self-evaluated function or social network, self-evaluated coping, or scores on the following tests: Barthel index, mini mental status examination and SF-36. The authors suggest that the study's insignificant findings may be attributed to the fact that usual care for stroke rehabilitation in the communities studied may already be sufficiently effective. Specifically, intervention participants received care from an interdisciplinary team comprising an occupational therapist, a physiotherapist and a physician from the rehabilitation ward. This team provided services to the patient during the last week of their hospital stay and for up to 30 days following discharge. In contrast, control group participants received usual care, which included rehabilitation and training on a rehabilitation ward with discharge planning services that included planning with caregivers and community-based public health nurses. Both groups received post-discharge care services (home care, day care centre and physiotherapy) (Torp et al, 2006).

Donnelly et al (2004) conducted a randomised trial of an early discharge rehabilitation service delivered by a community-based multidisciplinary stroke team compared with usual rehabilitation care delivered in the hospital; 113 UK patients participated in the study. The authors reported no differences in length of hospitalisation, functioning, quality of life or costs. Individuals receiving community-based rehabilitation services reported a higher level of satisfaction than those receiving usual care ($p=0.01$). However, members of both the intervention and control groups had similar improvements in patient functioning and quality of life as measured by the Barthel index, the Nottingham activities of daily living measure, the SF-36 and a quality-of-life measure (unnamed by the authors). The costs of community-based rehabilitation were lower than those of hospital-based care, on average. However, these differences did not reach statistical significance at 6 or 12 months follow-up. Similar to the studies reviewed by Teasell et al, the participants in this trial were representative of less severe stroke patients (Donnelly et al, 2004).

A RCT conducted by Thorsen et al (2005) in Sweden provides evidence that an ESD intervention had benefits at 5 years following stroke (n=54). Specifically, the intervention group had significantly more independence on extended ADLs ($p<0.05$) and was significantly more active in doing household chores as assessed by the Frenchay activities index ($p<0.05$) at 5-year follow-up. Both study groups received initial medical care and rehabilitation in an inpatient stroke unit. For the intervention group, an outreach team of occupational therapists, physiotherapists and a speech-language therapist provided in-home care for an average of 12 visits over 14 weeks. Notably, the length of hospitalisation

for the intervention group was significantly shorter than that observed among the control group (14 days versus 30 days; p<0.05) (Thorsen et al, 2005).

To examine the impact of ESD services in a rural community, Askim et al (2004) conducted a small RCT of stroke patients in Norway (n=62). The intervention group received post-acute services from a mobile stroke team that coordinated home-based rehabilitation in collaboration with the primary health care system during the first 4 weeks following discharge from the hospital. The team comprised a nurse, physiotherapist, occupational therapist and consulting services from a physician. Patients receiving usual care received post-acute services organised by rehabilitation clinics or the primary health care system. At 6-month follow-up, patients in the intervention and control groups had similar outcomes with regard to length of stay, independence (measured by the Barthel index), disability (measured by the modified Rankin scale), and quality of life (measured by the Nottingham health profile) (Askim et al, 2004).

In what setting should post-acute rehabilitation services be delivered?

Summary of evidence

Rehabilitation can improve functional outcomes when given in the community provided that it is therapy-based, meaning that the services are carried out by a multidisciplinary and task-oriented team.

Legg and Langhorne (2004) published a Cochrane Collaboration systematic review of 14 articles describing the results of six research studies conducted between1981and 2001 to assess the effects of therapy-based rehabilitation services targeted to community-based stroke patients. Examining the risk of deterioration in performing ADLs and improvements in performance of ADLs, the studies reviewed ranged in size from 20 to 466 participants and were conducted in Canada (1), Denmark (1), Hong Kong (1), the United Kingdom (9) and the United States (2). The authors included RCTs that compared stroke patients living at home and receiving a therapy service intervention with stroke patients receiving conventional care, defined as normal practice or no routine intervention. Therapy services were provided by a physiotherapist, an occupational therapist, or multidisciplinary staff working with patients primarily to improve task-oriented behaviour (for example, walking, dressing) and to reduce disability.

Therapy-based rehabilitation services for patients living at home after stroke reduce the odds of a poor outcome and have a beneficial effect on a patient's ability to perform personal and extended ADLs, based on analyses using fixed effects models for binary outcomes and random effects models for continuous outcomes. Specifically, evidence from the meta-analysis of six trials indicated that the odds of death or deterioration in ADLs were significantly lower in the group receiving therapy-based rehabilitation services (OR 0.67; 95% CI 0.46 to 0.97; p=0.03). Re-analysis of the 12 articles reporting data on death or a poor outcome (deterioration or dependency) indicate a similar result (OR 0.72; 95% CI 0.57 to 0.92). Patients receiving therapy-based rehabilitation services were also significantly more independent in personal ADLs than those patients who received no care or usual care (p=0.02). The authors conclude that therapy-based services are an effective means of decreasing dependency for stroke patients living at home. They estimate the effect of these services to be an increase on a Barthel index of 1 point (5 per cent) (Legg and Langhorne, 2004).

Stroke rehabilitation units

Summary of evidence

Stroke rehabilitation units are effective settings in which to treat stroke patients who need rehabilitation.

Drummond et al (2005) conducted a 10-year follow-up of a RCT to examine whether the benefits of a non-acute stroke rehabilitation unit persist for 10 years after stroke. The study used data on 292 patients who had been randomly allocated to receive treatment at a stroke rehabilitation unit or on conventional wards (for example, general medical or geriatric wards). At follow-up, the relative risk (RR) of death (RR=0.87; 95% CI 0.78 to 0.97), death or disability (RR=0.91; 95% CI 0.83 to 1.00), and death or institutional care (RR=0.91; 95% CI 0.83 to 1.00) indicated a more favourable outcome for participants who had received care in a stroke rehabilitation unit (Drummond et al, 2005).

Noorani et al (2003) conducted a systematic review of 22 RCTs to evaluate the clinical effectiveness of rehabilitation interventions after stroke for the Canadian Coordinating Office for Health Technology Assessment. The authors examined the following three models of delivering rehabilitation services in comparison to usual care:

- stroke unit care versus care on a general medical or geriatric ward (six studies)
- ESD services versus usual care (five studies)
- rehabilitation in the community versus usual care.

Studies reviewed ranged in size from 32 to 550 patients, focused on elderly patients, and were undertaken in a range of locations (half were conducted in the United Kingdom). Death and physical dependence (measured by Barthel index) were the main outcomes of interest. Study authors created odds ratios to pool binary outcomes and calculated weighted mean differences for continuous variables. Similar to other reviews cited, fixed effects models were employed for homogeneous study outcomes; otherwise, random effects models were used.

Six studies examined the effect of stroke unit care versus usual care; the meta-analysis showed a reduction in the odds of death (OR 0.6; 95% CI 0.42 to 0.86) recorded at final follow-up and an increase in the odds of living at home across four of the trials (OR 1.42; 95% CI 1.05 to 1.92). Five studies examined the effect of ESD services versus usual care on stroke outcomes. Intervention groups received ESD services from an interdisciplinary team and controls received conventional rehabilitation (for example, in a stroke unit or geriatric wards). The authors found that ESD patients did not have lower odds of death or institutionalised care than controls. No significant differences were observed between groups in the mean Barthel index score, although the percentage considered independent was higher for intervention patients than for controls in two of the trials (OR 1.82; 95% CI 1.16 to 2.86). Eight RCTs had compared home-based rehabilitation services provided by an interdisciplinary team of professionals with usual care (for example, in a hospital or community setting). The meta-analysis found no significant differences in death or dependency between cases and controls across trials and no decrease in institutional care (Noorani et al, 2003).

Dekker et al (1998) conducted a systematic review of six RCTs examining the outcomes of stroke patients at least 6 months following treatment at a rehabilitation day hospital. Studies reviewed ranged in size from 113 to 327 patients. The intervention group for all studies included patients who participated in a rehabilitation programme at a day hospital with a

multidisciplinary outpatient approach. However, many studies had not defined the frequency and duration of treatment. The control groups varied among studies, consisting of patients with conventional care, inpatient treatment, outpatient physiotherapy, home care, or no treatment. Studies reviewed had to report results of at least one relevant, reliable and valid instrument measuring change in disabilities, handicap or quality of life.

The authors concluded that the studies they reviewed provided insufficient evidence to determine whether day hospital rehabilitation (DHR) for stroke is effective in increasing functioning or quality of life. Specifically, two studies showed that functional improvement was significantly better after 6 weeks and 3 months respectively, but not after 5 months and 6 months. One study comparing intensive rehabilitation, conventional rehabilitation and no rehabilitation found that the greatest (and most statistically significant) improvement in function was obtained from intensive rehabilitation. In contrast, two studies found no significant changes in DHR patients in 6 weeks or 6 months. In addition, no authors of any of these studies provided statistics to specify the degree of functional improvement. The authors of the review concluded that information is conflicting about the efficacy of DHR for stroke patients because of inconsistent study designs used across studies (Dekker et al, 1998). The CRD determined that this review provides a very good quality assessment of the literature available regarding the effectiveness of rehabilitation after stroke in the day hospital setting.

How should stroke rehabilitation services be delivered?

Summary of evidence

There is evidence, albeit weak, to suggest that setting of rehabilitation is less important than when therapy is initiated, how intensive the therapy is, how long the therapy lasts, and whether the therapy is administered by appropriate therapists (for example, occupational, speech or physical therapists).

Horn et al (2005) provide a comprehensive review of findings from the Post-Stroke Rehabilitation Outcomes Project (PSROP), including patients who received care from one of five inpatient rehabilitation facilities in the United States. Their analysis covered three aspects of the delivery of stroke rehabilitation services based upon patient outcomes observed at discharge from rehabilitation: timing of initiation of rehabilitation services; duration of rehabilitation; and types of rehabilitation conducted.

The authors stratified 830 patients into moderate and severe case-mix groups (CMGs) to identify differences in outcomes among patients with moderate and severe strokes. Because the PSROP is an observational study, the investigators used multivariate analysis to control for a large number of patient characteristics, including the following:

- demographic characteristics
- functioning (as measured by the functional independence measure, or FIM score)
- stroke severity (as measured by the comprehensive severity index)
- health status (for example, body mass index)
- stroke location.

Earlier initiation of rehabilitation is associated with significantly better functioning as measured by higher discharge total and motor FIM scores. This relationship was stronger

for severe stroke patients (p<0.001) than for moderate stroke patients (p=0.014). Among patients who had had a moderate stroke, increased length of stay in a rehabilitation facility was associated with worse patient functioning (p<0.02). In contrast, among severe stroke patients, longer length of stay was related to better patient functional status and a higher likelihood of discharge to home (p<0.01). In addition, better functional outcomes and increased probability of discharge to home are associated with higher-level rehabilitation activities, including gait training, upper-extremity control, home management activities and problem-solving (p<0.05) (Horn et al, 2005).

The authors suggest that these findings should encourage earlier initiation of rehabilitation and early rehabilitation of complex activities. This is contrary to conventional theories of rehabilitation that endorse beginning therapy based upon a patient's current level of functioning and gradually increasing the complexity of activities. Such a shift in practice will require more timely coordination in the transition from acute care to rehabilitation for patients with stroke and an increased willingness of rehabilitation hospitals to admit patients with significant medical issues.

Bode et al (2004) report results of an observational study of 198 stroke patients that evaluated the relative importance of therapy focus and intensity on greater than expected functional gain, as measured by residual change scores. Patients were recruited from eight inpatient rehabilitation facilities and five sub-acute programmes in the United States. Stroke severity at admission was measured using the FIM instrument. The investigators used amount of time spent with physical, occupational and speech-language therapists to compute therapy intensity by discipline. Outcomes examined included self-care, cognitive ability and mobility.

Multivariate analyses showed that, controlling for stroke severity, greater than expected gains in self-care were predicted by more intensive function-focused occupational therapy and longer length of therapy (p<0.001). Predictors of change in mobility differed by gender. For men, greater than expected gains in mobility were predicted by more intense function-focused physical therapy and longer lengths of stay. By contrast, women whose mobility improved more than expected had been less impaired at admission. Study findings were similar regardless of patient setting (ie inpatient rehabilitation facility or sub-acute programme). The authors suggest that content and intensity of therapy is associated with outcomes for stroke patients (Bode et al, 2004).

Steultjens et al (2003) conducted a systematic review of 32 studies to determine whether occupational therapy interventions improve outcomes for stroke patients. Of these 32 studies, 18 were RCTs, six were case control trials, and eight used other study designs such as pre-post test or time series. The authors did not specify study locations. Studies were classified by the following seven intervention types:

- training of sensory-motor functions
- training of cognitive functions
- training of skills such as dressing or cooking
- advice and instruction in the use of assistive devices
- provision of splints and slings
- education of family and primary caregivers
- comprehensive (all six specific intervention categories above were part of treatment).

The authors conducted a meta-analysis of seven studies evaluating a comprehensive occupational therapy intervention with 65 to 466 patients. It showed a small but significant effect size for the efficacy of comprehensive occupational therapy on primary ADLs, extended ADLs and social participation among stroke patients. The pooled standardised mean difference for primary ADLs (0.46; 95% CI 0.04 to 0.88), extended ADLs (0.32; 95% CI 0.00 to 0.64) and social participation (0.33; 95% CI 0.03 to 0.62) favoured treatment. The authors suggest that this finding endorses the importance of occupational therapy as part of the multidisciplinary rehabilitation of stroke patients. The authors also conducted a qualitative review of the studies targeting specific interventions (sample sizes were too small to conduct meta-analyses) and found that the studies did not provide sufficient evidence to draw any conclusions (Steultjens et al, 2003). The CRD is in the process of reviewing the quality of this systematic review.

Ryan, Enderby and Rigby (2006) conducted a RCT to assess the relationship between therapy intensity and functionality, mental status and quality of life among stroke patients at 3 months following initiation of community-based rehabilitation services. Among 67 UK stroke patients, those who received six or more visits a week from a multidisciplinary rehabilitation team had better outcomes than those who received three or fewer visits from the team on a weekly basis. Specifically, functionality measured by the therapy outcome measure handicap and quality of life measured by the EuroQuol 5D were significantly higher among the intensive group at 3 month follow-up than among the non-intensive group ($p<0.05$). The intensive group also had significantly less anxiety and depression (measured by the hospital anxiety and depression scale) than the control group when simple imputation was applied to the data ($p<0.05$) (Ryan, Enderby and Rigby, 2006).

Di Lauro et al (2003) conducted a small RCT showing that higher intensity of rehabilitation therapy conducted during the first 14 days following stroke had no effect on patient outcomes. The investigators randomly assigned 60 stroke patients in Italy to one of two groups. The intervention group received rehabilitation services for 2 hours a day, divided into two sessions, whereas the control group participated in rehabilitation for a single 45-minute session a day. At 6-month follow-up, both groups had similar levels of disability as measured by the Barthel index (Di Lauro et al, 2003).

Wodchis et al (2005) conducted a retrospective cohort study of approximately 24,000 residents of all skilled nursing facilities (SNFs) in the states of Ohio and Michigan in the United States and Ontario in Canada to examine the effect of rehabilitation therapy (physical and occupational therapy) intensity in SNFs on resident discharges to home. Residents were stratified by length of stay to expected discharge assessed at admission (for example, within 30 days, between 30 and 90 days, uncertain, or not expected). Multivariate analyses showed that at least 330 minutes of rehabilitation therapy weekly increases the likelihood of discharge home for all groups except those expected to be discharged within 30 days ($p<0.05$). The likelihood of discharge home for patients expected to receive long term custodial care at the SNF was more than twice as high for residents who received 500 or more minutes of rehabilitation therapy each week than for those who received none ($p<0.05$). The dose-response relationship was strongest for residents with either an uncertain discharge prognosis or no discharge expected (Wodchis et al, 2005).

Jette, Warren and Wirtalla (2005) conducted a retrospective analysis using data from an administrative dataset containing data on 933 stroke patients to examine the relationship between therapy intensity provided at SNFs and patient length of stay and functional independence among residents of SNFs in the United States. The authors examined the effects of three different therapy types: physical, occupational, and speech and language. Functional independence was measured by grouping measures from the FIM instrument into three categories: mobility, ADLs, and executive control. Multivariate analyses showed

that length of stay (LOS) was significantly associated with the number of hours of therapy provided a day. Specifically, patients with less than 1 hour had an average LOS of 21.4 days, which was significantly longer than patients receiving 1 to 1.5 hours or more than 1.5 hours a day, who had average lengths of stay of 16.9 and 15.5 days respectively ($p<0.001$). In addition, higher intensity of physical and occupational therapy was associated with greater odds of improving by at least one stage in mobility and ADL functional independence ($p<0.05$). Higher OT and SLC intensity was associated with improved executive control ($p<0.05$) (Jette, Warren and Wirtalla, 2005).

Who should deliver care?

Summary of evidence

A stroke team is an effective means of delivering rehabilitation services when the team includes specialists from disciplines such as nursing, rehabilitation medicine, social services, occupational therapy, physiotherapy, speech and language therapy, and mental health.

Lincoln et al (2004) conducted a RCT of 421 stroke patients in the United Kingdom to evaluate the effectiveness of a multidisciplinary community-based stroke team for delivery of rehabilitation services. Comprising occupational therapists, physiotherapists, speech and language therapists and a mental health nurse, the Nottingham Community Stroke Team conducted an in-home assessment, which was followed by a team discussion of findings from the needs assessment to determine which services to provide to each patient in the intervention group. Services were provided for as long as each patient was receiving benefit from the treatment. In contrast, patients in the control group received routine care, including services provided by day hospitals, outpatient departments and social services occupational therapy, which patients accessed through the Stroke Association information service.

Patients in both study groups had comparable outcomes with respect to independence in daily living (Barthel index and extended ADLs), mood (general health questionnaire –12), quality of life (EuroQuol) and knowledge of stroke. However, the intervention group was significantly more satisfied with emotional support received ($p<0.01$). In addition, caregivers of patients in the intervention group reported significantly less strain (carer strain index; $p<0.05$), significantly greater overall satisfaction with care ($p<.01$) and, in particular, greater satisfaction with their knowledge of stroke ($p<0.01$) (Lincoln et al, 2004).

Nir, Zolotogorsky and Sugarman (2004) found that a structured nursing intervention resulted in improved functioning, adherence to dietary restrictions, health status, self-esteem and depression at 3 and 6 months following initiation of the programme. The investigators randomly assigned 155 elderly stroke survivors in Israel to two groups. Members of the intervention group participated in 12 weekly sessions with nurses who addressed affective, cognitive and instrumental needs of patients and caregivers. In particular, nurses worked with patients and caregivers to identify meaningful goals. Intervention and control group members received conventional rehabilitation services. Global FIM scores were significantly higher for members of the intervention group at 3 months following initiation of treatment, and this improvement was sustained at the 6-month follow-up ($p<0.001$). Compared with controls, patients participating in the nursing intervention reported improved adherence to dietary restrictions ($p<0.05$) and significantly less depression as measured by the geriatric depression scale at both follow-up times. In addition, at 6 months follow-up, members of the intervention group had significantly greater improvement in self-perception of health status and self-esteem (measured by the Rosenberg self-esteem scale) than controls ($p<0.001$) (Nir, Zolotogorsky and Sugarman, 2004).

Ellis et al (2005) completed a Cochrane Collaboration systematic review of the impact of stroke liaison workers on stroke patients and their caregivers. Evidence from the 16 RCTs reviewed indicates that patients who receive services from a stroke liaison worker were significantly more satisfied that someone had listened to them ($p<0.01$) than their peers who did not receive these services. In addition, caregivers who worked with a stroke liaison worker were significantly more satisfied that they were not neglected ($p<0.01$), received sufficient information about the causes of stroke ($p<0.05$), the stroke recovery process ($p<0.01$), and that someone had really listened to them ($p<0.001$). Further, intervention

patients who received liaison services from a nurse, rather than another type of health care professional (types not specified in the abstract), were significantly less depressed at follow-up ($p<0.01$) (Ellis et al, 2005).

What are best practices in supporting stroke patients' caregivers?

Summary of evidence

There is a lack of good evidence to warrant specific interventions to improve the quality of life for stroke patients' caregivers.

A stroke affects both patients and their families. Caregivers provide a great deal of care to the stroke patient, and often the caregiver is an elderly spouse who may also be in poor health. Health care delivery systems need to support both the patient and the caregiver to help maintain the patient in the community following a stroke.

Visser-Meily et al (2005) conducted a systematic review of interventions for caregivers of stroke patients and found insufficient evidence to warrant recommendation of specific interventions to improve carer quality of life. Conducted in Australia (1), Canada (1), Europe (14), New Zealand (1) and the United States (5), the 22 studies reviewed ranged in size from 20 to 170 individuals. Eighteen of the studies reviewed were RCTs. Most interventions (14 of the 18 RCTs) were targeted at both caregivers and patients, rather than tailored specifically to the needs of caregivers. The authors identified four types of caregiver interventions: specialist services to facilitate hospital discharge; psychoeducation; counselling; and peer support. They examined the following outcomes: quality of life; emotional state; burden; family functioning; social activity; coping; satisfaction with care; knowledge; and social support. The impact of the different types of interventions reviewed are as follows:

- Specialist services to facilitate hospital discharge – four of 12 studies resulted in significant improvements for caregivers.
- Psychoeducation – four of six studies had positive effects on caregiver knowledge about stroke.
- Counselling – three of four studies reviewed reported a positive outcome for caregivers.
- Peer support – the support group intervention examined did not have an impact upon caregiver burden or emotional state.

Three studies reported negative outcomes for caregivers. The studies found poorer general health with an early discharge and community rehabilitation team (one study), more dissatisfaction with information and higher caregiver burden for an integrated care pathway (one study), and poorer social functioning with a stroke education programme (one study) (Visser-Meily et al, 2005). A CRD review of the study found that this high-quality review accurately described the limited nature of evidence available regarding caregiver interventions.

Bugge, Alexander and Hagen (1999) conducted a longitudinal study to characterise caregiver strain during the first 1, 3 and 6 months following a stroke in a spouse/family member. The investigators interviewed 110 stroke caregivers in Scotland at each study interval, using the caregiver strain index and the SF-36. The majority of caregivers (73 per cent) were women, and almost all caregivers (87 per cent) were family members. On average, caregivers reported helping patients 6 hours a day.

Caregiver strain increased with time over the first 6 months following stroke, and use of caregiver support services was limited. Three issues from the caregiver strain index were found to be most challenging to caregivers at all three time periods: the confining nature of caregiving, changes to personal plans, and changes in family life. Case-mix adjusted regression models showed that, throughout the 6-month period, increased time spent with patients was associated with decreased strain ($p<0.01$), and decreased time spent helping patients was associated with increased strain ($p<0.01$). In addition, different factors were associated with level of caregiver strain during each of the follow-up periods as follows:

- 1 month post-stroke – male stroke patients ($p<0.01$) and patients with less neurological impairment ($p<0.05$) were associated with less caregiver strain.
- 3 months post-stroke – lower levels of patient disability were associated with less caregiver strain ($p<0.05$).
- 6 months post-stroke – better motor function at stroke onset ($p<0.05$) and continence within 7 days of stroke ($p<0.01$) were associated with less caregiver strain.

These findings suggest that caregivers of stroke patients undergo significant strain during the first 6 months following stroke and would likely benefit from interventions aimed at providing respite during this time period (Bugge, Alexander and Hagen, 1999).

Rehabilitation – emerging technologies

Robotic therapy devices may be a helpful tool to increase access to rehabilitation by reducing the amount of time a physical therapist needs to spend with each recovering stroke patient (Teasell and Kalra, 2005). Home-based telerehabilitation systems for sensing and tracking the motion of patients allow patients to practise movements on a more routine basis than they would be able to during outpatient physiotherapy two to three times a week. Zheng, Black and Harris (2005) reviewed a variety of devices that can be used to evaluate different movements conducted by users. They recommend that home-based devices should be portable and easily mounted on the body and that they should provide a summary of measurements to the user automatically. A review of randomised trials found that home-based stroke therapy reduced the odds of decreasing ability to perform ADLs and increased patient ability to undertake routine activities. Further, the Engineering and Physical Sciences Research Council has funded research to evaluate a real-time tracking system that provides both therapeutic instruction and support information (Zheng, Black and Harris, 2005).

3. Final conclusions/recommendations

In this review we focused primarily on the following areas related to the organisation and delivery of health care for patients with stroke:

- stroke risk reduction by treatment of TIAs
- timely access to emergency services for diagnosis and initiation of appropriate treatment
- inpatient care for the acute phase
- post-acute services including rehabilitation.

The evidence is summarised in Table 8.

A stroke is a medical emergency requiring timely intervention following the onset of symptoms to avert significant damage to the brain. Therefore, early recognition of symptoms by patients, families and emergency workers is critical to ensure that patients will have an opportunity to benefit from early interventions. The issues related to adequate access to emergency services include: awareness of the urgency of the symptoms; transportation to an acute medical facility for treatment; and access to trained personnel and diagnostic tests to differentiate between ischaemic and haemorrhagic strokes, particularly in remote or rural areas. The evidence for delivery system approaches to emergency care for stroke patients consists largely of observational studies, quasi-experimental studies and one systematic review. While not as rigorous as RCTs, the evidence does point to a number of models to address the gap between guidelines and current practice. There is some evidence regarding the effectiveness of educational campaigns to increase awareness of stroke symptoms, suggesting that a multipronged approach to community education for stroke symptom recognition can increase awareness and thus result in decreased time to intervention for stroke patients. However, the American Heart Association has recommended that additional research should be conducted to identify effective interventions.

Rapid transport to the emergency department by patients experiencing stroke symptoms is advisable. In environments where stroke centres are sparsely located, the use of helicopter transport may be used to get patients to a hospital quickly. In the event that a neurologist is not available in an emergency department , evidence suggests that emergency department physicians are able to diagnose a stroke correctly. In addition, some evidence supports the use of telemedicine, particularly in rural areas with limited access to neurologists or radiologists, to enable a prompt diagnosis of stroke and initiate treatment.

There is strong evidence that stroke care provided in organised stroke units results in significantly better patient outcomes compared to alternative forms of care, such as care delivered in a general medical ward. Patients who received organised stroke care have been found to experience lower risk of death, institutionalisation and dependency 1 year post-stroke. There are various types of organised stroke care, including stroke wards where care is delivered exclusively to stroke patients by a multidisciplinary team, mixed rehabilitation wards where patients receive care from a multidisciplinary team on a general rehabilitation ward, and mobile stroke teams consisting of multidisciplinary teams that provide stroke care in a variety of settings. The range of health professionals participating in these multidisciplinary teams include consultant physicians in stroke medicine, nurses, physiotherapists, occupational therapists, speech and language therapists, dietitians, clinical psychologists, pharmacists and social workers.

There is a lack of good evidence to support recommendations for the use of care pathways for inpatient care of acute stroke owing to the mixed results of the studies reviewed and the quality of evidence available. In the literature reviewed, the care provided was poorly defined and care pathway interventions varied across studies. In addition, because care pathways have multiple components, it is difficult to discern which component affected the outcomes observed (Kwan and Sandercock, 2004).

Because a significant proportion of stroke patients experience an impairment of some kind following the stroke, a critical component in the delivery of services to the stroke patient is post-acute care. Post-acute care for stroke patients aims to prevent additional strokes from occurring and provide rehabilitation services to enable the patient to reach his or her optimal physical, cognitive and social functional level. There is evidence that ESD allows patients to be discharged from the hospital earlier than they otherwise would be. ESD is care provided by a multidisciplinary team that begins during the inpatient stay and continues as a coordinated, community-based, post-acute health care service.

Post-acute rehabilitation for the stroke patient can be delivered in a number of settings. While strong evidence supports the benefits of rehabilitation and the start of rehabilitation soon after stroke onset, there is insufficient evidence to recommend one setting over another. The common feature is the availability of a multidisciplinary team in the various settings. From our review of the evidence, we conclude that the setting of rehabilitation is less important than when therapy is initiated, how intensive the therapy is, how long the therapy lasts, and whether the therapy is administered by appropriate therapists. A stroke team is an effective way to organise rehabilitation services.

Stroke is a condition with an acute onset that often results in a chronic need for support and assistance from family caregivers. Rehabilitation can be a lengthy process, and the primary caregiver is often the elderly spouse of the patient. Caregivers undergo significant stress when caring for a stroke patient, and while there is consensus that caregivers need support and respite, there is insufficient evidence to warrant recommendation of specific interventions to improve caregiver quality of life.

Table 8: Summary of evidence: health care delivery models for stroke

Area of focus	Summary of evidence
Emergency care	• Evidence supports a stroke care delivery model that includes coordinated stroke unit care or stroke centre, provided this approach includes multidisciplinary teams. • Evidence shows that a multidisciplinary coordinated care model results in significantly better patient outcomes compared to alternative forms of care, such as care delivered in a general medical ward. • Some evidence supports the use of education programmes for emergency medical services (EMS) dispatchers and paramedics to increase their recognition of stroke signs and symptoms and to decrease time to initiation of treatment. • Establishing standard operating procedures in the emergency department that include a care pathway plan for assessing and implementing emergency stroke care can decrease the time between arrival at the emergency department and start of treatment. • In the event that a neurologist is not available in emergency situations, some evidence supports the ability of emergency service physicians to diagnose a stroke correctly. • Some evidence supports the use of telemedicine to provide a safe, effective alternative model of acute stroke care in rural areas with limited access to neurologists or radiologists.
Stroke risk reduction: treatment of TIA	• The risk of stroke following a TIA is high. For prevention to be effective, the public needs to be educated to seek medical attention urgently and service delivery needs to be organised to provide immediate care. However, there is insufficient evidence to identify the most effective strategy to achieve these goals.
Acute care	• Evidence supports a stroke care delivery model that includes coordinated stroke care, provided this approach includes multidisciplinary care teams. • Evidence shows that this model results in significantly better patient outcomes compared to alternative forms of care, such as care delivered in a general medical ward. • There is a lack of good evidence to identify specific in-hospital care pathways for the treatment of acute stroke. • Treatment at home with supportive services for acute stroke is an option for some elderly patients.

Area of focus	Summary of evidence
Post-acute care	• Evidence supports stroke rehabilitation units as effective settings in which to treat stroke patients who need rehabilitation. • Rehabilitation can improve functional outcomes when given in the community, provided that it is therapy-based, meaning that the services are carried out by a multidisciplinary and task-oriented team. • There is evidence, albeit weak, to suggest that the setting of rehabilitation is less important than when therapy is initiated, how intensive the therapy is, how long the therapy lasts, and whether the therapy is administered by appropriate therapists (eg occupational, speech or physical therapists). • Evidence supports selective use of early supported discharge (ESD) as an effective alternative to longer inpatient stays. • A stroke team is an effective means of delivering rehabilitation services when the team includes specialists from disciplines such as nursing, rehabilitation medicine, social services, occupational therapy, physiotherapy, speech and language therapy, and mental health. • There is a lack of good evidence to warrant specific interventions to improve the quality of life for stroke patients' caregivers.

References

Alberts MJ, Hademenos G, Latchaw RE, Jagoda A, Marler JR, Mayberg MR, Starke RD, Todd HW, Viste KM, Girgus M, Shephard T, Emr M, Shwayder P and Walker MD (2000). 'Recommendations for the establishment of primary stroke centers'. Brain Attack Coalition. JAMA, 283 (23), 3102-9.

Alberts MJ, Latchaw RE, Selman WR, Shephard T, Hadley MN, Brass LM, Koroshetz W, Marler JR, Booss J, Zorowitz RD, Croft JB, Magnis E, Mulligan D, Jagoda A, O'Connor R, Cawley CM, Connors JJ, Rose-DeRenzy JA, Emr M, Warren M and Walker MD (2005). 'Recommendations for comprehensive stroke centers: a consensus statement from the Brain Attack Coalition'. Stroke, 36 (7), 1597-616.

Anderson C, Ni Mhurchu C, Brown PM and Carter K (2002). 'Stroke rehabilitation services to accelerate hospital discharge and provide home-based care: an overview and cost analysis'. Pharmacoeconomics, 20 (8), 537-52.

Askim T, Rohweder G, Lydersen S and Indredavik B (2004). 'Evaluation of an extended stroke unit service with early supported discharge for patients living in a rural community. A randomized controlled trial'. Clin Rehabil, 18 (3), 238-48.

Audebert HJ, Kukla C, Vatankhah B, Gotzler B, Schenkel J, Hofer S, Furst A and Haberl RL (2006). 'Comparison of tissue plasminogen activator administration management between Telestroke Network hospitals and academic stroke centers: the Telemedical Pilot Project for Integrative Stroke Care in Bavaria/Germany'. Stroke, 37 (7), 1822-7.

Bader MK and Palmer S (2006). 'What's the "hyper" in hyperacute stroke? Strategies to improve outcomes in ischemic stroke patients presenting within 6 hours'. AACN Adv Crit Care, 17 (2), 194-214.

Behrens S, Daffertshofer M, Interthal C, Ellinger K, van Ackern K and Hennerici M (2002). 'Improvement in stroke quality management by an educational programme'. Cerebrovasc Dis, 13 (4), 262-6.

Belvis R, Cocho D, Marti-Fabregas J, Pagonabarraga J, Aleu A, Garcia-Bargo MD, Pons J, Coma E, Garcia-Alfranca F, Jimenez-Fabrega X and Marti-Vilalta JL (2005). 'Benefits of a prehospital stroke code system. Feasibility and efficacy in the first year of clinical practice in Barcelona, Spain'. Cerebrovasc Dis, 19 (2), 96-101.

Blades LL, Oser CS, Dietrich DW, Okon NJ, Rodriguez DV, Burnett AM, Russell JA, Allen MJ, Fogle CC, Helgerson SD, Gohdes D and Harwell TS (2005). Rural community knowledge of stroke warning signs and risk factors'. Prev Chronic Dis, 2 (2), A14.

Bock B (1996). Response System for Patients Presenting with Acute Stroke. Bethesda, Maryland: National Institute of Neurological Disorders and Stroke.

Bode R, Heinemann A, Semik P and Mallinson T (2004). 'Relative importance of rehabilitation therapy characteristics on functional outcomes for persons with stroke'. Stroke (American Heart Association), 35 (11), 2537-42.

Brainin M, Funk G, Dachenhausen A, Huber G, Matz K and Eckhardt R (2004). Stroke emergency: evidence favours laying the patient on the paretic side'. Wien Med Wochenschr, 154 (23-24), 568-70.

Brice JH, Griswell JK, Delbridge TR and Key CB (2002). 'Stroke: from recognition by the public to management by emergency medical services'. Prehosp Emerg Care, 6 (1), 99-106.

Bugge C. Alexander H and Hagen S (1999). 'Stroke patients' informal caregivers: patient, caregiver, and service factors that affect caregiver strain'. Stroke (American Heart Association), 30 (8), 1517-23.

Camilo O and Goldstein L (2005). 'Lower stroke-related mortality in counties with stroke centers: North Carolina Stroke Facilities Survey'. Neurology, 64 (4), 762-3.

Choi J, Porche N, Albright K, Khaja A, Ho V and Grotta J (2006). 'Using telemedicine to facilitate thrombolytic therapy for patients with acute stroke'. Joint Commission Journal on Quality and Patient Safety, 32 (4), 199-205.

Conroy MB, Rodriguez SU, Kimmel SE and Kasner SE (1999). 'Helicopter transfer offers a potential benefit to patients with acute stroke'. Stroke, 30 (12), 2580-4.

Coull AJ, Lovett JK and Rothwell PM (2004). 'Population based study of early risk of stroke after transient ischaemic attack or minor stroke: implications for public education and organisation of services'. BMJ, 328 (7435), 326.

Crocco T, Moreno R, Jauch E, Racine A, Pio B, Liu T and Kothari R (2003). 'Teaching ACLS stroke objectives to prehospital providers: a case-based approach'. Prehospital Emergency Care, 7 (2), 229-34.

Das K, Mondal GP, Dutta AK, Mukherjee B and Mukherjee BB (2007). 'Awareness of warning symptoms and risk factors of stroke in the general population and in survivors stroke'. J Clin Neurosci, 14 (1), 12-16.

Dekker R, Drost EA, Groothoff JW, Arendzen JH, van Gijn JC and Eisma WH (1998). 'Effects of day-hospital rehabilitation in stroke patients: a review of randomized clinical trials'. Scand J Rehabil Med, 30 (2), 87-94.

Dennis, M. (2006) 'Developing a national system to monitor the quality of hospital-based stroke services. The Scottish Stroke Care Audit. NHS Quality Improvement Scotland.

Department of Health (2001). National Service Framework for Older Adults: Modern standards and service models. Department of Health.

Department of Health (2006). Improving Stroke Services: A guide for commissioners. Department of Health.

Di Lauro A, Pellegrino L, Savastano G, Ferraro C, Fusco M, Balzarano F, Franco MM, Biancardi LG and Grasso A (2003). 'A randomized trial on the efficacy of intensive rehabilitation in the acute phase of ischemic stroke'. J Neurol, 250 (10), 1206-8.

Donnelly M, Power M, Russell M. and Fullerton K. (2004). 'Randomized controlled trial of an early discharge rehabilitation service: the Belfast Community Stroke Trial'. Stroke, 35 (1), 127-33.

Drummond AE, Pearson B, Lincoln NB and Berman P (2005). 'Ten year follow-up of a randomised controlled trial of care in a stroke rehabilitation unit'. BMJ, 331 (7515), 491-2.

Duncan PW, Zorowitz R, Bates B, Choi JY, Glasberg JJ, Graham GD, Katz RC, Lamberty K and Reker D (2005). 'Management of adult stroke rehabilitation care: a clinical practice guideline'. Stroke, 36 (9), e100-43.

Early Supported Discharge Trialists. Services for reducing duration of hospital care for acute stroke patients (2005). Cochrane Database Syst Rev, 2, CD000443.

Ellis G, Mant J, Langhorne P, Dennis M and Winner J. (2005). Stroke liason workers for stroke patients and carers (Protocol). Cochrane Database of systematic Reviews. Issue 1. Art.No: CD005066. DOZ:10.10021 14651858.CD005066.

European Stroke Initiative Executive Committee and the EUSI Writing Committee (2000). 'European Stroke Initiative recommendations for stroke management. European Stroke Council, European Neurological Society and European Federation of Neurological Societies. Cerebrovasc Dis, 10 (5), 335-51.

Ferro J, Pinto A, Falcao I, Rodrigues G, Ferreira J, Falcao F, Azevedo E, Canhao P, Melo T, Rosas M, Oliveira V and Salgado A (1998). 'Diagnosis of stroke by the nonneurologist: a validation study'. Stroke (American Heart Association), 29 (6), 1106-9.

Gil Nunez AC and Vivancos Mora J (2004). 'Organization of medical care in acute stroke: importance of a good network'. Cerebrovasc Dis, 17 Suppl 1, 113-23.

Hacke W, Donnan G, Fieschi C, Kaste M, von Kummer R, Broderick JP, Brott T, Frankel M, Grotta JC, Haley EC Jr, Kwiatkowski T, Levine SR, Lewandowski C, Lu M, Lyden P, Marler JR, Patel S, Tilley BC, Albers G, Bluhmki E, Wilhelm M and Hamilton S (2004). Association of outcome with early stroke treatment: pooled analysis of ATLANTIS, ECASS, and NINDS rt-PA stroke trials'. Lancet, 363 (9411), 768-74.

Handschu R, Littmann R, Reulbach U, Gaul C, Heckmann JG, Neundorfer B and Scibor M (2003). Telemedicine in emergency evaluation of acute stroke: interrater agreement in remote video examination with a novel multimedia system'. Stroke, 34 (12), 2842-6.

Harraf F, Sharma AK, Brown MM, Lees KR, Vass RI and Kalra L (2002). 'A multicentre observational study of presentation and early assessment of acute stroke'. BMJ, 325 (7354), 17.

Hill MD, Barber PA, Demchuk AM, Sevick RJ, Newcommon NJ, Green T and Buchan AM (2000). 'Building a "brain attack" team to administer thrombolytic therapy for acute ischemic stroke'. CMAJ, 162 (11), 1589-93.

Hoffman A, Down, C, Grant R, Lowe D and Rudd A (2006). National Sentinal Stroke Audit. Phase 1 organisational audit 2006. London: Clinical Effectiveness and Evaluation Unit.

Horn S, DeJong G, Smout R, Gassaway J, James R and Conroy B (2005). 'Stroke rehabilitation patients, practice, and outcomes: is earlier and more aggressive therapy better?' Archives of Physical Medicine and Rehabilitation, 86 (12), S101-14.

Intercollegiate Stroke Working Party (2004). National Clinical Guidelines for Stroke (2nd ed). Royal College of Physicians of London.

Jagoda A (2003). Choosing Your Level of Care. Improving the Chain of Recovery for Acute Stroke in Your Community. Bethesda, Maryland: National Institute of Neurological Disorders and Stroke.

Jette D, Warren R and Wirtalla C. (2005). ,The relation between therapy intensity and outcomes of rehabilitation in skilled nursing facilities'. Archives of Physical Medicine and Rehabilitation, 86 (3), 373-9.

Johnston D, Oddone E, Horner R and Stechuchak K (2002). 'Beliefs regarding the effectiveness of stroke prevention practices: differences among provider specialties'. Journal of Clinical Outcomes Management, 9 (12), 667-75.

Johnston SC, Nguyen-Huynh MN, Schwarz ME, Fuller K, Williams CE, Josephson SA, Hankey GJ, Hart RG, Levine SR, Biller J, Brown RD Jr, Sacco RL, Kappelle LJ, Koudstaal PJ, Bogousslavsky J, Caplan LR, van Gijn J, Algra A, Rothwell PM, Adams HP and Albers GW (2006). 'National Stroke Association guidelines for the management of transient ischemic attacks'. Ann Neurol, 60 (3), 301-13.

Jungehulsing GJ, Rossnagel K, Nolte CH, Muller-Nordhorn J, Roll S, Klein M, Wegscheider K, Einhaupl KM, Willich SN and Villringer A (2006). Emergency department delays in acute stroke – analysis of time between ED arrival and imaging'. Eur J Neurol, 13 (3), 225-32.

Kaste M (2005). 'Thrombolysis: what more does it take?' Stroke, 36 (2), 200-2.

Kennedy J, Ma C and Buchan AM (2004). 'Organization of regional and local stroke resources: methods to expedite acute management of stroke'. Curr Neurol Neurosci Rep, 4 (1), 13-18.

Kidwell CS, Starkman S, Eckstein M, Weems K and Saver JL (2000). 'Identifying stroke in the field. Prospective validation of the Los Angeles prehospital stroke screen (LAPSS)'. Stroke, 31 (1), 71-6.

Kjellstrom T, Norrving B and Shatchkute A (2006). Helsingborg Declaration 2006 on European Stroke Strategies. Cerebrovasc Dis, 23 (2-3), 229-41.

Koennecke HC, Nohr R, Leistner S and Marx, P (2001). 'Intravenous tPA for ischemic stroke team performance over time, safety, and efficacy in a single-center, 2-year experience'. Stroke, 32 (5), 1074-8.

Kwan J and Sandercock P (2002). 'In-hospital care pathways for stroke'. Cochrane Database Syst Rev, 2, CD002924.

Kwan J and Sandercock P (2004). 'In-hospital care pathways for stroke'. Cochrane Database Syst Rev, 4, CD002924.

Langhorne P, Dennis MS, Kalra L, Shepperd S, Wade DT and Wolfe CD (2000). 'Services for helping acute stroke patients avoid hospital admission'. Cochrane Database Syst Rev, 2, CD000444.

Langhorne P, Taylor G, Murray G, Dennis M, Anderson C, Bautz-Holter E, Dey P, Indredavik B, Mayo N, Power M, Rodgers H, Ronning OM, Rudd A, Suwanwela N, Widen-Holmqvist L and Wolfe C (2005). 'Early supported discharge services for stroke patients: a meta-analysis of individual patients' data'. Lancet, 365 (9458), 501-6.

Larsen T, Olsen TS and Sorensen J (2006). 'Early home-supported discharge of stroke patients: a health technology assessment'. Int J Technol Assess Health Care, 22 (3), 313-20.

Lattimore SU, Chalela J, Davis L, DeGraba T, Ezzeddine M, Haymore J, Nyquist P, Baird AE, Hallenbeck J and Warach S (2003). 'Impact of establishing a primary stroke center at a community hospital on the use of thrombolytic therapy: the NINDS Suburban Hospital Stroke Center experience'. Stroke, 34 (6), e55-7.

Legg L and Langhorne P (2004). 'Rehabilitation therapy services for stroke patients living at home: systematic review of randomised trials'. Lancet, 363 (9406), 352-6.

Liferidge AT, Brice JH, Overby BA and Evenson KR (2004). Ability of laypersons to use the Cincinnati Prehospital Stroke Scale. Prehosp Emerg Care, 8 (4), 384-7.

Lincoln NB, Walker MF, Dixon A and Knights P (2004). 'Evaluation of a multiprofessional community stroke team: a randomized controlled trial'. Clin Rehabil, 18 (1), 40-7.

Marler JR, Tilley BC, Lu M, Brott TG, Lyden PC, Grotta JC, Broderick JP, Levine SR, Frankel MP, Horowitz SH, Haley EC Jr, Lewandowski CA and Kwiatkowski TP (2000). 'Early stroke treatment associated with better outcome: the NINDS rt-PA stroke study'. Neurology, 55 (11), 1649-55.

Mehdiratta M, Woolfenden AR, Chapman KM, Johnston DC, Schulzer M, Beckman J and Teal PA (2006). 'Reduction in IV t-PA door to needle times using an acute stroke triage pathway'. Can J Neurol Sci, 33 (2), 214-6.

Morgenstern LB, Lisabeth LD, Mecozzi AC, Smith MA, Longwell PJ, McFarling DA and Risser J. M (2004). 'A population-based study of acute stroke and TIA diagnosis'. Neurology, 62 (6), 895-900.

Morris DL, Rosamond W, Madden K, Schultz C and Hamilton S (2000). 'Prehospital and emergency department delays after acute stroke: the Genentech Stroke Presentation Survey'. Stroke, 31 (11), 2585-90.

Moser DK, Kimble LP, Alberts MJ, Alonzo A, Croft JB, Dracup K, Evenson KR, Go AS, Hand MM, Kothari RU, Mensah GA, Morris DL, Pancioli AM, Riegel B and Zerwic JJ (2006). 'Reducing delay in seeking treatment by patients with acute coronary syndrome and stroke: a scientific statement from the American Heart Association Council on cardiovascular nursing and stroke council'. Circulation, 114 (2), 168-82.

Murray J, Young J, Forster A and Ashworth R (2003). 'Developing a primary care-based stroke model: the prevalence of longer-term problems experienced by patients and carers'. Br J Gen Pract, 53 (495), 803-7.

National Audit Office (2005). Reducing Brain Damage: Faster access to better stroke care. Department of Health, National Audit Office.

National Institute of Neurological Disorders and Stroke rt-PA Stroke Study Group (1995). Tissue plasminogen activator for acute ischemic stroke. N Engl J Med, 333 (24), 1581-7.

National Sentinal Stroke Audit (2007). Report for England, Wales and Northern Ireland. Prepared on behalf of the Intercollegiate Stroke Working Pary by Royal College of Physicians of London.

Nir Z, Zolotogorsky Z and Sugarman H (2004). 'Structured nursing intervention versus routine rehabilitation after stroke'. Am J Phys Med Rehabil, 83 (7), 522-9.

Noorani HZ, Brady B, McGahan L, Teasell R, Skidmore B and Doherty TJ (2003). *A Clinical and Economic Review of Stroke Rehabilitation Services* [Issue 10]. Ottawa: Canadian Coordinating Office for Health Technology Assessment.

Pancioli AM, Broderick J, Kothari R, Brott T, Tuchfarber A, Miller R, Khoury J, and Jauch E (1998). 'Public perception of stroke warning signs and knowledge of potential risk factors'. JAMA, 279 (16), 1288-92.

Pandian JD, Jaison A, Deepak SS, Kalra G, Shamsher S, Lincoln DJ and Abraham G (2005). 'Public awareness of warning symptoms, risk factors, and treatment of stroke in northwest India'. Stroke, 36 (3), 644-8.

Phillips SJ, Eskes GA and Gubitz GJ (2002). 'Description and evaluation of an acute stroke unit'. CMAJ, 167 (6), 655-60.

Reeves MJ, Hogan JG and Rafferty AP (2002). 'Knowledge of stroke risk factors and warning signs among Michigan adults'. Neurology, 59 (10), 1547-52.

Ricauda N, Bo M, Molaschi M, Massaia M, Salerno D, Amati D, Tibaldi V and Fabris F (2004). 'Home hospitalization service for acute uncomplicated first ischemic stroke in elderly patients: a randomized trial'. Journal of the American Geriatrics Society, 52 (2), 278-283.

Rodin M, Saliba D and Brummel-Smith K (2006). Guidelines abstracted from the Department of Veterans Affairs/Department of Defense clinical practice guideline for the management of stroke rehabilitation'. J Am Geriatr Soc, 54 (1), 158-62.

Ryan T, Enderby P and Rigby AS (2006). 'A randomized controlled trial to evaluate intensity of community-based rehabilitation provision following stroke or hip fracture in old age'. Clin Rehabil, 20 (2), 123-31.

Sacco RL, Adams R, Albers G, Alberts MJ, Benavente O, Furie K, Goldstein LB, Gorelick P, Halperin J, Harbaugh R, Johnston SC, Katzan I, Kelly-Hayes M, Kenton EJ, Marks M, Schwamm LH and Tomsick T (2006). 'Guidelines for prevention of stroke in patients with ischemic stroke or transient ischemic attack: a statement for healthcare professionals from the American Heart Association/American Stroke Association Council on Stroke: co-sponsored by the Council on Cardiovascular Radiology and Intervention: the American Academy of Neurology affirms the value of this guideline'. Stroke, 37 (2), 577-617.

Sandercock P, Berge E, Dennis M, Forbes, J, Hand P, Kwan J, Lewis S, Lindley R, Neilson A, Thomas B and Wardlaw J (2002) 'A systmatic review of the effectiveness, cost-effectiveness and barriers to implementation of thrombolytic andneuroprotective therapy for acute ischaeimic stroke in the NHS.' Health Technol Assess 2002;6(26).

Schneider AT, Pancioli AM, Khoury JC, Rademacher, E, Tuchfarber A, Miller R, Woo D, Kissela B and Broderick JP (2003). 'Trends in community knowledge of the warning signs and risk factors for stroke'. JAMA, 289 (3), 343-6.

Schwamm L, Rosenthal E, Hirshberg A, Schaefer P, Little E, Kvedar J, Petkovska I, Koroshetz W and Levine S (2004). ,Virtual TeleStroke support for the emergency department evaluation of acute stroke'. Academic Emergency Medicine, 11 (11), 1193-7.

Schwamm LH, Pancioli A, Acker JE 3rd, Goldstein LB, Zorowitz RD, Shephard TJ, Moyer P, Gorman M, Johnston SC, Duncan PW, Gorelick P, Frank J, Stranne SK, Smith R, Federspiel W, Horton KB, Magnis E and Adams RJ (2005). 'Recommendations for the establishment of stroke systems of care: recommendations from the American Stroke Association's Task Force on the Development of Stroke Systems'. Stroke, 36 (3), 690-703.

Scottish Intercollegiate Guidelines Network (2002). Guidelines on CHD and Stroke. Edinburgh, Scotland: Scottish Intercollegiate Guidelines Network.

Scott PA, Pancioli AM, Davis, LA, Frederiksen SM, and Eckman J. (2002). Prevalence of atrial fibrillation and antithrombotic prophylaxis in emergency department patients. Stroke. 2002;33:2664-2669.

Segura T, Vega G, Lopez S, Rubio F and Castillo J (2003). 'Public perception of stroke in Spain'. Cerebrovasc Dis, 16 (1), 21-6.

Sharma M, Clark H, Armour T, Stotts G, Cote R, Hill, MD, Demchuck A, Moher D, Garritty C, Yazdi F, Lumely-Leger K, Murdock M, Sampson M, Barrowman N and Lewin G (2005). Acute Stroke Evaluation and Treatment. Evidence Report/Technology Assessment #127 Rockville, MD: Agency for Healthcare Research and Quality.

Shepperd S and Iliffe S (2005). 'Hospital at home versus in-patient hospital care'. Cochrane Database Syst Rev, 3, CD000356.

Silver FL, Rubini F, Black D and Hodgson CS (2003). 'Advertising strategies to increase public knowledge of the warning signs of stroke'. Stroke, 34 (8), 1965-8.

Silliman SL, Quinn B, Huggett V and Merino JG (2003). 'Use of a field-to-stroke center helicopter transport program to extend thrombolytic therapy to rural residents'. Stroke, 34 (3), 729-33.

Steultjens EM, Dekker J, Bouter LM, van de Nes JC, Cup EH and van den Ende CH (2003). 'Occupational therapy for stroke patients: a systematic review'. Stroke, 34 (3), 676-87.

Stroke Unit Trialists' Collaboration (2002). Organised inpatient (stroke unit) care for stroke. Cochrane Database Syst Rev, 1, CD000197.

Stroke Unit Trialists' Collaboration (2007). Organised inpatient (stroke unit) care for stroke. Chochrane Database of Systematic Reviews CD00197 pub 2. Date of last substantive update August 17, 2007.

Sug Yoon S, Heller RF, Levi C, Wiggers J and Fitzgerald PE (2001). 'Knowledge of stroke risk factors, warning symptoms, and treatment among an Australian urban population'. Stroke, 32 (8), 1926-30.

Teasell, RW, Foley NC, Bhogal SK and Speechley MR (2003). 'Early supported discharge in stroke rehabilitation'. Top Stroke Rehabil, 10 (2), 19-33.

Teasell RW and Kalra L (2005). 'What's new in stroke rehabilitation: back to basics'. Stroke, 36 (2), 215-7.

Thorsen AM, Holmqvist LW, de Pedro-Cuesta J and von Koch L (2005). 'A randomized controlled trial of early supported discharge and continued rehabilitation at home after stroke: five-year follow-up of patient outcome'. Stroke, 36 (2), 297-303.

Torp CR, Vinkler S, Pedersen KD, Hansen FR, Jorgensen T, Willaing I and Olsen J (2006). 'Model of hospital-supported discharge after stroke'. Stroke, 37 (6), 1514-20.

Visser-Meily A, van Heugten C, Post M, Schepers V and Lindeman E (2005). 'Intervention studies for caregivers of stroke survivors: a critical review'. Patient Educ Couns, 56 (3), 257-67.

Waite K, Silver F, Jaigobin C, Black S, Lee L, Murray B, Danyliuk P and Brown EM (2006). 'Telestroke: a multi-site, emergency-based telemedicine service in Ontario'. J Telemed Telecare, 12 (3), 141-5.

Wang S, Gross H, Lee SB, Pardue C, Waller J, Nichols FT 3rd, Adams RJ and Hess DC (2004). 'Remote evaluation of acute ischemic stroke in rural community hospitals in Georgia'. Stroke, 35 (7), 1763-8.

Wardlaw JM, del Zoppo G and Yamaguchi T (2000). 'Thrombolysis for acute ischaemic stroke'. Cochrane Database Syst Rev, 2, CD000213.

Wodchis WP, Teare GF, Naglie G, Bronskill SE, Gill SS, Hillmer MP, Anderson GM, Rochon PA and Fries BE (2005). 'Skilled nursing facility rehabilitation and discharge to home after stroke'. Arch Phys Med Rehabil, 86 (3), 442-8.

Wojner-Alexandrov AW, Alexandrov AV, Rodriguez D, Persse D and Grotta JC (2005). 'Houston paramedic and emergency stroke treatment and outcomes study (HoPSTO)'. Stroke, 36 (7), 1512-8.

Woolf SH and Johnson RE (2005). 'The break-even point: when medical advances are less important than improving the fidelity with which they are delivered'. Ann Fam Med, 3 (6), 545-52.

Wu O and Langhorne P (2006). 'The challenge of acute-stroke management: Does telemedicine offer a solution?' International Journal of Stroke, 1, 201-7.

Zheng H, Black ND and Harris ND (2005). 'Position-sensing technologies for movement analysis in stroke rehabilitation'. Med Biol Eng Comput, 43 (4), 413-20.

APPENDIX

Table A-1. Articles relevant to the delivery of stroke care and associated MeSH indexing

Citation	MeSH headings
Phase I: Best papers	
Rudd AG, Hoffman A, Irwin P, Pearson M, Lowe D; Intercollegiate Working Party for Stroke (2005). 'Stroke units: research and reality. Results from the National Sentinel Audit of Stroke'. Qual Saf Health Care, Feb, 14 (1), 7-12.	MH – Cerebrovascular accident/*therapy MH – Great Britain MH – Health services research MH – Hospital units/*statistics and numerical data MH – Humans MH – Personnel staffing and scheduling MH – Specialties, medical
Forster A, Smith J, Young J, Knapp P, House A, Wright J (2001). 'Information provision for stroke patients and their caregivers'. Cochrane Database Syst Rev 3, CD001919. Review.	MH – *Caregivers MH – Case-control studies MH – *Cerebrovascular accident MH – Health knowledge, attitudes, practice MH – Health services accessibility MH – Humans MH – *Patient education/methods/standards
Early Supported Discharge Trialists 'Services for reducing duration of hospital care for acute stroke patients'. Cochrane Database Syst Rev, 1, 2002, CD000443. Review. Update in: Cochrane Database Syst Rev, 2, 2005, CD000443.	MH – Cerebrovascular accident/*rehabilitation MH – Cost-benefit analysis MH – *Home care services MH – *Home nursing MH – Humans MH – Length of stay MH – Randomised controlled trials
Phase II: Expanded group of relevant papers	
Cadilhac DA, Moodie ML, Lalor EE, Bilney LE, Donnan GA; National Stroke Foundation (2006). 'Improving access to evidence-based acute stroke services: development and evaluation of a health systems model to address equity of access issues'. Aust Health Rev, Feb, 30 (1), 109-18.	MH – Acute disease MH – Australia MH – Cerebrovascular accident/*therapy MH – *Evidence-based medicine MH – *Health services accessibility MH – Humans MH – *Models, organisational MH – National health programmes

Citation	MeSH headings
Russman AN, Katzan IL (2005). 'Acute stroke treatment in the community: improving our performance and expanding our options'. Semin Neurol, Dec, 25 (4), 337-44. Review.	MH – Cerebrovascular accident/*therapy MH – *Community health services MH – Delivery of health care/methods MH – Emergency medical services/methods MH – Humans MH – *Residence characteristics
Gandjour A, Lauterbach KW (2005). 'How much does it cost to change the behavior of health professionals? A mathematical model and an application to academic detailing'. Med Decis Making, May-Jun, 25 (3), 341-7.	MH – Antihypertensive agents/therapeutic use MH – Cerebrovascular accident/prevention and control MH – Coronary disease/prevention and control MH – Cost-benefit analysis MH – Education, medical, continuing/*economics MH – Evidence-based medicine/economics/ *statistics and numerical data MH – Germany MH – Guideline adherence/economics/*statistics and numerical data MH – Health services misuse MH – Humans MH – Hypertension/complications/diagnosis/drug therapy MH – *Models, econometric MH – Physicians, family/*education/ psychology/ standards MH – Primary prevention/*economics/standards MH – Quality assurance, health care/*economics MH – Quality-adjusted life years MH – Risk factors
Lees KR, Hankey GJ, Hacke W (2003). 'Design of future acute-stroke treatment trials'. Lancet Neurol, Jan, 2 (1), 54-61. Review.	MH – Cerebrovascular accident/classification/ drug therapy/pathology/*therapy MH – Clinical trials MH – Data collection MH – Humans MH – *Research design MH – Treatment outcome

Citation	MeSH headings
Panzarasa S, Madde S, Quaglini S, Pistarini C, Stefanelli M (2002). 'Evidence-based careflow management systems: the case of post-stroke rehabilitation'. J Biomed Inform, Apr, 35 (2), 123-39.	MH – Cerebrovascular accident/*rehabilitation MH – Delivery of health care/methods/organisation and administration MH – Evidence-based medicine/methods/ *organisation and administration MH – Humans MH – Management information systems MH – *Models, organisational MH – Patient care management/methods/ *organisation and administration MH – Patient care planning/organisation and administration MH – Patient care team/organisation and administration MH – Practice guidelines MH – Total quality management/methods/ organisation and administration
McKenna K, Tooth L, Strong J, Ottenbacher K, Connell J, Cleary M (2002). 'Predicting discharge outcomes for stroke patients in Australia. Am J Phys Med Rehabil, Jan, 81 (1), 47-56.	MH – Activities of daily living MH – Adolescent MH – Adult MH – Aged MH – Australia MH – Cerebrovascular accident/*rehabilitation MH – Data collection MH – Female MH – Humans MH – *Length of stay MH – Logistic models MH – Male MH – Middle aged MH – *Patient discharge MH – Predictive value of tests MH – *Treatment outcome

Citation	MeSH headings
Long AF, Kneafsey R, Ryan J, Berry J (2002). 'The role of the nurse within the multi-professional rehabilitation team'. J Adv Nurs, Jan, 37 (1), 70-8.	MH – Arthritis, rheumatoid/nursing/rehabilitation MH – Cerebrovascular accident/nursing/rehabilitation MH – Communication MH – England MH – Femoral neck fractures/nursing/rehabilitation MH – Humans MH – Interprofessional relations MH – *Nurse's role MH – Nursing assessment MH – Patient care team/*organisation and administration MH – Professional-family relations MH – Rehabilitation/*nursing/organisation and administration
Quaglini S, Caffi E, Cavallini A, Micieli G, Stefanelli M (2001). 'Simulation of a stroke unit careflow'. Medinfo, 10 (Pt 2), 1190-1.	MH – Brain ischemia/therapy MH – Cerebrovascular accident/*therapy MH – *Computer simulation MH – Decision support techniques MH – Delivery of health care MH – Hospital departments/*organisation and administration MH – Humans MH – *Models, organisational MH – Practice guidelines

Citation	MeSH headings
Stineman MG, Ross RN, Hamilton BB, Maislin G, Bates B, Granger CV, Asch DA (2001). 'Inpatient rehabilitation after stroke: a comparison of lengths of stay and outcomes in the Veterans Affairs and non-Veterans Affairs health care system'. Med Care, Feb, 39 (2), 123-37.	MH – Activities of daily living MH – Aged MH – Cerebrovascular accident/*rehabilitation MH – Cost control MH – Diagnosis-related groups/classification MH – Female MH – Geriatric assessment MH – Health services research MH – Home care services/standards/utilisation MH – Hospitals, veterans/*standards/*utilisation MH – Humans MH – Length of stay/*statistics and numerical data MH – Linear models MH – Logistic models MH – Male MH – Middle aged MH – Multivariate analysis MH – *Outcome assessment (health care) MH – Programme evaluation MH – Social support MH – United States MH – United States Department of Veterans Affairs MH – Utilisation review

Citation	MeSH headings
Oddone E, Brass LM, Booss J, Goldstein L, Alley L, Horner R, Rosen A, Kaplan L (2000). 'Quality enhancement research initiative in stroke: prevention, treatment, and rehabilitation'. Med Care, Jun, 38 (6), Suppl 1, I92-104. Review.	MH – Adult MH – Benchmarking/organisation and administration MH – Cause of death MH – Cerebrovascular accident/complications/ mortality/psychology/*therapy MH – Databases, factual MH – Documentation/methods/standards MH – Endarterectomy, carotid MH – Health services research/*organisation and administration MH – Humans MH – Outcome and process assessment (health care)/organisation and administration MH – Physician's practice patterns/standards/ statistics and numerical data MH – Quality of life MH – Rehabilitation/methods/standards MH – Risk factors MH – Total quality management/*organisation and administration MH – United States/epidemiology MH – United States Department of Veterans Affairs/ *organisation and administration
Baker CM, Miller I, Sitterding M, Hajewski CJ (1998). 'Acute stroke patients comparing outcomes with and without case management'. Nurs Case Manag, Sep-Oct, 3 (5), 196-203.	MH – Acute disease MH – Aged MH – Case management/*standards MH – Cerebrovascular disorders/*nursing MH – Critical pathways/*standards MH – Female MH – Humans MH – Male MH – Models, nursing MH – Nursing records MH – *Outcome assessment (health care) MH – Pilot projects MH – Retrospective studies

Citation	MeSH headings
Deaton C. 'Outcomes measurement. Multidisciplinary approaches and patient outcomes after stroke'. J Cardiovasc Nurs. 1998 Oct;13 (1), 93-6.	MH – Cerebrovascular disorders/*therapy MH – Critical pathways/organisation and administration MH – Humans **MH – Interprofessional relations** **MH – Models, organisational** **MH – Outcome assessment (health care)/ *organisation and administration** MH – Patient care team/*organisation and administration
Allen SS, Harris IB, Kofron PM, Anderson DC, Bland CJ, Dennis T, Satran L, Miller WJ (1992). 'A comparison of knowledge of medical students and practicing primary care physicians about cardiovascular risk assessment and intervention'. Prev Med, Jul, 21 (4), 436-48.	**MH – *Cardiovascular diseases/diagnosis/ aetiology/ prevention and control** MH – *Clinical competence MH – Educational measurement MH – *Physicians, family MH – Reproducibility of results MH – Risk factors MH – *Students, medical

Endnotes

1 The quality of this review was not evaluated by the CRD.

2 The quality of this systematic review has not been assessed by the CRD.

3 A review from the CRD indicated that although findings may not be comparable across the studies because the duration and nature of the ESD programmes differed, the authors of the review provided an accurate summary of the available evidence.