3 Stroke

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1 Summary

Introduction

Stroke accounts for 11% of all deaths in England and Wales, and is also an important cause of morbidity, since the majority of patients survive their first stroke, often with significant disability. The significance of stroke as a major health care problem has been recognised in recent government white papers, which have set targets for reductions in stroke mortality. Standard five of the National Service Framework (NSF) for older people states that: '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.'

There have been important advances in the evidence base for the prevention, treatment and rehabilitation of stroke in the last decade. Commissioners of health care face important decisions about how to implement this evidence and comply with the NSF and how to allocate priorities to different aspects of stroke care. This chapter aims to provide the background information to support such decision making.

Sub-categories

There are several different ways of categorising the problems related to stroke. From a perspective of health care needs assessment, no single classification is ideal. A pragmatic solution is to use the following sub-categories:

- **People at high risk of stroke:** This category has been included because stroke prevention should have a key role in health strategies, exemplified by local Health Improvement Plans. Mortality targets set by the government ensure that stroke prevention will remain a priority for Health Authorities and Primary Care Groups/Trusts.
- **Transient ischaemic attack (TIA):** Defined as an acute loss of focal cerebral or ocular function with symptoms lasting less than 24 hours, which is presumed after adequate investigation to be due to embolic or thrombotic vascular disease.
- **Stroke (acute phase):** The World Health Organisation (WHO) defines stroke as a syndrome of rapidly developing symptoms and signs of focal, and at times global, loss of cerebral function lasting more than 24 hours or leading to death, with no apparent cause other than that of vascular origin. Although sub-arachnoid haemorrhage is included within this WHO definition, it is appropriately dealt with separately (*see* below).

- **People with sequelae of stroke:** Needs for rehabilitation and continuing care services relate to the medium- and long-term consequences of stroke. Such patients also benefit from therapy aimed at the reduction of risk of further stroke or other vascular events.
- **Sub-arachnoid haemorrhage:** This clinical syndrome is caused by blood in the sub-arachnoid space, typically due to leakage of blood from an aneurysm near the circle of Willis. While sub-arachnoid haemorrhage may lead to cerebral infarction, the acute management is different from that for focal stroke, and therefore it is useful to consider it as a separate sub-category.

Prevalence and incidence

Using data from a number of different sources, including the Health Survey for England, and UK-based prevalence surveys and incidence studies, the following estimates of numbers of cases per 100 000 population in a year were made:

Table 1: Summary of epidemiology of stroke and risk factors for stroke in a population of 100,000.

Sub-category	Expected number of new cases per year (incidence)	Expected number of existing cases (prevalence)
Risk factors for stroke		
Atrial fibrillation	330	1,100
Hypertension (BP > 140/90)		34,000
Current smokers		28,000
Diabetes mellitus		2,000
Ischaemic heart disease		5,500
Transient ischaemic attack	35	
Stroke		1,500
First stroke (excluding sub-arachnoid haemorrhage)	164	
Recurrent stroke	57	
People with moderate disability from stroke	N/A	1,000
Sub-arachnoid haemorrhage	10	

These estimates are based upon the population structure of England and Wales as a whole. The prevalence and incidence of stroke rise with age, so these figures need to be adjusted for areas that have different age distributions, such as retirement areas or new towns. The prevalence and incidence of stroke also depends upon other population factors such as ethnic mix and socio-economic status.

Services available and their costs

Prevention of stroke

Both population-based strategies and approaches to reduce the risk in individuals at high risk of stroke are used. Services available to treat people at high risk of stroke include: blood pressure reduction; anticoagulation for people in atrial fibrillation; investigation of transient ischaemic attack, and treatment with carotid endarterectomy in appropriate cases. Aspirin is also indicated for many people at high risk of stroke. Other relevant services include those related to smoking cessation, weight reduction and exercise promotion.

Acute management and rehabilitation of stroke

The majority of patients with acute stroke are cared for initially in hospital, though a proportion remain at home. Community services available to facilitate home care in different parts of the country include: rapid response teams; hospital at home; day hospital; outpatient and domiciliary services. In hospital, patients may be cared for in specialist facilities or on general wards. Types of specialist facility that are available under the broad umbrella term of 'stroke unit care' include stroke teams, dedicated stroke units (which may be for acute care and/or rehabilitation), and mixed rehabilitation units. Recent audits suggest that the majority of patients are cared for on general wards. In some areas, intermediate care facilities such as community hospitals and social rehabilitation units are available to facilitate transfer from hospital back into the community. Approximately 19% of stroke survivors are transferred to long-term institutional care.

Services for sub-arachnoid haemorrhage

Acute sub-arachnoid haemorrhage is usually managed in hospital. Both acute medical therapy, in the form of nimodipine, and surgery (to repair underlying vascular defects) are available.

Costs of stroke care

Stroke has been estimated to account for between 4–6% of total NHS costs. It has been estimated that approximately two-thirds of these costs arise from the treatment and care of people with 'old' strokes.

Effectiveness and cost-effectiveness

Population strategies to prevent stroke

Evidence from observational studies supports a number of population strategies to lower the incidence of stroke, directed at reducing smoking, reducing socio-economic deprivation, lowering blood pressure and encouraging healthy lifestyles.

Prevention in people at high risk of stroke

Treating hypertension, anticoagulating people in atrial fibrillation, treating people at high cardiovascular risk with antiplatelet agents, treating people with vascular disease with statins, tight control of blood glucose and blood pressure in diabetics, and performing carotid endarterectomy in people with significant carotid artery stenosis are all approaches that have been demonstrated to be effective in randomised controlled trials (RCTs). Evidence from observational studies supports the encouragement of changes in lifestyle, such as stopping smoking, healthy diet, exercise and avoidance of excessive alcohol consumption.

Acute treatment of stroke

There is good evidence that patients receiving organised inpatient or stroke unit care have lower mortality than those cared for in other settings. While many pharmacological interventions in acute stroke have been studied, aspirin and thrombolysis (in certain specific circumstances) are the only ones shown by RCTs to be effective.

Stroke rehabilitation

There is good evidence that organised stroke care given by a co-ordinated specialist team reduces disability and rates of institutionalisation. Within the overall package of stroke unit care, there is a growing evidence base for individual components. There is now evidence from RCTs supporting the use of physiotherapy, occupational therapy and family support for carers.

Treatment of sub-arachnoid haemorrhage

Nimodipine is effective in the treatment of acute sub-arachnoid haemorrhage.

Models of care and recommendations

Guidelines for stroke care

National guidelines and statements on stroke care have been produced by the Intercollegiate Working Party on Stroke, the Edinburgh Consensus Meetings, and the Scottish Intercollegiate Guidelines Network (SIGN). These provide an excellent basis for considering the optimum pattern of stroke services for a defined population.

The key components of a strategy for primary stroke prevention include: identification and treatment of hypertension; identification and treatment of atrial fibrillation; careful control of hypertension in diabetes; lifestyle advice with regard to smoking, diet, weight, and exercise; and treatment with a statin of patients with known vascular disease and elevated cholesterol.

The same issues apply to treatment of people who have had a stroke or transient ischaemic attack (TIA), but because the risks of subsequent strokes are high, each is of relatively greater importance. In addition, following ischaemic stroke, patients should be on aspirin, or another antiplatelet agent if aspirin-intolerant. Patients with a TIA or minor stroke should be assessed rapidly for eligibility for carotid endarterectomy, which should be performed in a centre with a low complication rate. This might necessitate referral to regional or sub-regional units.

There is consensus that the vast majority of patients with acute stroke should initially be assessed in hospital. Aspirin is an effective acute treatment for ischaemic stroke, and is preferably administered after brain imaging has been performed to rule out intracranial haemorrhage. Thrombolytic therapy is a reasonable treatment to give in selected patients, but only in specialist centres in a carefully monitored environment. Further research is required before such a model of care can be 'rolled out' to a wider population.

There is strong evidence that acute care and rehabilitation of stroke patients is highly effective when carried out in inpatient stroke units that offer an organised, multidisciplinary approach to care. All stroke patients should have access to such care. The extent to which these results can be reproduced in other settings, such as community hospitals, day hospitals and at home, have not yet been demonstrated. While some studies have been carried out looking at early discharge schemes, the precise contribution that these should make has still to be defined. Nevertheless, it is impractical to expect stroke units (with an average unit size of 6–15 beds) to cater for the needs of a typical district general hospital catchment area serving a population of 300 000, which can anticipate having on average 30 patients with stroke in hospital at a time. Therefore, different models of DGH care that conform to the broader definition of 'stroke unit care' need to be employed, and locality-based models of intermediate care need to be developed and evaluated.

Towards a quantified model for stroke care

With regard to services specifically aimed at stroke prevention, in a typical population of 100 000 it is estimated that in a year:

- 539 of the estimated 1100 patients in atrial fibrillation will need anticoagulation
- 99 patients will need rapid neurological assessment and or assessment for eligibility for carotid endarterectomy
- 14 patients will need carotid endarterectomy.

With regard to acute stroke treatment and rehabilitation, in a typical population of 100 000 which suffers 221 first or recurrent strokes in a year it is estimated that:

- 12 hospital beds will be required (within a setting that conforms to stroke unit care)
- access to neurosurgical services is required for patients with sub-arachnoid haemorrhage and patients with stroke who develop hydrocephalus
- access to community-based specialist rehabilitation services is required – the size of these will depend upon the extent to which hospital-based or community-based rehabilitation is the preferred model within a given area.

Priorities for stroke care

Within the optimum model for stroke care promoted by national guidelines, priority should be given to establishment of stroke units and developing models of care that permit care of equivalent quality to stroke unit care to be applied to a larger proportion of stroke patients. In hospital, this will mean ensuring co-ordinated, multidisciplinary specialist care in settings other than stroke units, such as neurological and geriatric rehabilitation wards. With regard to stroke prevention, simple interventions such as aspirin in appropriate patients are highly cost-effective. Anticoagulation for atrial fibrillation and carotid endarterectomy in selected patients are also cost-effective treatments, though the former has greater potential, both in terms of numbers of strokes that might be prevented and relative cost (approximately £4000 versus £28 000 per stroke prevented). More effective treatment of hypertension is the strategy that has the most potential for reducing stroke incidence, but the relative cost-effectiveness is critically dependent upon whether older or newer antihypertensive agents are used.

2 Introduction

Stroke as a major health issue

Stroke is a major health problem in the UK. It accounted for over 56 000 deaths in England and Wales in 1999, which represents 11% of all deaths.[1] The majority of patients survive a first stroke, often with significant morbidity. Overall it has been estimated that caring for people with stroke accounts for 4–6% of the total NHS budget.[2,3] While there is evidence that age-specific mortality from stroke has been declining in recent years,[1] this is unlikely to result in any decline in need for services, since this in part reflects better survival following stroke. Furthermore, ageing of the population will offset any age-specific decline in incidence.

International comparisons of stroke mortality

The burden of stroke in terms of mortality in the UK can be set in a worldwide context. An analysis of World Health Organisation (WHO) data shows that mortality is lowest in affluent industrialised

countries, and that UK mortality is broadly similar to that in other Western European countries.[4] For example, the mortality rate for men aged 35–74 in 16 Western European countries ranges from 34 per 100 000 (Switzerland) to 162 per 100 000 (Portugal). The UK is ranked ninth in this set of countries, with a mortality of 65 per 100 000. International comparisons of case fatality (i.e. whether or not strokes that occur are fatal) give a slightly different picture, with the UK tending to have higher case fatality than other areas of Western Europe.[5,6] It is difficult to disentangle whether the differences in case fatality are due to differences in methods of data collection, case-mix, or care provided. High case fatality but average mortality from stroke (as experienced in the UK) taken at face value would imply lower incidence, but this is not borne out by comparative incidence studies.[6,7] This would suggest that the likeliest explanation for the discrepancy is methodological artefact (which may affect either or both case fatality and mortality).

Stroke and government policy

The importance of stroke has been stressed in government policy over the last decade. Two white papers, the *Health of the Nation*[3] and *Saving Lives: Our Healthier Nation*,[8] set targets for reductions in stroke mortality. There is a chapter on stroke in the National Service Framework (NSF) for older people in which standard five aims 'to reduce the incidence of stroke in the population and ensure that those who have had a stroke have prompt access to integrated stroke care services'.[9] The standard given is that: '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 implementation of the NSF standard sets a challenge. The information in this chapter illustrates the dimensions of the task ahead to implement the NSF standard. The chapter summarises the epidemiology of stroke (section 4), the current pattern of stroke services (section 5), the evidence of effectiveness of services and interventions (section 6), and models of care to achieve the aim of the NSF (section 7).

Key issues

Within a publicly financed health care system with limited resources, a key issue is how best to distribute the health care resources that are available for stroke care. As in other areas of health care, there is controversy over which part of the system is in most need of extra resources. Should the emphasis be on hospital-based or community-based services? On services for prevention or treatment? On acute treatments or longer-term rehabilitation? These questions have no simple answers, and the solutions lie in getting the balance right between these different facets of stroke services. One aim of this chapter is to provide the background information that will help commissioners of health care services to make rational choices in these difficult areas.

There have been significant improvements in the evidence base for stroke in the last decade. Effective strategies are available to prevent stroke, and to treat and rehabilitate stroke patients. However, audits suggest that many people with stroke are not receiving optimal care.[10] This raises important issues of implementation. The Intercollegiate Working Party (IWP) for Stroke has prepared multidisciplinary guidelines for stroke care which reflect this evidence base,[11] and a key question for commissioners of health care is how best to support implementation of these guidelines, which have been explicitly incorporated into the National Service Framework.

The data that are available from epidemiological studies are only of limited value for a health care needs assessment. While there are now reasonable data on the incidence and prevalence of stroke, data on the

incidence and prevalence of disability and impairment, which is a stronger predictor of the need for rehabilitation and continuing care services, are limited. Therefore, there is a danger that needs assessment (and hence service provision) can become too focused on the needs of people with acute stroke, and less on their rehabilitation and longer-term care needs.

3 Sub-categories

Stroke is a neurological impairment of sudden onset which is caused by a disruption of the blood supply to the brain. Stroke is an umbrella term that includes different pathologies and clinical syndromes. This can lead to some confusion in the literature. In this chapter, for pragmatic reasons that are explained below, stroke is distinguished from sub-arachnoid haemorrhage and from transient ischaemic attack (*see* 'Sub-categories used in this chapter' below for definitions of these conditions that are used in this chapter). In fact, the standard definition of stroke[12] includes sub-arachnoid haemorrhage, but because the clinical syndrome of sub-arachnoid haemorrhage is quite distinct from stroke and is managed in a different way, in this chapter sub-arachnoid haemorrhage is considered separately. The standard definition of stroke excludes transient ischaemic attack on the basis of duration of symptoms: to be labelled 'a stroke', symptoms have to last for more than 24 hours, otherwise the label 'transient ischaemic attack' applies. However, the underlying pathology is the same, and the management in terms of secondary prevention is identical. The following section reviews the different ways in which stroke can be sub-classified and explains why the sub-categories used in this chapter have been selected.

Possible sub-categorisations

Stroke can be sub-categorised in different ways: by pathological type; by pathological cause; by associated risk factors; by prognosis; by anatomical site; or by impact on disability and handicap. From the perspective of a health care needs assessment, none of these sub-categorisations is entirely satisfactory on its own.

Pathological type

There are two major pathological types of stroke: cerebral infarction and intra-cerebral haemorrhage. A third important acute cerebrovascular disease is sub-arachnoid haemorrhage, which may or may not result in a clinical stroke. The vast majority of stroke is cerebral infarction. For example, in the Oxford Community Stroke Project, 81% of first strokes were cerebral infarction, 10% primary intracerebral haemorrhage, 5% sub-arachnoid haemorrhage, and 5% of uncertain type.[13] The pathological type of stroke is of prognostic significance (*see* Table 2 overleaf) and of clinical significance in that there are some differences in the acute management of patients with intracerebral haemorrhage and cerebral infarction (*see* sections 5 and 6). Sub-arachnoid haemorrhage presents and is managed differently from the other acute cerebrovascular diseases.

While it is useful to distinguish the pathological types of stroke, the exercise is of only limited utility in health care needs assessment. The pathological type is only a very crude predictor of disability and handicap, and these are important determinants of medium- and long-term health care needs. Routine data sets do not discriminate well between types,[14] so practical ability to sub-categorise to this level of detail is limited.

Table 2: Case fatality rates by pathological type of stroke: adapted from Bamford *et al.*[13]

Stroke type	Mortality at one month (95% CI)	Mortality at one year (95% CI)
Cerebral infarction	10% (7–13)	23% (19–27)
Primary intracerebral haemorrhage	50% (38–62)	62% (43–81)
Sub-arachnoid haemorrhage	46% (29–63)	48% (24–72)
Uncertain type	77% (46–100)	84% (52–100)
All	19% (16–22)	31% (27–35)

Pathological cause

The sequence of events leading to permanent brain damage varies considerably, and the underlying mechanisms are interrelated and can lead from one to another (*see* Figure 1). The principal pathological types of stroke are associated with different underlying causes. Cerebral infarction is usually due to thrombosis or embolism, though it can also be a consequence of intracerebral haemorrhage or sub-arachnoid haemorrhage. Embolism may arise either from the heart or from atheromatous arteries. The distinction between thrombosis and embolism and identifying the source of the embolus is of potential relevance in targeting secondary prevention, and for clinical trials of acute treatments. However, accurate classification is usually arbitrary – presence of a source of embolus, for example, does not prove that a stroke had an embolic cause. A classification of sub-type of ischaemic stroke based on presumed underlying pathological cause was proposed by the TOAST (Trial of ORG10172 in Acute Stroke Treatment) investigators: large artery atherosclerosis; cardio-embolism; small-vessel occlusion; stroke of other determined aetiology; stroke of undetermined aetiology.[15] This classification is difficult to apply. The TOAST investigators found that the initial clinical impression of stroke sub-type only agreed with final determination of sub-type (incorporating all investigation results and performed three months after stroke) in 62% of patients, and 15% of patients did not have a clear aetiological sub-type even at three months.[16] Use of modern magnetic resonance imaging techniques can substantially improve the early classification of stroke sub-type.[17] US data from the Stroke Data Bank of the National Institute of

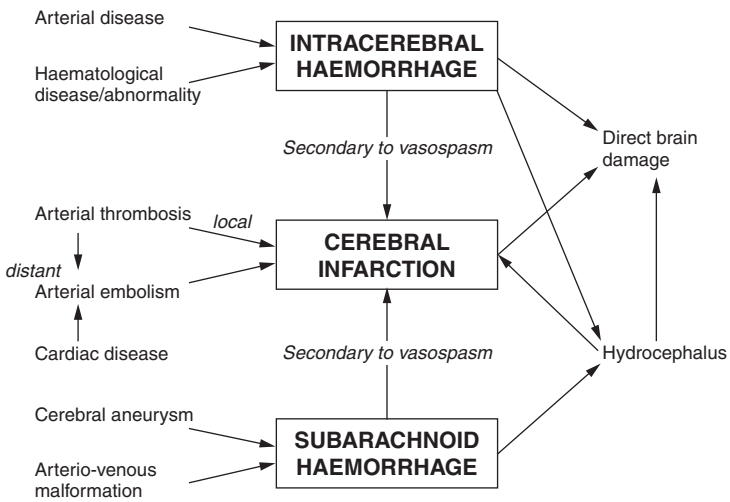


Figure 1: Pathological categorisation of stroke.

Neurological and Communicative Disorders and Stroke and the Framingham study suggest that, using the TOAST classification:[18] 60% of ischaemic stroke is attributed to an embolic cause; 25% of ischaemic stroke to small-vessel occlusion (lacunar stroke); and 15% of ischaemic stroke to large vessel atherothrombosis.

Simple classification of the pathological cause of the stroke is also of prognostic relevance. Follow-up of patients with ischaemic stroke in Rochester, Minnesota found that this classification predicted risk of stroke recurrence at one month (but not in the long term), and long-term (five-year) survival.[19]

Intracerebral haemorrhage may occur as part of sub-arachnoid haemorrhage, but more commonly occurs on its own. The usual causes are vasculopathy secondary to hypertension or vascular disease, intracranial aneurysm (usually associated with sub-arachnoid haemorrhage), and arterio-venous malformations.

Sub-arachnoid haemorrhage is often due to leakage from an intracranial aneurysm, but may also occur as a result of arterio-venous malformations or other vascular abnormalities such as angiomas. Approximately 20% of sub-arachnoid haemorrhage has no demonstrable underlying cause.[20,21]

Associated risk factors

Several medical conditions increase risk of stroke, such as hypertension, atrial fibrillation, diabetes, ischaemic heart disease, and carotid artery stenosis. Aspects of lifestyle modify stroke risk, such as diet, smoking, alcohol, and exercise (*see* section 4). Knowledge of the prevalence of such factors and the strength of their association with stroke is relevant for a disease prevention needs assessment. Estimates can be made of the relative contribution of each risk factor to the overall burden of stroke, which in turn can inform prioritisation of stroke prevention initiatives (*see* section 7).

Prognosis

Prognosis following stroke can be described in terms of survival, risk of a further stroke (recurrence), or extent of long-term disability. Prognostic factors are different for each of these. A number of studies have derived models for predicting outcome of stroke in terms of survival and/or disability.[22–25] These models tend to use a combination of some or all of past medical history (e.g. previous stroke; diabetes), demographic variables (age, sex), and early clinical features (e.g. impaired consciousness; urinary incontinence). Prognosis influences need for health services, so a prognosis-based sub-categorisation could be of value. However, predicting outcome for individuals is very difficult and for groups remains crude. It is questionable whether complex multi-variate models are significantly more useful than simple univariate predictors such as level of consciousness or incontinence.[22,25]

Prognostic models have been applied to the process of adjusting data sets for differences in case-mix, which is important for interpreting variations in outcome.[26,27] As such, the models are of possible value in monitoring the quality of stroke services (*see* section 8).

Anatomical site

Bamford *et al.*, using data from the Oxford Community Stroke Project, defined four sub-categories of cerebral infarction on the basis of presenting symptoms and signs: lacunar infarcts (LACI); total anterior circulation infarcts (TACI); partial anterior circulation infarcts (PACI); and posterior circulation infarcts (POCI) – *see* Table 3 overleaf.[28]

While the classification is based upon bedside clinical features, the labels attached to each sub-category are anatomical, which reflects the close correlation between symptoms and signs and site of cerebral

Table 3: The Oxford Community Stroke Project classification of sub-types of cerebral infarction.[28]

Lacunar infarcts (LACI)	A pure motor stroke, a pure sensory stroke, a sensori-motor stroke, or an ataxic hemiparesis.
Total anterior circulation infarcts (TACI)	A combination of new higher cerebral dysfunction (e.g. dysphasia), homonymous visual field defect and ipsilateral motor and/or sensory deficit of at least two areas (out of face, arm and leg).
Partial anterior circulation infarcts (PACI)	Only two of the three components of a TACI, or with higher cerebral dysfunction alone, or with a motor/sensory deficit more restricted than those classified as LACI (e.g. confined to one limb).
Posterior circulation infarcts (POCI)	Any of: ipsilateral cranial nerve palsy with contralateral motor and/or sensory deficit; bilateral motor and/or sensory deficit; disorder of conjugate eye movement; cerebellar dysfunction; isolated homonymous visual field defect.

infarction. As shown in Table 4, this classification is of prognostic significance. A TACI is associated with high mortality, and significant disability in most survivors. A PACI is associated with the highest risk of early (i.e. within 3 months) recurrence of stroke. A patient with a POCI has the best chance of a good recovery, and patients with a LACI the best chance of survival. The advantage of this classification is that it uses relatively simple clinical criteria. The disadvantages are that it does not extend to sub-arachnoid haemorrhage or intracerebral haemorrhage, and that, for lacunar strokes, the relationship between clinical classification and anatomical site may not be very close. For example, Toni *et al.* found that only 56% (123/219) of patients with clinically defined lacunar strokes had anatomically defined lacunar strokes, while 27% (47/170) of patients with anatomical lacunar strokes did not have clinical lacunar strokes.[29] Nevertheless, as a clinical classification, the system remains of value.

Table 4: Prognostic significance of the Oxford Community Stroke Project stroke sub-types (Bamford *et al.*).[28]

	Case fatality (%)			**Functionally dependent (Rankin 3–5) (%)**			**Dead or dependent**		
	1 month	**6 mths**	**1 year**	**1 month**	**6 mths**	**1 year**	**1 month**	**6 mths**	**1 year**
LACI	2	7	11	36	26	28	38	34	40
TACI	39	56	60	56	39	36	96	96	96
PACI	4	10	16	39	34	29	44	45	45
POCI	7	14	19	31	18	19	38	32	38
All	10	18	23	39	29	28	50	48	51

Impact in terms of disability and handicap

Disability and handicap are important determinants of rehabilitation and care needs. A fuller discussion of the concepts of disability and handicap, and their relationship to impairments, is given in Appendix 1. Several measures are available and used either in routine clinical practice or for audit and research purposes.[30,31] The Barthel Activities of Daily Living Index is perhaps the most commonly used measure of

disability (*see* Table 5).[32] This gives a disability score from 0 (severe disability) to 20 (independent), and can be sub-divided into groups. It has limitations, in that it has floor and ceiling effects, and is insensitive to small differences.[30] It describes disability at a given point in time, and while this is of relevance to current health care needs, it is only a weak predictor of future disability.

Table 5: Examples of disability measures: the Barthel Index[32] and the Modified Rankin Scale.[13]

Modified Rankin Scale
0 No symptoms
1 Minor symptoms which do not interfere with lifestyle
2 Minor handicap: symptoms which lead to some restriction in lifestyle but do not interfere with the patient's capacity to look after themselves
3 Moderate handicap: symptoms which significantly restrict lifestyle and prevent totally independent existence
4 Moderately severe handicap: symptoms which clearly prevent independent existence though not needing constant attention
5 Severe handicap: totally dependent, requiring constant attention night and day
Barthel Activities of Daily Living (ADL) Index
Score from 0–20, on the basis of assessment of ten different items:
Bowel control (score 0–2); Bladder control (score 0–2); Grooming (score 0 or 1); Toilet use (score 0–2); Feeding (score 0–2); Ability to transfer from bed to chair and vice versa (score 0–3); mobility (score 0–3); dressing (score 0–2); ability to climb stairs (score 0–2); bathing (score 0 or 1).
Reliability depends upon accurate application of standardised definitions.

Several scales include elements of both disability and handicap. One of the simplest of these is the Rankin scale, usually used in modified form with six grades,[13] from no symptoms to severe disability (*see* Table 5). This scale has the virtue of simplicity and is therefore suitable for large-scale epidemiological studies and clinical trials. It is often collapsed down to two levels. For example, in the Oxford Community Stroke Project it was reduced to 'functionally independent' (grades 0–2) and 'functionally dependent' (grades 3–5) (*see* Table 4). Measures of handicap may focus on single dimensions such as social activities (e.g. the Frenchay Activities Index)[33] or address handicap more broadly. An example of the latter is the London Handicap Scale,[34] which measures handicap using the six dimensions of the WHO classification.[35] Measures of this type are of value in clinical trials and audits and could have a role in local health care needs assessments where primary data are being collected, but because they are not in routine use, they cannot usefully form the basis of sub-categorisation for the purposes of this chapter.

Sub-categories used in this chapter

Need for health care is defined both in terms of the incidence and prevalence of a condition, and the effectiveness of services to treat that condition (*see* An introduction to HCNA). It follows that the most useful sub-categorisation of stroke would be into categories for which there were data available for both epidemiology and effectiveness. The sub-categories used in this chapter reflect this pragmatic reasoning, rather than being underpinned by a firm theoretical basis. They do not follow any single one of the categorisations described above. Nevertheless, the preceding discussion is important to underline the

limitations of the classification that will be used, to raise issues that are of importance in considering local health care needs assessments, and to highlight alternative sub-classifications that would be of value if data were available.

The sub-categories that are used in this chapter are:

- people at high risk of stroke
- transient ischaemic attack
- stroke (acute phase)
- people with sequelae of stroke
- sub-arachnoid haemorrhage.

People at high risk of stroke

This category has been included since stroke prevention should have a key role in health strategy, such as local Health Improvement Plans. Indeed, the mortality targets set by the government ensure that stroke prevention will remain a priority for Health Authorities and Primary Care Groups.[8] For discussion of who is at high risk of stroke, and therefore included in this sub-category, *see* section 4.

Transient ischaemic attack

This is a particular sub-group within the high risk group. A transient ischaemic attack (TIA) may be defined as an acute loss of focal cerebral or ocular function with symptoms lasting less than 24 hours which, after adequate investigation, is presumed to be due to embolic or thrombotic vascular disease.[36] The distinction between TIA and stroke is one of duration of symptoms, with 24 hours representing a watershed between the two. In a significant minority of patients (14% in one series), patients with a clinical TIA have suffered a cerebral infarct in the appropriate area as demonstrated by CT scan.[37] The relevance of including TIA as a sub-category is that patients with a recent TIA are at high risk of suffering a completed stroke (*see* section 4). Some patients with a carotid territory TIA (as opposed to vertebro-basilar territory TIA) will benefit from carotid endarterectomy to reduce this risk (section 6). Therefore the incidence of TIA predicts need for health services aimed at assessing whether such patients would be suitable candidates for endarterectomy, and indeed need for the operation itself. The distinction between TIA and minor stroke is arbitrary, and in practical terms for a health care needs assessment TIA should be considered with minor stroke. However, since most of the available epidemiological data separates TIA from minor stroke, the sub-category of TIA on its own is used for pragmatic reasons.

Stroke (acute phase)

Stroke may be defined as a 'syndrome of rapidly developing symptoms and signs of focal, and at times global, loss of cerebral function lasting more than 24 hours or leading to death, with no apparent cause other than that of vascular origin'.[12] This definition includes sub-arachnoid haemorrhage, which is a cause of global loss of cerebral function. However, sub-arachnoid haemorrhage will be considered as a separate category for the purposes of this chapter (*see* below). Patients who suffer a stroke need four types of service: acute treatment; secondary prevention; rehabilitation; and continuing care. Unfortunately, none of the sub-categorisations of stroke discussed above adequately predicts need for all these categories of service. Acute treatment and secondary prevention needs are largely determined by stroke incidence, whereas rehabilitation and continuing care needs relate to severity of stroke and persistence of symptoms, whether defined in terms of impairment, disability or handicap.

People with sequelae of stroke

Given that needs for rehabilitation and continuing care services relate to the sequelae of stroke, it is important to have a sub-category that reflects this. The American Heart Association has classified the consequences of stroke in terms of six categories of impairment: motor; sensory; visual; language; cognition; and affect.[38] There are some data on the prevalence of these impairments following stroke, so this categorisation has some utility for the purposes of health care needs assessment.

Sub-arachnoid haemorrhage

Sub-arachnoid haemorrhage is characterised clinically by a history of acute onset of headache, meningism, and photophobia, often associated with loss of consciousness with no history of trauma.[13] This clinical syndrome is caused by blood in the sub-arachnoid space, typically due to leakage of blood from an intracranial aneurysm near the circle of Willis. While sub-arachnoid haemorrhage may lead to cerebral infarction due to an intracerebral component of haemorrhage or associated spasm of blood vessels, the acute management is different from that for focal stroke, and therefore it is useful to consider it as a separate sub-category.

The chapter will also make use of the available routine classification systems for stroke. These include the International Classification of Disease (ICD) codes and the Health Care Resource Group Codes (HRGs). Therefore, it is useful to outline how these systems classify stroke.

International Classification of Disease (ICD) codes

Routine NHS data such as mortality and hospital episode statistics utilise the International Classification of Disease (ICD) codes. Until recently, data have been coded using the ICD-9 system,[39] but a newer system has been developed, ICD-10.[40] The ICD codes use a classification based on a mixture of pathological type, cause, and anatomical site (*see* Table 6 overleaf). The principal ICD-9 codes encompassing stroke are 430–438, but if information is imprecise, then strokes are occasionally placed under less specific codes.[41] Commonly, codes 430–438 are combined to give an overall code group for cerebrovascular disease incidence or mortality. It should be noted that these codes include diagnoses that are not strictly included in clinical definitions of stroke, such as transient cerebral ischaemia, sub-dural haemorrhage and cerebral arteritis.

Table 6 also illustrates the extent of use of these codes, by showing the number of deaths coded to each three-digit classification in England and Wales in 1998. Approximately two-thirds of stroke deaths were coded as 'acute but ill-defined cerebrovascular disease'. In a study of coding of acute stroke in Oxford hospitals, it was found that 89% of patients who died or discharged with a diagnosis of stroke confirmed through a prospective stroke register were coded using ICD-9 code 436.[41] Thus, however desirable sub-classification of stroke might be using systems such as those outlined in 'Possible sub-categorisations' above, in practice, routine data sets do not provide sufficiently detailed diagnostic information to enable their use.

The equivalent alpha-numeric ICD-10 codes are shown in Table 7 overleaf. In ICD-10, cerebrovascular diseases are covered by the codes I 60–I 69. The principal changes compared to ICD-9 are:

- transient cerebral ischaemia is now classified elsewhere
- the four digit codes (not shown) allow more precise specification of anatomical site and of pathology
- occlusion and stenosis of pre-cerebral arteries now specifies '*not resulting in cerebral infarction*'
- a new code allowing for occlusion and stenosis of cerebral arteries that does not result in cerebral infarction.

Table 6: ICD-9 classification of stroke[39] and coding of deaths from stroke in England and Wales 1998.[14]

			Number of deaths in 1998 (% of total 'stroke')
430	Sub-arachnoid haemorrhage		2,686 (4.7)
431	Intracerebral haemorrhage		4,532 (7.9)
432	Other and unspecified intracranial haemorrhage	432.0 Non-traumatic extradural haemorrhage 432.1 Sub-dural haemorrhage 432.9 Unspecified intracranial haemorrhage	415 (0.7)
433	Occlusion and stenosis of pre-cerebral arteries	433.0 Basilar artery 433.1 Carotid artery 433.2 Vertebral artery 433.3 Multiple and bilateral 433.8 Other 433.9 Unspecified	222 (0.4)
434	Occlusion of cerebral arteries	434.0 Cerebral thrombosis 434.1 Cerebral embolism 434.9 Unspecified	4,644 (8.1)
435	Transient cerebral ischaemia		141 (0.2)
436	Acute but ill-defined cerebrovascular disease		36,919 (64.2)
437	Other and ill-defined cerebrovascular disease	437.0 Cerebral atherosclerosis 437.1 Other generalised ischaemic cerebrovascular disease 437.2 Hypertensive encephalopathy 437.3 Cerebral aneurysm, non-ruptured 437.4 Cerebral arteritis 437.5 Moyamoya disease 437.6 Non-pyogenic thrombosis of intracranial venous sinus 437.8 Other 437.9 Unspecified	7,453 (13.0)
438	Late effects of cerebrovascular disease		504 (0.9)

Table 7: ICD-10 classification of stroke.

I 60	Sub-arachnoid haemorrhage
I 61	Intracerebral haemorrhage
I 62	Other non-traumatic intracranial haemorrhage
I 63	Cerebral infarction
I 64	Stroke, not specified as haemorrhage or infarction
I 65	Occlusion and stenosis of pre-cerebral arteries, not resulting in cerebral infarction
I 66	Occlusion and stenosis of cerebral arteries, not resulting in cerebral infarction
I 67	Other cerebrovascular diseases
I 68	Cerebrovascular disorders in diseases classified elsewhere
I 69	Sequelae of cerebrovascular disease

These modifications make it easier to differentiate between those conditions that result in cerebral infarction (i.e. stroke) and those that do not.

Health care resource group codes (HRGs)

The NHS Executive has developed health care resource groups as a resource management tool. They group together patients who are expected to consume similar amounts of health care resource. The groups are defined on the basis of diagnoses (using the ICD codes described above) or procedures [using the Office of Population Censuses and Surveys classification (OPCS-4)]. NHS reference costs provide data on the average costs for each HRG (*see* section 5). Table 8 lists the HRG codes and labels for procedures and conditions of particular relevance to stroke. The categories are broad. For example, one would anticipate a very large range of costs within the category of A22, depending upon factors such as the degree of disability and whether or not a patient survived. Such wide variation in costs is indeed seen (*see* 'Costs of stroke care' in section 5).

Table 8: Health Resource Group codes relevant to stroke.

HRG code	HRG label	Procedures/conditions included
A01	Intracranial procedures except trauma – 1	Drainage of extra-dural space
A02	Intracranial procedures except trauma – 2	Drainage of sub-dural space
A03	Intracranial procedures except trauma – 3	Operations on aneurysm of cerebral artery (excision or ligation); ligation of carotid artery; drainage of sub-arachnoid space; evacuation of haematoma (intracerebral; cerebellar)
A04	Intracranial procedures except trauma – 4	Operations on aneurysm of cerebral artery (clipping; obliteration)
A19	Haemorrhagic cerebrovascular disorders	Sub-arachnoid haemorrhage; intracerebral haemorrhage
A20	Transient ischaemic attack, aged > 69 or with complications	TIA
A21	Transient ischaemic attack, aged < 70 with no complications	TIA
A22	Non-transient stroke or cerebrovascular accident, aged > 69 or with complications	Cerebral infarction; stroke not specified as haemorrhage or infarct
A23	Non-transient stroke or cerebrovascular accident, aged < 70 with no complications	Cerebral infarction; stroke not specified as haemorrhage or infarct
Q05	Extracranial or upper limb arterial surgery	Carotid artery surgery, including endarterectomy

World Health Organisation classifications of impairment, disability and handicap (ICFDH, ICF)

The classifications of stroke considered so far in this section have mostly focused on the underlying pathology. This is appropriate when considering health care needs for prevention and acute treatment, but less so when considering rehabilitation and continuing care needs. Rehabilitation can be defined as *an*

active problem-solving and educational process which focuses on the patient's disability (activities affected) and which aims to maximise the patient's social participation while minimising both the patient's somatic and psychological pain and distress and the distress of and stress on family members. This definition of rehabilitation is based upon the WHO model of impairment, disability and handicap. The original WHO model was published in 1980, but has now been updated as the International Classification of Functioning, Disability and Health.[42] For discussion of the WHO models, *see* Appendix 1. The key ways in which the updated model (ICF) has changed from the original model are that:

- the terms impairment, disability and handicap are replaced by new terms (functions, activities and participation) which extend their meanings to include positive experiences
- environmental factors are explicitly incorporated in the model.

4 Prevalence and incidence

People at high risk of stroke

People may be at higher risk of stroke owing to inherent factors that cannot be altered, such as age, sex, family history and ethnicity. The effect of these will be considered under the epidemiology of stroke in 'Stroke', below. It is possible to produce long lists of potentially modifiable risk factors for stroke. However, these lists are based largely on associations observed in epidemiological studies, and the relationship between the risk factor and stroke is not necessarily causal, and may simply be due to confounding.[43–45] Table 9 (*see* overleaf) shows the more important modifiable risk factors. It has been divided into those factors where there is reasonable evidence that treatment or removal of the risk factor does lead to a reduction in stroke risk, and those where the evidence is less certain. A summary of the evidence that treatment/avoidance of these factors is effective in reducing stroke risk is provided in section 6.

While some of these risk factors (e.g. atrial fibrillation) are either present or absent ('dichotomous variables'), others, such as hypertension and obesity, are continuous variables. Table 9 presents the data using well accepted (but arbitrary) cut-offs between what is 'normal' and 'abnormal' which can be used to define a 'higher risk' individual. However, the lower the level of blood pressure, the lower the risk of stroke.[46] This is part of the rationale behind strategies to achieve whole population risk reduction (*see* 'Prevention of stroke' in section 5).

The importance of each of the risk factors in population terms depends upon three factors: how strong the association with stroke is (i.e. the relative risk), how common the risk factor is (i.e. the prevalence) and how common the disease is in the population group (i.e. the absolute risk). Thus, among the risk factors in the top half of Table 9, hypertension and smoking are the most important factors, given their high prevalence. Similarly, in the second half of the table, the potential importance of physical inactivity and obesity is underlined by high prevalence. Conversely, transient ischaemic attack is less important because it is relatively uncommon, though the high relative risk emphasises its importance for the individuals in whom it occurs. Oral contraception is of relatively minor importance in population terms as a risk factor for stroke since it is used in a population in whom the absolute risk of stroke is very low.

Several of the risk factors shown in Table 9 (hypertension, diabetes, ischaemic heart disease, obesity) are dealt with in other chapters in the health care needs assessment series, so will not be considered further here. An important risk factor that does need some further consideration is atrial fibrillation.

Table 9: Prevalence of modifiable risk factors for stroke.

Risk factor	Relative risk of stroke in patient with risk factor	Prevalence of risk factor in England
Good evidence that treatment/avoidance can lower stroke risk		
Hypertension	1.5 for every 5 mmHg increase in diastolic blood pressure[46]	38% of men and 30% of women have either a systolic blood pressure greater than 140 mmHg or a diastolic blood pressure greater than 90 mmHg[47]
Atrial fibrillation	4–5[48,49]	5% of people aged 65 years and older[50,51]
Smoking	1.5[52]	28% of men and 27% of women[47]
Diabetes mellitus	2–3[44]	Diagnosed diabetes: 2–3% of men and 1.5–2.5% of women,[47,53] with an additional 1% of men and women with undiagnosed diabetes (glycosylated haemoglobin > 5.2%)[54]
Ischaemic heart disease	2.5[44]	7% of men and 4.5% of women (self-reported angina or heart attack that had been confirmed by a doctor)[47]
Previous stroke	15 in first year after stroke, dropping to 2 after 5 years[55]	1.5–1.75% of population[56,57]
Transient ischaemic attack	80 within first month; 13 within first year; 7 overall[58]	About 1.5% of people aged 55 or over report symptoms of typical TIA in preceding 3 years (not UK data)[59]
Weaker evidence that treatment/avoidance can lower stroke risk		
Obesity	1–2[44]	17% of men and 21% of women are obese (BMI > 30 kg/m^2), and an additional 45% of men and 32% of women are overweight (BMI 25–30 kg/m^2)[47]
Physical inactivity	2.5[60]	35% of men and 41% of women engage in less than 30 mins of moderate exercise per week[47]
Excessive alcohol consumption	1.5–2 for 5 units/day[61,62]	15% of men and 3% of women drink more than 35 units per week[47]
Oral contraception	3, or 2 if low oestrogen preparation[63]	27% of women aged 16–54 are current users of oral contraception (including injections or implants)[47]

Atrial fibrillation

There have been four UK prevalence surveys of atrial fibrillation, which are summarised in Table 10 (*see* overleaf). It can be seen that given the different age groups and methods used to identify atrial fibrillation, there is a reasonable consistency in the findings. Approximately a quarter of atrial fibrillation is paroxysmal (i.e. episodic) and the rest chronic.[64–66] Atrial fibrillation is more common in men than women. Longitudinal studies have shown that risk of atrial fibrillation is also independently associated with increasing age, heart failure, valve disease, coronary heart disease, diabetes and hypertension.[67,68] In a prevalence survey of people aged ≥65 (baseline data collection for the Cardiovascular Health Study), 57% of people with atrial fibrillation had clinical cardiovascular disease, and a further 35% had sub-clinical

Table 10: English prevalence surveys of atrial fibrillation.

Study	Population	Method of identifying AF	Results
Sudlow *et al.*[50]	Random sample of 4,843 people aged = 65 drawn from HA register of 26 practices in Northumberland	ECG	Overall prevalence: 4.7% 65–74: 3.5% men, 2.4% women; 75+: 10% men, 5.6% women
Connell and Gray[64]	Single practice in Gateshead (n = 9,162)	From GP case notes, some verified by ECG	Overall prevalence: 91/9,162 (1%); 76% chronic, 24% paroxsymal
Wheeldon *et al.*[51]	Single practice in Sheffield: all patients aged ≥65 (n = 1,422)	ECG	Overall prevalence: 5.4%; 75+: 6.6%
Lip *et al.*[65]	2 Birmingham practices (n = 16,519)	From GP case notes	Prevalence: 50+: 2.4%; 73% chronic, 27% paroxysmal

cardiovascular disease (abnormal findings on echocardiography or carotid ultrasound).[69] In other words, atrial fibrillation may be regarded in most cases as a manifestation of underlying cardiovascular disease. Data from the Framingham study suggest that the prevalence of atrial fibrillation has risen over time, from 3.2% in men aged 65–84 in 1968 to 9.1% in 1989.[67]

The best estimate of the prevalence of atrial fibrillation comes from a synthesis of four large population-based surveys carried out in the USA and Australia.[70] The results of this synthesis are consistent with the UK estimates shown in Table 10. Therefore, in Table 11, the age-specific prevalence rates derived from these four population surveys are applied to the population structure of England and Wales[14] in order to obtain best estimates of UK age-specific numbers of cases of atrial fibrillation. It can be seen from Table 11

Table 11: Estimate of age-specific numbers of cases of atrial fibrillation in England and Wales.

Age group	Age-specific prevalence rate	Population of England & Wales (1000s)	No of cases of AF (1000s)	% of all AF
40–44	0.1%	3,479.8	3.5	0.6%
45–49	0.3%	3,403.8	10.2	1.7%
50–54	0.5%	3,500.1	17.5	2.9%
55–59	0.8%	2,709.4	21.7	3.6%
60–64	1.5%	2,489.9	37.3	6.2%
65–69	3.0%	2,314.7	69.4	11.6%
70–74	5.0%	2,085.7	104.3	17.4%
75–79	7.0%	1,781.2	124.7	20.8%
80–84	10%	1,089.6	109.0	18.2%
85–89	10%	669	66.9	11.2%
90+	10%	347.7	34.8	5.8%
All ages	1.1%	52,427.9		
> 40	2.5%	23,870.9	599.3	
> 65	6.1%			85%
> 75	8.6%			56%

that the prevalence of atrial fibrillation rises with age, and over half (56%) of people with atrial fibrillation are aged 75 or over. A recent (1996–7) prevalence survey of *diagnosed* atrial fibrillation based upon data from a large health maintenance organisation in Canada found similar rates to those shown in Table 11.[71] Given that this survey would have omitted people with undiagnosed atrial fibrillation – in England this is about a quarter of all people with AF[72] – this provides a hint that perhaps age-specific prevalence of atrial fibrillation is rising.

There have been two incidence studies of atrial fibrillation: Framingham and the Cardiovascular Health Study, neither of which are UK-based.[68,73] In the Cardiovascular Health Study, the incidences for men aged 65–74 and 75–84 were 17.6 and 42.7 per 1000 person years, and for women 10.1 and 21.6. Framingham results were similar, but with smaller differences between men and women. In the Framingham study, during 40 years of follow up, 621 people out of 5209 developed atrial fibrillation. Atrial fibrillation in this cohort was associated with a 1.5- (men) to 1.9-fold (women) increased risk of mortality after adjustment for pre-existing cardiovascular disease.[74] The median survival of people aged 55–64 in atrial fibrillation was 12.6 years for men and 12.1 years for women, as compared with 18.1 years and 21.3 years respectively for people not in atrial fibrillation. Similar excess in adjusted mortality for people in atrial fibrillation has been reported from a smaller cohort (87 patients in AF) in Western Australia.[75]

There is a strong independent association between atrial fibrillation and stroke. Two cohort studies have reported relative risks of stroke in 'lone' atrial fibrillation (i.e. with no other evidence of cardiovascular disease) of between 4 and 5.[48,49] Furthermore, data from Framingham suggests that strokes occurring with atrial fibrillation are more severe and more likely to be fatal.[76] The Oxford Community Stroke Project reported a higher 30-day case fatality rate for cerebral infarction associated with atrial fibrillation (23%) as compared to sinus rhythm (8%).[77] The proportion of strokes in the population that are attributable to atrial fibrillation rises with age. Arrhythmia is associated with 30.7% and accounts for 23.5% of strokes in people aged 80–89, as compared to 8.5% and 2.8% respectively in 60–69 year olds.[73] Analysis of the Stroke Data Bank of the US National Institute of Neurological and Communicative Disorders and Stroke suggested that 9% of all ischaemic stroke is due to atrial fibrillation.[18]

Risk of stroke in patients with atrial fibrillation has been consistently found in several studies to be independently associated with increasing age, previous stroke or TIA, and hypertension.[78–80] Recent heart failure has been found to increase risk in some studies[79] but not others.[78,80] Being female[78,80,81] or diabetic[78] have also been identified as independent risk factors in some studies. Echocardiographic features such as global left ventricular dysfunction and left atrial size also predict stroke risk in atrial fibrillation, after clinical factors have been taken into account.[82]

Other risk factors for stroke

In addition to the risk factors for stroke considered in Table 9, there are several other factors that have been found to be associated with stroke risk, listed in Table 12 (*see* overleaf).[44,83]

Two factors in this table that have received some attention in terms of stroke prevention strategies in recent years, and are therefore worth considering in slightly more detail, are hypercholesterolaemia, and asymptomatic carotid artery stenosis.

Cholesterol and risk of stroke

There is no strong evidence of any independent association between serum cholesterol and risk of stroke.[84] Despite this, an overview of cholesterol lowering with statin drugs found that treatment with statins reduces risk of stroke.[85] There are possible explanations for this apparent contradiction. Firstly, there is some evidence that low cholesterol is associated with increased risk of haemorrhagic stroke,[86] so it may be

Table 12: Other risk factors for stroke.

Other specific cardiac factors	Infective endocarditis; mitral stenosis; recent large myocardial infarction; left ventricular hypertrophy; cardiomyopathy
Haematological factors	Sickle cell disease; raised packed cell volume; hypercoagulability, including raised fibrinogen
Biochemical factors	Hyperhomocysteinaemia; hypercholesterolaemia
Clinical factors	Migraine; snoring
Dietary factors	Low potassium; low fruit and vegetable intake
Other factors	Asymptomatic carotid artery stenosis; major life events

that this masks a positive association between serum cholesterol and risk of ischaemic stroke. Secondly, it may be that statins lower stroke risk indirectly by lowering risk of myocardial infarction, which is an established risk factor for stroke. Thirdly, it may be that statins do not reduce stroke risk by lowering cholesterol, but by some other mechanism. As will be discussed in section 6, the evidence for cholesterol lowering to prevent stroke is strongest for patients with existing coronary heart disease, so in the context of the epidemiology of risk factors for stroke, serum cholesterol is of most relevance in this sub-group of patients.

Asymptomatic carotid artery stenosis

Atherosclerosis of the internal carotid artery is an important cause of stroke. Epidemiological data suggest that it is responsible for 9% of all ischaemic stroke.[18] When associated with symptoms of transient ischaemic attack, severe carotid artery stenosis (i.e. 70–99% stenosis) is associated with a 20% risk of major stroke in three years.[87,88] However, asymptomatic stenosis carries a lower risk of stroke. The risk of ipsilateral stroke or death in the medical control group of the Asymptomatic Carotid Artery Stenosis trial was 11% after 5 years.[89] Patients with an asymptomatic stenosis of 60–99% are at twice the risk of a first stroke as compared to patients with stenosis of less than 60%.[90] However, approximately 45% of strokes in this population are attributable to other pathology, such as small vessel occlusion and emboli from a cardiac source.[90,91] Furthermore, this population is at high risk of ischaemic heart disease. Indeed, Ogren *et al.* found no association between asymptomatic carotid stenosis and risk of stroke in a cohort of men born in 1914, which was perhaps due to the high mortality from ischaemic heart disease in those men with severe carotid stenosis.[92] Therefore, the relevance of the prevalence of asymptomatic carotid artery stenosis is perhaps more in relation to cardiovascular disease prevention strategies in general than it is to stroke prevention. The evidence for carotid endarterectomy to prevent stroke in asymptomatic carotid artery stenosis will be considered in section 6.

Transient ischaemic attack

While there have been a number of studies worldwide of the epidemiology of transient ischaemic attack, the most robust study in the UK is the Oxfordshire Community Stroke Project, carried out between 1981 and 1986. The age-specific annual incidence rates derived from this study are shown in Table 13.[93] The overall incidence is similar in males and females, though the incidence in 55–84 year olds is higher in men than in women. Oxfordshire has one of the lowest death rates from stroke in the UK, and so it is likely that

Table 13: Age/sex-specific annual incidence rates with 95% confidence intervals (per 1000 population) for transient ischaemic attack in the Oxfordshire Community Stroke Project, 1981–86.

Age band	Males	Females	Persons
< 15	0.00	0.00	0.00
15–44	0.02 (0.00–0.04)	0.02 (0.00–0.04)	0.02 (0.01–0.03)
45–54	0.25 (0.06–0.44)	0.26 (0.07–0.45)	0.25 (0.12–0.39)
55–64	1.22 (0.77–1.66)	0.63 (0.31–0.94)	0.92 (0.65–1.19)
65–74	2.43 (1.68–3.17)	0.90 (0.47–1.33)	1.61 (1.20–2.03)
75–84	3.01 (1.79–4.23)	2.29 (1.45–3.13)	2.57 (1.87–3.27)
85+	0.70 (0.00–2.07)	2.87 (1.26–4.49)	2.32 (1.09–3.67)
All ages	0.39 (0.31–0.46)	0.31 (0.24–0.38)	0.35 (0.30–0.40)

TIA incidence is higher elsewhere in the country. Approximately 80% of the TIAs were in the carotid distribution, and 20% in the vertebro-basilar distribution, which is similar to findings elsewhere.[94,95]

A much higher incidence of transient ischaemic attack (1.9 per 1000 per year) was recently reported from the General Practice Research Database (GPRD).[96] This probably reflects considerable misclassification error. For example, the prevalence of stroke recorded in this data set is only a sixth of what has been recorded in population surveys (*see* 'Prevalence of stroke' below), and many people with a label of transient ischaemic attack turn out to have other diagnoses.[97]

As shown in Table 9, a transient ischaemic attack is associated with a very high risk of stroke (relative risk of 80, 95% confidence interval: 34–158) in the first month following the event.[58] This falls to a relative risk of 13 in the first year, and to 7 in the first seven years. In absolute terms, this equates to a 4.4% (95% CI: 1.5–7.3%) risk of stroke in the first month, an 11.6% (95% CI: 6.9–16.3%) risk in the first year, and a 29.3% (95% CI: 21.3–37.3%) risk in the first five years, with an average annual risk of 6%.[58] People with TIA are also at significant risk of myocardial infarction, with an approximate annual risk of 2.4%.[58]

For a health care needs assessment, it is the incidence of transient ischaemic attacks rather than prevalence that is of most interest, because this will dictate the need for carotid endarterectomy (*see* sections 6 and 7). The prevalence (i.e. the number of people who have had a history of a TIA) is relevant in that it highlights a group of people who are at high risk of future stroke, and therefore targets for secondary prevention. Unfortunately, there are no good UK-based estimates of the prevalence of transient ischaemic attack. In a Dutch study carried out between 1990 and 1993, the prevalence of a history of symptoms suggestive of a transient ischaemic attack within the last three years (assessed by a trained study physician) was 3.7% of men and 2.9% of women aged 55 or over. However, the prevalence was 50% lower if only people with classical features of a transient ischaemic attack were included.[59] In the Atherosclerosis Risk In Communities (ARIC) Study set in the United States between 1987 and 1989, 3% of people aged 45–64 reported the occurrence of symptoms during their life which were classified by diagnostic algorithm as being due to a transient ischaemic attack.[98] Both these prevalence estimates are higher than would be anticipated from the Oxford Community Stroke Project, or from other incidence studies,[94,95] which suggests some over-ascertainment, possibly due to difficulty of accurate assessment of past symptoms.

Stroke

Incidence of first stroke

There have been several studies worldwide of stroke incidence.[7] This report will focus on three incidence studies of first ever stroke in England: the Oxford Community Stroke Project (OCSP),[99] the South London Stroke Register (SLSR)[100] and the East Lancashire Study (ELS).[101] The methodology of these studies is summarised in Table 14 and the resulting age-specific incidence rates are shown in Table 15. In these studies, cases of sub-arachnoid haemorrhage were included under the broad umbrella of 'stroke'.

Table 14: English studies of first stroke incidence.

	Number of strokes	Period of study	Population	Method of case ascertainment
OCSP	675	1981–86	All patients registered with 50 GPs (10 practices) in Oxfordshire (total population: 105,476)	1 GPs notified all possible strokes. 2 Admission and casualty registers of Oxford hospitals reviewed. 3 Oxford Record Linkage study enabled identification of those who died or were discharged from Oxford hospitals with stroke. 4 Death certificates and post-mortem reports reviewed. Possibles reviewed by a study neurologist as soon as possible either at home, in hospital, or in a special outpatient clinic. CT scan or post-mortem was sought in every case.
ELS	642	1994–95	All patients registered with 93 practices in East Lancashire (total population: 405,272)	1 GPs notified all possible strokes. 2 Ward log books of local hospitals checked monthly. 3 Discharge diagnoses from routine hospital coding. 4 Death certificates reviewed. 5 Rehabilitation and support service staff were asked to report possible strokes. GP case notes or FHSA records reviewed of possibles.
SLSR[103]	1,254	1995–98	Residents of 22 wards of Lambeth, Southwark and Lewisham Health Commission (total population: 234,533)	12 notification sources: A&E records; hospital wards; brain imaging requests; death certificates; coroner's records; GPs; hospital medical staff; community therapists; bereavement officers; hospital-based stroke registers; GP computer records; others: notification by patients or relatives. Possibles reviewed by a study physician within 48 hours where possible. Outpatient and domiciliary visits offered.

The all age (standardised) rates at the bottom of Table 15 reflect the overall incidence rate that would have occurred if the age-specific incidence rates are experienced in England and Wales as a whole. Thus,

Table 15: Age-specific annual incidence of first stroke (per 1000 population) in three English populations, with 95% confidence intervals.

Age group	Oxfordshire	East Lancashire	South London
< 15	0.03		0.01 (0.00–0.04)
15–24	0.06		0.03 (0.00–0.07)
25–34	0.08		0.12 (0.08–0.18)
35–44	0.23		0.30 (0.21–0.42)
< 45	0.09 (0.06–0.13)		
< 50		0.09 (0.06–0.13)	
50–54		0.88 (0.49–1.26)	
45–54	0.57 (0.35–0.79)		0.87 (0.68–1.10)
55–64	2.91 (2.37–2.45)	1.69	2.19 (1.88–2.53)
65–74	6.90 (5.93–7.87)	4.67	4.96 (4.44–5.51)
75–84	14.34 (12.49–16.19)	10.64	9.34 (8.41–10.34)
85+	19.87 (15.78–23.95)	20.86	19.72 (17.08–22.65)
All age (crude)	1.60 (1.48–1.72)	1.58 (1.46–1.71)	1.33 (1.26–1.41)
All age (standardised)	**2.17***	**1.65***	**1.74****

Notes: *Age- and sex-standardised to England and Wales, 1998[14] ; **age-standardised to England and Wales, 1998.

depending upon which incidence study is used, the incidence of first stroke in England seems to lie between 1.65 and 2.17 per 1000 population. The standardised rates are all higher than the crude rates because these three studies were carried out in populations that overall are younger than England and Wales as a whole. They differ from the previously published standardised rates because a different standard population was used. For example, the OCSP standardised its rates using the 1981 England and Wales population, and quoted an all age (standardised) rate of 2.0.[99] The higher rate shown in Table 15 reflects changes to the age structure of England and Wales that have occurred between 1981 and 1998. In other words, assuming stable age-specific incidence, there would have been an 8.05% rise in the overall incidence of stroke between 1981 and 1998 due to ageing of the population. It is notable that the Oxfordshire rates are higher than those observed in East Lancashire and South London. Oxfordshire has a lower standardised mortality ratio (SMR) for stroke than the other districts: the SMR for Oxfordshire over the period 1993–95 was 90, as compared to 98 in Lambeth, Southwark and Lewisham and 104 in East Lancashire.[102] Therefore, unless case fatality is significantly lower in Oxfordshire than in the other districts, Oxfordshire is unlikely to have a higher incidence than the other areas. Two possible explanations for the observed rates are differences in case ascertainment, and secular changes in stroke incidence.

The methods of case ascertainment in the three studies are summarised in Table 14. It is conceivable that case ascertainment was more complete in Oxfordshire than in the other areas, given that the Oxfordshire study population was smaller, and the GPs involved all had to be 'enthusiastic' to collaborate.[99] There was also a significant 'carrot' for GPs to notify patients, namely rapid review by a study neurologist and access to CT scanning. Research nurses visited practices at least once a week. The South London and East Lancashire studies both aimed to recruit from defined geographical areas, and therefore will have included GPs of varying degrees of enthusiasm. South London compensated for this by having many different methods of identifying possible cases, and also offered early assessment by a specialist. Minor strokes are most likely to be missed by community registers, since such cases may not be admitted to hospital,[104] and the duration of symptoms/residual disability will be shorter. Some evidence that the Oxford Community Stroke Project did indeed detect a higher proportion of minor strokes is provided by the case fatality in the

three studies. 30-day case fatality in the OCSP was 19%,[13] as compared to 26% in South London[103] and 34% in East Lancashire (*see* 'Survival following stroke' below).[101]

The Oxfordshire study was performed a decade before the other studies, so the observed difference may reflect a decline in age-specific incidence of stroke in the intervening decade. There have been significant reductions in age-specific stroke mortality over this period,[1] and it is likely that this in part reflects decline in incidence (*see* 'Trends in stroke incidence and mortality', below).

While the overall rate of stroke was different in the three studies, the general pattern of an increasing incidence with age is similar. The expected number of new first strokes in a population of 100 000 with the age- and sex-specific structure of England and Wales is shown in Table 16, based on the age- and sex-specific incidence rates of the OCSP. Two estimates are made. In the first, (A), it is assumed that there has been no reduction in age-specific incidence between 1981–86 and the present day and in the second, (B), it is assumed that there has been a 20% reduction in age-specific incidence. These show that although the age-specific rates are generally higher in men than women, more women than men would be expected to have a stroke, owing to the longer life expectancy of women. 81% of strokes (175/216) would be anticipated to occur in people aged 65 or over. The anticipated stroke rate is between 174 and 216 per 100 000 population, depending upon what assumption is made about change in age-specific incidence rates. If a 20% reduction in incidence is assumed since the time that the OCSP was carried out and the present day, then the overall incidence rate matches the rate for the South London Stroke Register (1.74 per 1000 – *see* Table 15). Capture–recapture analysis of the South London register results suggests that it is extremely unlikely that it could be under-counting by as much as 20% (which would be the implication if assumption (A) was adopted).[105] Therefore, the range 1.74–2.16 per 100 000 seems a plausible range of likely stroke incidence, taking all the UK-specific epidemiological data that are available into account. In estimating stroke incidence in a local population, once age structure has been taken into account, it is also important to take into account factors such as ethnic mix (*see* 'Ethnicity and stroke' below) and other socio-demographic factors (*see* 'Other factors affecting stroke incidence' below).

Table 16: Estimated numbers of new first strokes in a typical population of 100,000 in England and Wales.

Age	Males				Females				Total number of strokes	
	OCSP rate (/1000)	Popn	Number of strokes		OCSP rate (/1000)	Popn	Number of strokes			
			A	B			A	B	A	B
< 45	0.08	31,235	2	2	0.11	29,872	3	3	5	5
45–54	0.67	6,579	4	4	0.46	6,589	3	2	7	6
55–64	3.47	4,900	17	14	2.35	5,017	12	9	29	23
65–74	8.11	3,890	32	25	5.84	4,503	26	21	58	46
75–84	15.87	2,123	34	27	13.39	3,352	45	36	79	63
85+	18.42	514	9	8	20.36	1,425	29	23	38	31
Total		49,241	98	80		50,758	118	94	**216**	**174**

Note: Number of strokes in A assumes stable incidence between 1981–86 (i.e. when OCSP was performed) and present day; B assumes 20% decline in age-specific incidence over this time period.

Incidence of recurrent stroke

While the key incidence studies of stroke have focused on incidence of first stroke, in terms of a health care needs assessment recurrent stroke is of equal importance. The OCSP showed that the risk of suffering a

recurrence within five years of a first stroke was 30% (95% CI: 20–39%).[55] The East Lancashire Study identified 642 first strokes and 290 recurrent strokes.[101] In other words, using the East Lancashire data, it would be necessary to inflate the estimated numbers of stroke in a population by as much as 45%. Recent estimates in the US of the 'inflation factor' for recurrent strokes vary from 30%[106] to 43%.[107] In the WHO MONICA project, the 'inflation factor' was 20%.[108] This is lower than the other studies, probably because it was set in younger populations – the study population was aged 35–64 years. The proportion of recurrent strokes that might be anticipated depends upon factors such as the age of the population (older age means more recurrent stroke), and ethnic mix.[107]

Prevalence of stroke

Surveys carried out in Newcastle and North Yorkshire found the prevalence of stroke to be between 1.5 and 1.75%.[56,57] Prevalence of stroke in adults (aged 16 or over) in the Health Survey from England in 1998 was found to be 2.1 per 1000 in women and 2.3 per 1000 in men.[47] Prevalence rises with age: 9–10% of people aged 75 or over have had a stroke. The prevalence of stroke recorded in general practice is much lower than this. Data from the General Practice Research Database (GPRD) suggests that the prevalence is only 2.3 per 1000.[109] The discrepancy probably reflects both under-recording in GP records and that the stroke had to be recorded between 1994 and 1998 to be included. Interestingly, the recording of TIA in this database is much higher than one would anticipate from epidemiological studies (*see* 'Transient ischaemic attack' above).

Survival following stroke

Survival following first stroke in the three British-based epidemiological studies is shown in Table 17. The almost two-fold variation between Oxfordshire and East Lancashire either reflects differences in case ascertainment, or differences in survival. The likeliest explanation is that the OCSP had better ascertainment of minor stroke due to differences in study design (*see* 'Incidence of first stroke' above). After the first year, non-stroke cardiovascular disease is the commonest cause of death in stroke survivors.[110]

Table 17: Case fatality following first stroke.

Time after stroke	OCSP	ELS	SLSR
28 days	19%	34%	26%
90 days		40%	33%
180 days			37%
1 year	31%		

Notes: OCSP: Oxfordshire Community Stroke Project; ELS: East Lancashire Study; SLSR: South London Stroke Register.

Prognosis is worse for recurrent stroke – in the US, two-year case fatality of first stroke is 43%, as compared to 52% for recurrent stroke.[111]

Ethnicity and stroke

Risk of death from stroke in Britain is higher in minority ethnic groups. An analysis of death by country of birth for the period 1989–92 found that mortality was highest among those born in West Africa and

Table 18: Standardised mortality ratios (and 95% Confidence Intervals) for stroke in England and Wales by country of birth, 1989–92.[112]

Country of birth	Men	Women
Total population	100	100
Scotland	125 (115–136)	125 (113–137)
Ireland	138 (128–148)	123 (113–133)
East Africa	114 (86–147)	122 (88–164)
West Africa	271 (210–344)	181 (118–265)
Caribbean	168 (151–186)	157 (136–179)
South Asia	155 (143–168)	141 (127–157)

the Caribbean, but was also significantly raised in those from South Asia, Ireland and Scotland (*see* Table 18).[112]

In the South London Stroke Register, the age- and sex-adjusted incidence of stroke was 2.2 times higher in people of African or Caribbean origin as compared to the white population, but case fatality was similar in the different populations.[103] Similar differences in stroke incidence by ethnicity have been observed in the United States.[107]

Other factors affecting stroke incidence

There are wide variations in stroke mortality throughout England and Wales. Standardised mortality ratios (SMRs) for stroke in Health Authorities in England and Wales in 1993–95 varied from 74 (95% CI: 67–81) in Redbridge and Waltham Forest to 130 (95% CI: 121–139) in Wigan and Bolton.[102] Socio-economic deprivation appears to be an important factor underlying this variation.[113,114] Regional differences in lifestyle (*see* Table 9 for other factors associated with risk of stroke) may also account for some of the observed variation. There is also some evidence that adverse socio-economic circumstances in childhood may influence subsequent risk of mortality from stroke.[115]

Trends in stroke incidence and mortality

Age-specific mortality from stroke in England and Wales has been declining throughout the twentieth century.[116] For example, in 65–74 year old men, there was an average annual reduction in stroke mortality of 1.5% per year from 1901 to 1939, 0.1% per year from 1940 to 1967, and 2.2% per year from 1968 to 1991. Between 1986 (the last year of the OCSP) and 1999, age-adjusted mortality from stroke fell by 42% in men and by 32% in women.[1] The changes in age-specific mortality rates over this period are shown in Figures 2 and 3 (*see* overleaf).

Between 1986 and 1999, there have continued to be falls in mortality in all ages, but these have been more pronounced in the older age groups, and there is a hint that the decline in mortality has slowed in the younger age groups since 1993 (Figure 2). There are three major categories of explanation for this observed fall in mortality: artefact; decline in incidence; or decline in case fatality. While there are important errors in the death certification of stroke,[118] artefactual changes in how doctors have been recording death is unlikely to explain the fall, since there have been similar declines in mortality from coronary heart disease, which is the likeliest alternative cause to appear on the death certificate.[1] Data on trends in incidence are not available for England and Wales, so empirical evidence for a fall in incidence needs to be sought from other countries. The evidence is mixed. For example, in Denmark there has been a 3% per annum decline

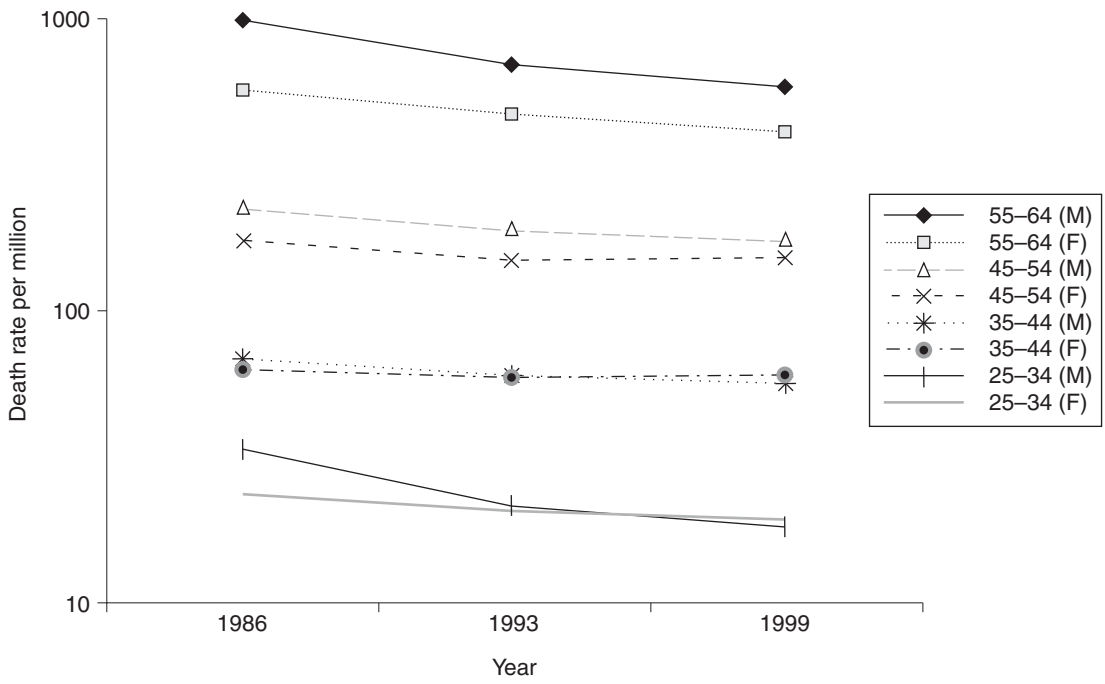


Figure 2: Trends in age-specific stroke mortality in England and Wales, ages 25–64, 1986–99.[1,14,117]

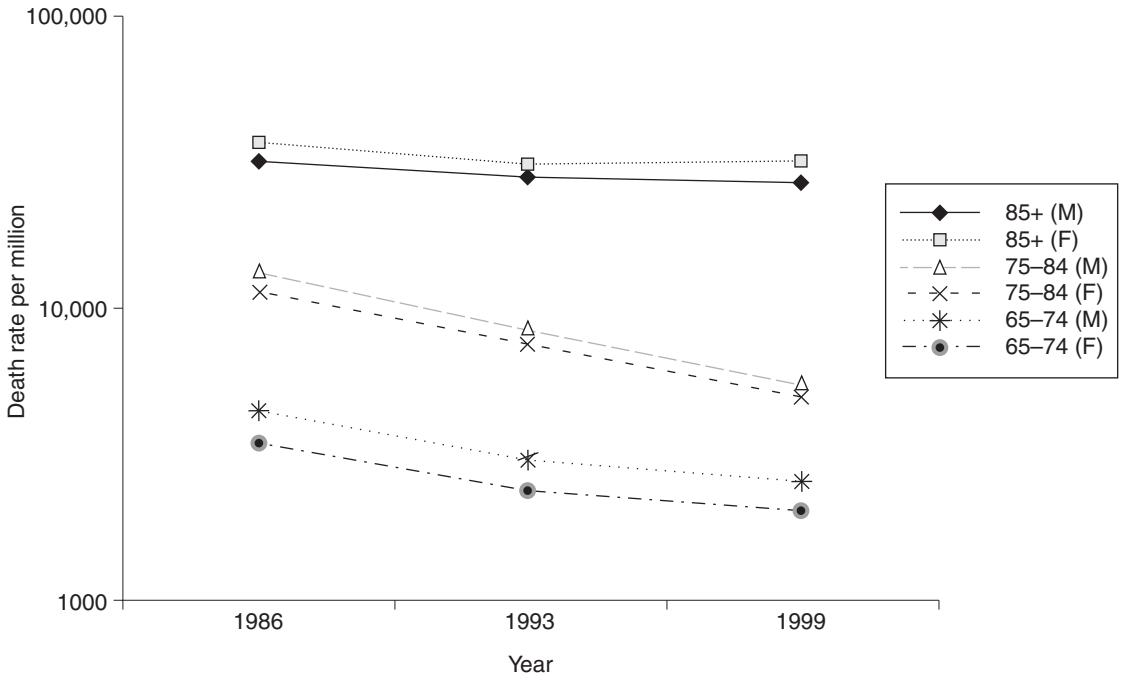


Figure 3: Trends in age-specific stroke mortality in England and Wales, ages 65 and over, 1986–99.[1,14,117]

in age-adjusted incidence between 1982 and 1991, but no overall decline in incidence due to demographic change.[119] In the WHO MONICA project (which covered stroke in people under the age of 65), incidence declined in the majority of the populations studied (13/17 for men; 15/17 for women) between 1985 and 1990.[120] In the Swedish MONICA site, while incidence fell in under 65s, it rose in 65–74 year olds.[121] In New Zealand, there was no consistent pattern of decline in age-specific incidence between 1981 and 1991,[122] and in the US rates appear to have fallen between 1985 and 1989 in people aged over 70, and then started to rise again.[123] Data from Rochester, Minnesota, suggested that stroke rates rose between the 1970s and 1980s, but were stable during the 1980s.[124] There are more consistent international data to suggest that there has been a decline in case fatality from stroke (i.e. improved survival after stroke), but not of sufficient magnitude to explain the fall in stroke mortality in England and Wales.[121,125–127] Therefore, the most plausible explanation for the decline in stroke mortality is that there has been a decline in both incidence and case fatality. To reflect this, the estimated numbers of new strokes in Table 16 includes an assumption (B) of a 20% decline in incidence between 1986 and 1989, as a partial explanation of the 42% decline in mortality over the same time period.

People with sequelae of stroke

There are two ways of quantifying the sequelae of stroke. Either one can look at the proportion of people who might be expected to have a specific problem after a given time following their stroke (the equivalent of incidence) or one can look at the frequency of stroke-related problems in a community at a given point in time (a prevalence survey). Both have their uses in needs assessment, since the former will predict the need for acute rehabilitation services, and the latter the need for long-term support.

Incidence of disability following stroke

There has been a lack of data on the incidence of disability following stroke. A summary of some UK-based studies carried out in the 1980s is shown in Table 19.[128] Recent data on the prevalence of acute impairments following first stroke from the South London Stroke Register showed that 21% of patients had a normal Barthel score (*see* Table 5 for explanation), and 51% had severe disability (Barthel score < 10).[129] These results are similar to the acute prevalence data shown in Table 19. In the OCSP, 65% of stroke survivors were functionally independent one year after their stroke.[13]

Prevalence of disability following stroke

A prevalence survey in North Yorkshire found that 33% of stroke survivors had some cognitive impairment, 27% a problem with their speech, and 12.5% difficulty swallowing.[56] 55% required help in one or more activity of daily living. A prevalence survey in Newcastle reported 70% were dependent on others (Modified Rankin score 3–5).[57] Extrapolating these results to a population with a prevalence of stroke of 1.5–1.75%, one would anticipate the prevalence of stroke with moderate residual disability to be between 0.8% and 1.2%.

Time course of recovery following stroke

It is also useful to know the recovery pattern following stroke, since this will influence need for (and appropriate timing of decisions about) institutional care. In the Copenhagen stroke study, it was found that functional recovery (as measured by the Barthel Index, *see* Table 5) was completed within 13 weeks of the stroke in 95% of patients. However, the more severe the stroke, the longer it took for recovery to take

Table 19: Acute (0–7 days), three-week and six-month impairment/disability rates.[131–134]

Phenomenon		Acute	3 week	6 month
Impairments	Initial loss/depression of consciousness	5%	–	–
	Not oriented (or unable to talk)	55%	36%	27%
	Marked communication problems (aphasia)	52%	29%	15%
	Motor loss (partial or complete)	80%	70%	53%
Disabilities	Incontinent of faeces	31%	13%	7%
	Incontinent of urine	44%	24%	11%
	Needs help grooming (teeth, hair, face)	56%	27%	13%
	Needs help with toilet/commode	68%	39%	20%
	Needs help with feeding	68%	38%	33%
	Needs help moving from bed to chair	70%	42%	19%
	Unable to walk independently indoors	73%	40%	15%
	Needs help dressing	79%	51%	31%
	Needs help bathing	86%	65%	49%
	Very severely dependent	38%	13%	4%
	Severely dependent	20%	13%	5%
	Moderately dependent	15%	15%	12%
	Mildly dependent	12%	28%	32%
	Physically independent	12%	31%	47%

Note: The acute figures are of limited accuracy as many patients were not assessed within the first week. Many of these were very ill and probably very dependent. Consequently the figures relating to acute disability are minimum estimates.

place. Thus, it took up to 20 weeks before maximal recovery was achieved in patients with very severe strokes.[130]

Mood disorders following stroke

Depression and anxiety are important sequelae of stroke.[135] For example, in a follow up at six months of patients admitted to hospital in Edinburgh who were entered into a trial to assess the effect of a stroke family care worker, 22% were anxious (i.e. scored more than 8 on the HAD anxiety scale) and 20% depressed (more than 8 on the HAD depression scale).[136] Estimates of incidence differ between studies due to variations in design, including in particular how depression is defined.[135] For example, 60% of patients in the Edinburgh study scored over 4 on the GHQ-30,[136] and 54% of patients in the control group of a study in Finland were classed as depressed (10 or more on the Beck Depression Inventory).[137]

Effect of stroke on informal carers

Stroke has important effects on the well-being of carers as well as patients. Care giving is associated with significant strain, anxiety, and stress.[138–141] A literature review reported the prevalence of depression in carers of stroke patients to vary from 34% to 52%.[142] A more recent study found a 17% prevalence of depression, a 37% prevalence of anxiety, and a 55% prevalence of an abnormal score (>4) on the General Health Questionnaire (GHQ–30) six months after stroke.[143] These problems persist. In the Perth Community Stroke Study, over half of carers of stroke survivors with residual moderate or severe disability at one year had evidence of emotional distress, and the majority reported disruption of social

activities (79%) and leisure time (55%).[144] In a matched case-control study, spouses of patients with stroke were significantly more likely to be depressed than controls 1–3 years after stroke.[145]

Sub-arachnoid haemorrhage

The overall incidence of sub-arachnoid haemorrhage in the Oxford Community Stroke Project was 10 per 100 000 per year.[13] This is consistent with international studies, though these show a wide variation in incidence from 2 to 22 per 100 000.[146] In a study in New Zealand, at least 68% of cases were associated with an underlying intracranial aneurysm or arterio-venous malformation.[20] Mortality from sub-arachnoid haemorrhage is high. In the New Zealand study, 36% had died within 48 hours of presentation, and 57% within one year. In the OCSP, 46% were dead within one month, and 48% within one year.

Summary of epidemiology of stroke at level of Primary Care Group

Table 20 shows that from a primary care perspective, the vast bulk of the workload is concerned with prevention and long-term care. A GP with a list size of 2000 would only expect to see one case of sub-arachnoid haemorrhage every five years, fewer than one transient ischaemic attack per year, and three patients with a first stroke and one patient with a recurrent stroke per year. On the other hand, each GP would expect to have 22 patients with atrial fibrillation under their care, and 20 patients who have moderate disability from a stroke.

Table 20: Summary of epidemiology of stroke and risk factors for stroke in a population of 100,000 and for a GP with a list size of 2,000.

Sub-category	Expected number of new cases per year (incidence)		Expected number of existing cases (prevalence)	
	For a GP	For a PCG	For a GP	For a PCG
Risk factors for stroke				
Atrial fibrillation	7	330	22	1,100
Hypertension (BP > 140/90)			680	34,000
Current smokers			560	28,000
Diabetes mellitus			40	2,000
Ischaemic heart disease			110	5,500
Transient ischaemic attack	0.7	35		
Stroke			30	1,500
First stroke (excluding sub-arachnoid haemorrhage)	3	164		
Recurrent stroke	1	57		
People with moderate disability from stroke			20	1,000
Sub-arachnoid haemorrhage	0.2	10		

Notes: PCG = Primary Care Group, with a population of 100,000; numbers of first strokes derived from assumption B in Table 16.

5 Services available and their costs

This section describes the types of service and intervention that are available for stroke care and gives data as to how widely they are used. It does not comment on whether they are effective (this is covered in section 6), whether they should or should not be available (covered in section 7), or whether the utilisation rate is appropriate. To interpret whether or not the utilisation rate is appropriate, it is important to consider both the effectiveness and cost-effectiveness of the intervention.

Prevention of stroke

Rose identified two complementary strategies for disease prevention: the population approach, whereby the aim is to reduce the level of risk in the whole population, and the 'high risk' approach, which aims to focus attention on reducing risk in individuals known to be at higher risk of the disease.[147] 'High risk' individuals in this context include: people at high risk of stroke; people with transient ischaemic attack; and people with previous stroke.

Population strategies

These include both strategies to make environmental and socio-economic conditions more favourable to health, and strategies to influence behaviour in such a way that 'healthy' choices are more likely to be made. Such approaches overlap. For example, provision of no-smoking areas both makes the environment healthier and may discourage people from smoking. The population strategies relevant to stroke highlighted in the white paper *Saving Lives: Our Healthier Nation* are summarised in Table 21.[8]

Table 21: Population strategies highlighted in *Saving Lives: Our Healthier Nation.*

	Local players and communities	**Government and national players**
Social and economic	Tackle social exclusion Provide incentives to employees to cycle or walk to work	Raise cost of smoking through taxation Tackle joblessness, social exclusion and poor education
Environmental	Provide smoke-free environments Reduce stress at work Provide safe cycling and walking routes	
Personal behaviour	Enforce ban on illegal sale of cigarettes to children Improve access to affordable food in deprived areas Provide facilities for physical activity	Encourage development of healthy schools and workplaces Control advertising and promotion of cigarettes Develop healthy living centres Ensure access to and availability of foods for a healthy diet Provide information about health risks of smoking, poor diet and lack of exercise
Health services		Encourage health care professionals to give advice on healthier living

Prevention in people at high risk of stroke

Hypertension, diabetes, and ischaemic heart disease are dealt with in other chapters in this series of health care needs assessments. Workers in primary care are well placed to offer appropriate lifestyle advice (diet; smoking; alcohol; weight; exercise).

For people in atrial fibrillation, the principal treatments to reduce stroke risk are anticoagulation with warfarin, usually with a target INR (International Normalised Ratio) of 2.5, or use of an antiplatelet agent, commonly aspirin, with newer alternatives available such as clopidogrel. Treatment with warfarin requires regular blood tests in order to ensure that the INR is near the target. Traditionally, INR has been monitored in hospital-based anticoagulation clinics, but newer models are emerging, including monitoring in primary care,[148] use of computerised decision support software to regulate dosing,[149] and patient self-management of INR.[150]

UK-based audits have shown that the majority of patients in atrial fibrillation are treated with aspirin rather than warfarin. Estimates of the proportion of people in atrial fibrillation on warfarin vary between 21% and 36%.[50,51,64,65] Warfarin is used less often in elderly people. For example, Sudlow *et al.* found that only 17% of patients in atrial fibrillation over the age of 74 were on warfarin.[50] This reluctance by clinicians to use warfarin in elderly patients is also reflected in US data.[151–153] Analysis of the National Ambulatory Care Surveys suggests that while warfarin use increased in the USA between 1989 and 1993 (from 13% to 40% of patients in atrial fibrillation), there has been no further rise in warfarin use between 1993 and 1996 (33% of patients in 1996 were on warfarin).[154] As in the other studies, the National Ambulatory Care Surveys showed that warfarin was less likely to be used in the very elderly.

Echocardiography is sometimes used to increase the precision of estimating risk of stroke in atrial fibrillation. In a study in West Birmingham, Lip *et al.* found that about a fifth of patients in atrial fibrillation had had an echocardiograph performed.[65]

Prevention in people who have had a transient ischaemic attack or stroke

Interventions commonly used are summarised in Table 22.

Table 22: Secondary prevention in people who have had a transient ischaemic attack or stroke.

Lifestyle advice	Diet; smoking; alcohol; weight; exercise, where appropriate
Blood pressure reduction	
Antiplatelet agents	Most commonly aspirin; other agents such as dipyridamole and clopidogrel are also used
Anticoagulation	For patients in atrial fibrillation and those with certain types of valvular heart disease, and for those where the stroke was considered cardio-embolic in origin
Statins	For patients with known coronary heart disease
Carotid endarterectomy	For patients with significant (> 70%) carotid artery stenosis on the same side

Note: Effectiveness of these interventions is discussed in section 6.

A survey conducted by the Stroke Association (1378 respondents) found that after a stroke 63% were taking aspirin, 23% were not taking aspirin because of a contraindication, and 14% were not taking aspirin but had no contraindication.[155] While this survey is difficult to interpret owing to a low response rate (less than 34%), it does echo other audits of aspirin use. For example, out of 198 men in the British Regional Heart Study with a history of stroke or transient ischaemic attack, only 80 (40%) were taking aspirin when surveyed in 1992.[156] Analysis of the General Practice Research Database (GPRD) found that between 1992

and 1996 around 37% of patients with a diagnosis of TIA were on aspirin, and 17% of patients with a diagnosis of stroke.[96] A survey of aspirin use in patients identified from GP registers as having coronary heart disease found that 63% were taking aspirin.[157]

Given the high relative risk of stroke early after a transient ischaemic attack (*see* Table 9), systems have been developed for 'fast track assessment' of patients with a transient ischaemic attack. These include urgent neurology outpatient assessment, and express carotid duplex services.[158] A substantial proportion of people referred with a transient ischaemic attack either do not have this diagnosis confirmed, or do not proceed to surgery. In a review of 332 patients referred to a regional neurovascular clinic, in only 60% of cases did the neurologist agree with the diagnosis.[97] In the first year of an express carotid duplex service in Gloucester, 90 scans were performed, and 14% of these patients went on to have a carotid endarterectomy.[158] The median gap between onset of symptoms and surgery for these patients was 51 days.

An audit of 709 carotid endarterectomies performed in 1994 by 59 participating surgeons in the UK and Ireland found that the mean ipsilateral stenosis was 82% (range: 30%–99%).[159] A study in Wessex reported that in 1995–96, the crude rate of carotid endarterectomy was 8.9 per 100 000 population, but estimated that need for the operation was at a level of 15.3 per 100 000.[160] A study of national carotid endarterectomy rates based on Hospital Episode Statistics (HES) found that, between 1990 and 1995, rates increased from 1.2 per 100 000 to 4.8 per 100 000.[161]

Acute management and rehabilitation of stroke

Patients with acute stroke are treated and rehabilitated in a variety of different settings, as illustrated in Figure 4.

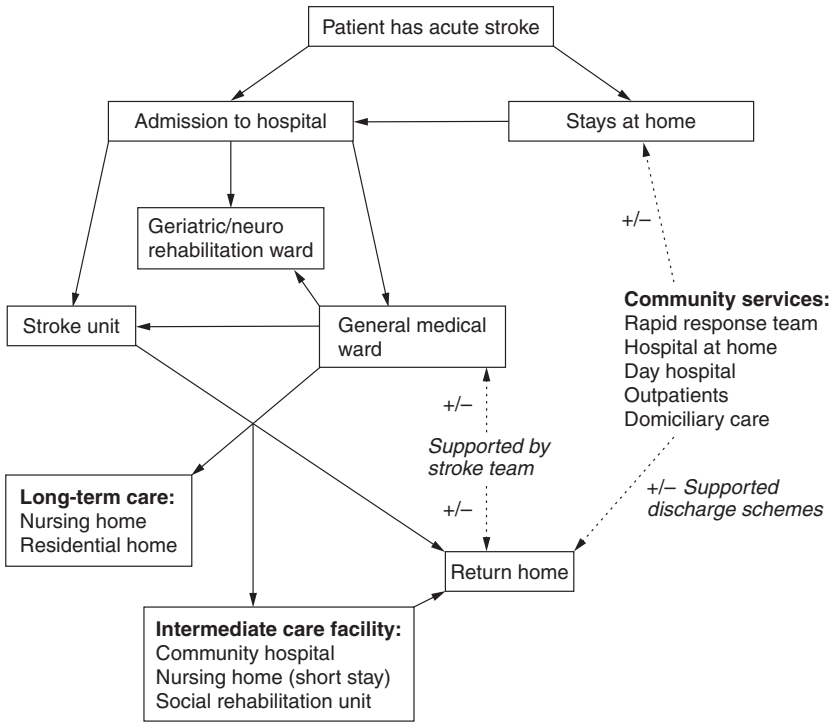


Figure 4: Patient pathways for stroke.

There is wide variation between localities in the proportion of patients with acute stroke who are admitted to hospital. 55% of people with first stroke were admitted to hospital in the OCSP,[162] 70% in the East Lancashire Study,[101] 71–78% of patients under the age of 75 across three districts in Southern England,[163,164] and 84% of patients on the South London Stroke Register.[100] The proportion in the OCSP admitted to hospital is lower than the others probably both because in this study there was more complete ascertainment of minor strokes and because neurologists would visit patients at home or see them in an outpatient clinic. Also, it was carried out earlier than the other studies, and there may have been changes in admission patterns over time. Schemes such as 'rapid response teams', 'hospital at home'[165] and day hospital services have been developed to facilitate keeping people at home. In Oxfordshire, whether or not someone was admitted depended both upon the severity of stroke, and whether or not the patient lived alone.[162] The principal reason given by GPs for requesting admission to hospital was for nursing or social care (a factor in 87% of admissions).

Diagnosis of stroke

The diagnosis of stroke can be made on clinical grounds based on history and bedside signs, and this clinical diagnosis is reasonably accurate in that investigations such as cranial imaging seldom show unexpected alternative pathological diagnoses (*see* discussion in 'Diagnosis' in section 6).[166] The majority of patients admitted to hospital with stroke will have a CT scan or other type of brain imaging primarily to exclude or demonstrate cerebral haemorrhage.[167,168]

Acute treatments

Treatments available for acute stroke are reviewed in section 6. With the exception of aspirin, acute drug treatments such as heparin and thrombolytic therapies (not licensed in Europe for acute stroke) are used only rarely. A Stroke Association survey of consultants caring for stroke patients carried out during 1998 found that 94.1% 'rarely or never used thrombolysis'.[167] In patients who cannot swallow, 60% of consultants start feeding within the first week, usually (90%) with a naso-gastric tube. If unsafe swallowing persists, 75% of consultants favour use of percutaneous endoscopic gastrotomy (PEG).

Stroke unit care

Among patients admitted to hospital, a major distinction is whether patients are treated on a stroke unit, or in a general medical ward. The term 'stroke unit' care has come to be synonymous with 'organised in-patient' care.[169] This implies care by a co-ordinated, multidisciplinary team including nurses and doctors. Under this broad umbrella, several types of 'stroke unit' have been defined:[170]

- stroke ward: geographically defined area where stroke patients receive stroke unit care
- stroke team: a mobile team delivering stroke unit care to patients in a variety of wards; this does not always include a specialist nurse
- dedicated stroke unit: a disease-specific stroke unit managing only stroke patients
- mixed assessment/rehabilitation unit: a generic disability unit (which fulfils the definition of a stroke unit) specialising in the management of disabling illnesses including stroke; for example, this would include geriatric and neurological rehabilitation wards
- acute stroke unit: a stroke unit accepting patients acutely and continuing for several days (usually < 1 week)
- combined acute/rehabilitation stroke unit: a stroke unit accepting patients acutely but continuing care for several weeks if necessary
- rehabilitation stroke unit: a stroke unit accepting patients after a delay of 1–2 weeks and continuing care for several weeks if necessary.

From responses to the Stroke Association survey of consultant physicians in the UK it was estimated that in 1998 approximately half of stroke patients were cared for in an organised stroke service.[167] In the National Sentinel Audit for stroke, which carried out a case note review of 6894 consecutive stroke patients admitted to 197 trusts in England, Wales and Northern Ireland during 1998, the proportion of patients receiving stroke unit care was lower.[10] 18% of patients were shown to spend more than half of their inpatient stay on a stroke unit, 15% on a rehabilitation unit, and 67% on general wards. This general pattern of results is consistent with the Clinical Standards Advisory Group (CSAG) review of stroke services in a small random sample of 13 districts and boards in the UK that was carried out during 1996–97. Out of 20 trusts that provided rehabilitation services for people with stroke, 13 had a designated stroke service, of which nine could be classified as stroke units.[168] CSAG noted that there 'was rarely a full multidisciplinary team capable of working in a patient's home'.

The Stroke Association survey (1998) found that the majority of consultants admit stroke patients to an acute admission ward – only 12% admit directly to a stroke unit.[167] 75% of consultants had access to specialised stroke services – either a defined unit, or a multidisciplinary stroke team. The majority of the stroke units were rehabilitation units, but a minority of consultants (17%) had access to acute stroke units, or to combined acute/rehabilitation units (16%). Access to acute stroke unit care was much higher in Scotland (41%) and Northern Ireland (52%) than England (29%) and Wales (21%).

In terms of what is different about the medical components of stroke unit care as compared to general ward care supported by a specialist stroke team, Evans *et al.* reported that stroke unit care was associated with more intensive monitoring, greater use of oxygen and antipyretics, measures to reduce aspiration, and early nutrition.[171]

Components of the multidisciplinary team

A key feature of stroke unit, or 'organised', care is access to a multidisciplinary team. The component parts of this team for a ten-bedded unit are summarised in Table 23 (*see* overleaf).[170] The National Sentinel Audit for stroke found that while the majority of trusts had access to core professional staff, other professionals were not necessarily available – for example, only 29% had support from a clinical psychologist.[10] The Stroke Association consultant survey found that a third of consultants did not have access to a multidisciplinary team for their stroke patients.[167]

Surgical intervention in acute stroke

Neurosurgeons offer two relevant interventions (excluding treatment of sub-arachnoid haemorrhage): evacuation of intracerebral haemorrhage; and the treatment of acute hydrocephalus arising from cerebellar haemorrhage or infarction. Both these operations are uncommon in the UK. There is uncertainty over the value of the former, though it is quite widely used in some countries, such as Japan; the latter is accepted practice, but acute hydrocephalus is a relatively uncommon complication.

Length of stay

In the National Sentinel Audit, the mean age of patients admitted to hospital with stroke was 75 years, with a 28% mortality at 30 days.[10] For those discharged alive, the median length of stay was 21 days. The mean length of stay (including deaths) in a study in Dublin was 31 days,[172] which is similar to the average in Oxfordshire (unpublished data held on file from the Oxford Stroke Register, 1995).

Table 23: Multidisciplinary involvement in with typical WTE staff for a ten-bedded stroke unit (after Langhorne and Dennis[170]).

	Professional	WTE*
Core team	Physicians	Consultant: 0.5–1 wte
	Nurses	Junior medical: 0.4–0.8 wte
	Physiotherapists	7–12 wte
	Occupational therapists	1–2 wte
	Speech and language therapists	0.9–1.3 wte
	Social workers	0.2–0.6 wte
		< 0.4–0.7 wte
Other professionals	Audiologist	
	Chaplain	
	Chiropodist	
	Clinical psychologist	
	Dentist	
	Dietician	
	Orthoptist	
	Pharmacist	
Other medical/surgical consultants	Neurosurgeon	
	Psychiatrist	
	Ophthalmologist	
	Radiologist	
	Rheumatologist	
	Vascular surgeon	

* WTE = whole time equivalent.

Community services

These services may be used either to help people with stroke avoid hospital admission, or to support people with stroke after transfer out of hospital. A review of community-based rehabilitation services carried out by the Audit Commission in twelve different areas of England and Wales reported that 80% of localities had access to day hospitals and 50% to a multidisciplinary team.[173] While most such teams include physiotherapy and occupational therapy, the other professional groups (including nursing and medical) were only represented in a minority.[174]

Intermediate care facilities

There are several definitions of 'intermediate care'.[175] Perhaps the most useful definition for the purposes of this chapter is: 'a service that meets the needs of those who because of their age or psychosocial circumstances would benefit from an extended period of rehabilitation from a multidisciplinary team following acute illness or treatment which could not be reasonably provided in their own homes, in an acute hospital or in a specialist unit.'[176] The National Service Framework for Older People describes intermediate care as a bridge between acute hospital, and primary and community care, and gives its aim as 'to provide integrated services to promote faster recovery from illness, prevent unnecessary acute hospital admissions, support timely discharge and maximise independent living'.[9] In the context of stroke care,

they have a potential role for patients who 'would otherwise face unnecessarily prolonged hospital stays . . . [or] long-term residential care'.[9]

The Audit Commission identified social services residential rehabilitation schemes as an important form of intermediate care. Half of the areas included in the Audit Commission review had social rehabilitation schemes. Typically, such care is based in units that were previously local authority residential homes. Costs tend to be shared between health and social services.[173] Amounts of medical input vary. Being 'social' rehabilitation schemes, users also have to pay a contribution.

Another form of intermediate care is the community hospital (CH).[177,178] In 1993, there were around 350 community hospitals in the UK, with about 10 000 beds.[176] Stroke is the commonest medical diagnosis associated with CH admission.[179]

Long-term care

In the National Sentinel Audit, 74% of patients were discharged to independent or warden-controlled housing, 7% were transferred to another hospital, and 19% were transferred into institutional care. There were wide variations between different regions of the UK as to the proportion of patients discharged to institutional care who had been admitted from home with a stroke (6–19%).[180] These results are consistent with an unpublished study (data held on file) of 532 consecutive stroke admissions in patients aged 65 or over to acute hospitals in Oxfordshire. After six months, 228 (43%) were at home, 233 (44%) had died, 56 (10%) were in residential care, and 15 (3%) were still in hospital (mostly a community hospital). This is the equivalent of 19% of survivors being in institutional care. Surveys of nursing homes estimate that between 14%[181] and 23%[182] of beds in nursing homes are occupied by people who have had a stroke.

Carer support

Recognising the wider impact of stroke, services have been developed which target carers as well as patients. These include specific single-faceted interventions such as information giving, educational programmes and counselling,[183] and more generic services where the aim is to provide information and advice, emotional and social support, and liaison with health and social services. These generic services have been variously called: 'social work',[184] 'specialist nurse support',[185] 'family support organisation'[186] and 'family care work'.[187]

Services for sub-arachnoid haemorrhage (SAH)

Someone with a diagnosis of sub-arachnoid haemorrhage, which carries a high mortality (*see* section 4), would be admitted to hospital. Investigations and treatments used are shown in Table 24 (*see* overleaf). Evidence of the effectiveness of these interventions is summarised in 'Sub-arachnoid haemorrhage' in section 6.

Costs of stroke care

The overall costs of stroke care to the NHS are variously put at between 4%[2] and 6%[3] of the total expenditure on the NHS. Bosanquet and Franks estimated that people who have had strokes accounted for

Table 24: Management of sub-arachnoid haemorrhage: possible investigations and treatments.

1 To make diagnosis	Brain imaging	CT scan MRI scan
	Lumbar puncture	
2 To search for cause of haemorrhage	Vascular imaging	Angiography MR angiography CT angiography Transcranial colour-coded duplex sonography
3 Treatment of acute haemorrhage	Evacuation of intracerebral haematoma	
4 Prevention of re-bleeding	Medical therapy	Antifibrinolytic drugs
	Surgical therapy	Clipping of aneurysm
	Interventional radiology	Coil embolisation
5 Prevention of secondary cerebral ischaemia	Medical therapy	Nimodipine

£2318 million in 1995–96, which is the equivalent of 5.8% of total NHS and social services expenditure.[188] They estimated that £758 million of this was attributable to the cost of treating new patients, and £1560 million to the cost of treatment of 'old patients' (i.e. costs attributable to long-term care, community support and acute admissions for recurrent strokes). If the costs of informal care are also taken into account (estimated at £672 million), then the total cost would rise to £2990 million.[188]

Publication of the NHS reference costs allows simple estimates to be made of some of the hospital-related components of care. The relevant health resource group (HRG) codes (*see* 'Health care resource group codes (HRGs)' in section 3) and their costs for 1999 are shown in Table 25. This shows the average cost of a Finished Consultant Episode (FCE) in NHS trusts in England. FCEs can be difficult to interpret, because a patient may have several FCEs over the course of a single admission. For example, over a six-month period in one study, 470 FCEs relating to stroke were identified, which corresponded to 318 separate admissions – an average of 1.5 FCEs per admission.[41] There is very wide variation in costs of an FCE between different trusts. Thus, for example, while the average cost of an FCE for an admission with stroke in someone aged 70 or over was £2099, the range for the middle 50% of trusts was from £1179 to £2729, and the total range was from £45 to £16 415![189] The wide range illustrates some of the current limitations of use of HRGs in this context. It is not clear to what extent the wide range reflects erroneous data or differences in case-mix between different trusts. Use of the range for the middle 50% of trusts (as shown in Table 25) gives a more conservative estimate of the spread of cost. However, estimates from research studies suggest that the total cost of an individual stroke case admitted to hospital in the UK is between £5800 and £8500 (1996–7 prices)[170,190] which falls outside this range.

6 Effectiveness and cost-effectiveness

Important sources of data on evidence of effectiveness of stroke services include: the Cochrane Library (*see* Appendix 2); the Royal College of Physicians' National Clinical Guidelines for Stroke;[11] *Clinical Evidence*;[191] and the review by the NHS Centre for Reviews and Dissemination of systematic reviews of

Table 25: NHS reference costs relevant to stroke (1999).[189]

HRG code	Mean cost of FCE (range for middle 50% of trusts)	
	Non-elective inpatient	Elective inpatient
Carotid artery stenosis		
Q05 (carotid artery surgery including endarterectomy)	£1,767 (895–2,132)	**£1,940 (833–2,075)**
Transient ischaemic attack		
A20 (age > 69 or with complications)	**£918 (686–1,395)**	£1,384 (556–1,739)
A21 (age < 70 with no complications)	**£624 (459–1,068)**	£1,461 (502–1,413)
Stroke		
A22 (age > 69 or with complications)	**£2,099 (1,179–2,729)**	£2,635 (911–3,365)
A23 (age < 70 with no complications)	**£1,623 (1,004–2,240)**	£2,096 (677–2,142)
A19 (includes intracerebral haemorrhage)	**£1,413 (928–2,004)**	£1,918 (652–2,415)
A03 (includes evacuation of intracerebral/cerebellar haematoma)	**£3,870 (1,141–4,223)**	£3,502 (1,013–3,717)
Sub-arachnoid haemorrhage		
A19 (includes sub-arachnoid haemorrhage)	**£1,413 (928–2,004)**	£1,918 (652–2,415)
A03 (includes drainage of sub-arachnoid space; excision/ligation of cerebral artery aneurysm)	**£3,870 (1,141–4,223)**	£3,502 (1,013–3,717)
A04 (includes clipping/obliteration of cerebral artery aneurysm)	**£5,365 (1,347–6,089)**	£4,715 (1,070–5,370)

Note: **Bold costs** indicate more usual type of admission.

research relevant to the 'wider public health' agenda.[192] This section draws heavily on these sources, with reference to more recent specific studies where relevant.

Population strategies to prevent stroke

Rees *et al.* recently reviewed the evidence relevant to government policy on heart disease and stroke.[193] Their conclusions are summarised below.

Prevention of smoking

Raising the cost of cigarettes through taxation reduces consumption.[194] The effect is greater on women and younger people, but it creates financial hardship for poorer sections of society.[195] Provision of smoke-free workplaces[196] and control of advertising[197] both reduce overall tobacco consumption. School-based programmes which employ social reinforcement techniques[198] and mass media campaigns[199] may both be effective at reducing uptake in young people. Health education campaigns that simply provide information tend to be effective only in higher socio-economic groups.[200]

Socio-economic deprivation

Evidence on the direct health effects of income supplementation is lacking, since the trials that were performed did not use suitable health outcome measures.[201] Structural and legislative measures are most effective at reducing health inequalities.[200]

Healthy lifestyle

A systematic review of exercise health promotion strategies concluded that public health strategies aimed at changing the environment to encourage walking and cycling would reach a greater proportion of the inactive population than strategies aimed at increasing use of exercise facilities.[202]

While eating more fresh fruit and vegetables has been shown to be associated with a lower risk of stroke,[203] health effects of changes in consumption have not been demonstrated through trials. Public health strategies to reduce salt consumption such as reducing salt content in processed foods may have an impact on blood pressure (*see* chapter on hypertension).[204]

Prevention in people at high risk of stroke

The evidence for treatments to reduce risk of stroke in different categories of people is summarised in Table 26. Treatment of hypertension, diabetes and ischaemic heart disease is covered in more detail in other chapters. The grading of the quality of evidence takes into account both the nature of the evidence

Table 26: Effectiveness of treatments to reduce risk in high risk individuals.

Risk group	Intervention	Reduction in stroke risk	Quality of evidence*
Hypertension	Lowering blood pressure	35–40% with a mean reduction of 5–6 mmHg in diastolic blood pressure[209]	A1
Atrial fibrillation	Adjusted dose warfarin Aspirin	59%, with mean achieved INR from 2.0–2.6[210] 20–22%, with doses in trials varying between 50 mg and 1,300 mg/day[210,211]	A1 B1
	Warfarin versus aspirin	32–36% reduction if treated with warfarin in preference to aspirin[210,212]	B1
Carotid artery stenosis (asymptomatic)	Carotid endarterectomy	27–38% reduction in risk of ipsilateral stroke or perioperative stroke or death after mean of 3 years follow-up[213,214]	C1
People at high vascular risk**	Aspirin	27% reduction in risk of MI, stroke or vascular death; 31% reduction in risk of non-fatal stroke[215] There is no evidence that higher doses (e.g. 300 mg/day) are any more effective than lower doses (e.g. 75 mg/day)[216]	A1
	Thienopyridine derivatives (ticlopidine and clopidogrel) in preference to aspirin	12% reduction if treated with a thienopyridine in preference to aspirin[217,218]	C1
	Statin therapy	*See* text for discussion of MRC/BHF heart protection study	
Ischaemic heart disease	Lowering cholesterol with statins	29% reduction if treated with a statin[219]	A1

Notes: * *See* introductory chapter to HCNA series for grading used; ** Including peripheral vascular disease, ischaemic heart disease and cerebrovascular disease.

(grade 1–4) and the size of the effect (A–E). The definitions are given in the introductory chapter to this series. The size of the effect incorporates both relative effect (reduction in stroke risk – as shown in Table 26) and absolute effect. Thus, carotid endarterectomy in asymptomatic individuals has been graded C since asymptomatic carotid artery stenosis does not confer significant stroke risk, so the benefits of the operation in absolute terms are small.[90] The published evidence that statins reduce stroke risk is derived largely from two cardiovascular secondary prevention studies – the Cholesterol and Recurrent Events (CARE) Study[205] and the Scandinavian Simvastatin Survival Study (4S).[206] Therefore, cholesterol lowering has been included as a treatment in people with ischaemic heart disease. However, the indications for statins will widen as a result of the recently reported but unpublished MRC/BHF Heart Protection study. This trial involved 20 000 volunteers who were at increased risk of coronary heart disease, regardless of baseline cholesterol level. The results presented at the 2001 American Heart Association Scientific Meeting showed that treatment with statins reduces the risk of heart attacks and strokes 'by at least one-third, not just in people who already have coronary disease, but also in those who have diabetes, narrowing of arteries in their legs or a previous history of stroke'.[207]

With regard to lifestyle interventions to reduce risk of stroke (e.g. smoking cessation, weight loss, healthy diet, exercise, control of alcohol consumption), there is little direct evidence from trials that such interventions are effective. Justification for their use is through extrapolation from observational studies that demonstrate associations between the risk factor and stroke, and that changes in risk factor status are associated with better outcome (quality of evidence: B2). Observational evidence suggests that moderate alcohol consumption may actually protect against ischaemic stroke.[208]

Prevention in people who have had a stroke or transient ischaemic attack

Lowering blood pressure

A meta-analysis of individual patient data on the effects of lowering blood pressure of patients with hypertension and a history of stroke, who had been included in randomised controlled trials of the effects of antihypertensive therapy, found risk of subsequent stroke was reduced by 28% (95% CI: 61–85%) (quality of evidence: A1).[220] The benefits of lowering blood pressure in people with stroke have been confirmed by the PROGRESS trial, which showed similar effects (28% reduction in stroke risk) in both hypertensive and non-hypertensive stroke patients.[221,222] The trial also showed that the more intensive the treatment, the larger was the effect. Thus, giving combination therapy (an ACE inhibitor plus a thiazide diuretic) achieved greater reductions in blood pressure (mean reduction: 12/5 mmHg) and stroke risk (43%) compared with a single agent (ACE inhibitor) (5/3 mmHg reduction in blood pressure, and 5% reduction in stroke risk). These findings are consistent with observational data showing that the lower the diastolic blood pressure, the lower the risk of a second stroke.[223]

Treatment of atrial fibrillation

For secondary prevention in atrial fibrillation, warfarin reduces risk of stroke by 68%, a similar order of magnitude to that achieved in primary prevention.[210] Due to the higher risks of stroke in people who have already had a stroke, the benefits of warfarin over aspirin in absolute terms are higher than for primary prevention.

Carotid endarterectomy for symptomatic carotid artery stenosis

In patients with severe carotid artery stenosis (> 80% in the European Carotid Surgery Trial (ECST), which is the equivalent of > 70% in the North American Symptomatic Carotid Endarterectomy Trial (NASCET)) surgery reduces the risk of disabling stroke or death by 48% (95% CI: 27–73%) (quality of evidence: A1).[224] In patients with moderate stenosis (ECST 70–79%; NASCET 50–69%) surgery reduces risk of stroke or death by 27% (95% CI: 15–44%) (quality of evidence: B1). In patients with lesser stenoses, surgery increases the risk of stroke or death by 20% (95% CI: 0–44%) (quality of evidence: E1).[224] The benefits of carotid endarterectomy are outweighed by the harm if the surgical complication rate exceeds 6%.[224] A variety of surgical techniques are used for carotid endarterectomy, but there is insufficient evidence to favour one approach over another.[225–31] The recently reported CAVATAS trial found that endovascular treatment (i.e. percutaneous transluminal balloon angioplasty with stents also used in some patients) achieved similar results to carotid endarterectomy in terms of ipsilateral stroke recurrence three years after the intervention (hazard ratio: 1.04; 95% CI: 0.63–1.70).[232] However, the confidence intervals are wide, and one year after treatment severe (70–99%) ipsilateral stenosis was more common in the endovascular group (14% versus 4%). Endovascular techniques have evolved since this study was initiated, with greater experience of use of stents. The ongoing CREST (Carotid Revascularisation Endarterectomy versus Stenting Trial) and International Carotid Stenting Study (ICSS) will provide further data to clarify whether or not endovascular procedures are as effective as carotid endarterectomy.[233,234]

A post hoc sub-group analysis of the North American Symptomatic Carotid Endarterectomy (NASCET) trial found that the absolute benefits of surgery were significantly greater in elderly people. The absolute risk reduction of ipsilateral ischaemic stroke for people with 70–99% stenosis was 28.9% [Number Needed to Treat (NNT) = 3] in people aged 75 or over, as compared to 15.1% (NNT = 7) in people aged 65–74 and 9.7% (NNT = 10) in people aged under 65.[235] Furthermore, the absolute risk reduction was significant in older patients (aged 75 or over) with lesser degrees of stenosis (50–69%). This finding is supported by pooling of data from the Carotid Endarterectomy Trialists' Collaboration (CETC).[236]

There are some observational data to suggest that surgeons who perform very few carotid endarterectomies per year (less than 5) achieve worse outcomes, and that hospitals with greater through-put (over 100 operations per year) achieve better results[237] (quality of evidence: B2).

Antiplatelet agents

Aspirin is effective in secondary prevention of stroke, despite causing a small increase in risk of haemorrhagic stroke.[215] The size of the risk reduction is similar to that achieved by primary prevention (Table 26). Thienopyridines (clopidogrel; ticlopidine) are effective alternatives.[218] Whether or not adding dipyridamole to aspirin increases the effectiveness, as has been suggested by one trial, the European Stroke Prevention Study (ESPS-2),[238] is currently being reviewed by the Antithrombotic Trialists Collaboration.[239] The combination of clopidogrel and aspirin has been shown to be more effective than aspirin alone in preventing vascular events in patients with acute coronary syndrome and in patients undergoing percutaneous coronary interventions.[240,241]

Statin therapy

The unpublished MRC/BHF Heart Protection study provides evidence of the effectiveness of statin use in people who have had a stroke (*see* 'Prevention in people at high risk of stroke' above).

Ineffective therapies

Long-term anticoagulation in people with non-embolic stroke (in the absence of atrial fibrillation or valvular heart disease) confers no benefit, but does increase risk of bleeding.[242] In a recently reported trial which compared warfarin to aspirin for prevention of recurrent ischaemic stroke in patients who had a prior non-cardioembolic stroke, non-significant advantages in terms of lower stroke rates and major haemorrhage were found for aspirin over warfarin (stroke rates: 16% versus 18%; major haemorrhage rates: 1.5% versus 2.2%).[243]

Acute treatment of stroke

Diagnosis

The accuracy of clinical diagnosis depends upon the setting and the time after onset of symptoms when the diagnosis is made. A study in Ohio found that 62 out of 86 (72%) patients diagnosed as having had a stroke or TIA by ambulance personnel had this diagnosis confirmed in hospital.[244] A study in Los Angeles found higher levels of accuracy were achieved by ambulance personnel in association with the use of a screening instrument (the Los Angeles Prehospital Stroke Screen – the LAPSS). 86% of patients diagnosed as having had a stroke on the LAPSS had this diagnosis confirmed in hospital.[245] Estimates of the accuracy of diagnosis in Accident and Emergency vary between a predictive value of 81 and 95%.[246,247] The main source of error is distinguishing stroke from other causes of acute neurological deficit, such as post-ictal deficits, systemic infection, tumours and toxic metabolic disturbances. In the OCSP, out of 325 patients diagnosed as having a 'clinically definite first stroke' by an experienced physician after admission, only 5 turned out to have different final diagnoses (2 sub-dural; 2 glioma; 1 metastasis).[248] Only 3 out of 411 patients diagnosed as not having had a stroke were subsequently found (on the basis of CT scan or autopsy) to have had one. Infarcts on a CT scan are most apparent after a few days, though up to half of patients with a clinically definite stroke will not have a diagnostic lesion on a CT scan.[249]

In their review of the evidence, the Intercollegiate Working Party for Stroke concluded that little directed research has been carried out to assess the process of diagnosis for stroke, and that: 'No research has evaluated critically the role of brain imaging.'[11] There are three reasons for performing brain imaging (CT or MRI scan) in acute stroke: to identify other causes for the symptoms (as discussed in the preceding paragraph); to exclude cerebral haemorrhage; and to assess eligibility for thrombolysis in centres where this is given.

CT scanning (or other brain imaging) has a role to differentiate cerebral infarction from haemorrhage, since this will help determine both acute treatment and secondary prevention strategy. In this regard, case series show that it becomes more difficult to distinguish cerebral haemorrhage from cerebral infarction as time elapses after the stroke, and that, after two weeks, the scan may be classified incorrectly.[250] While early CT can accurately identify intracerebral haemorrhage, it can be difficult to differentiate between a primary intracerebral haemorrhage (PICH) and haemorrhagic transformation of an infarct (HTI). The possibility of mistaking a an HTI for a PICH reduces the earlier that the CT scan is performed.[248]

As acute treatments which require early intervention become available (*see* below), early clinical diagnosis may be less adequate. For example, in a series of 70 patients who were examined within 6 hours of onset of symptoms, and diagnosed at that time as having had an anterior circulation stroke, 6 were found to have different final diagnoses (3 metabolic upset; 1 migraine; 1 alcohol withdrawal; 1 hysteria).[251] Furthermore, of the 64 patients who did have a stroke, in 15 it was not an anterior circulation stroke, but something else (e.g. intracerebral haemorrhage; small vessel occlusion).

Echocardiography can identify cardiac sources of embolus in patients with stroke and clinical evidence of cardiac disease. There is evidence from observational studies that patients with intracardiac thrombus benefit from anticoagulation.[252]

Acute interventions

A large number of interventions in acute stroke have been reviewed by the Cochrane Stroke Group. Interventions that show some promise, but for which there is insufficient evidence of effectiveness to recommend them currently outside clinical trials, include cooling therapy (on the basis of pathophysiology)[253] and fibrinogen depleting agents (ancrod).[254] Treatments that are in common use in several parts of the world for which no evidence of effectiveness was found include: anticoagulants for acute stroke,[255] including low molecular weight heparins;[256] deliberate lowering of blood pressure in acute stroke;[257] and surgery for primary supratentorial intracerebral haemorrhage.[258]

Two interventions for which there is some evidence of beneficial effect are antiplatelet therapy and thrombolysis. Aspirin, at a dose of 160–300 mg daily, started within 48 hours of onset of symptoms, leads to a small but significant reduction in risk of death or dependency (6% risk reduction) (quality of evidence: C1).[259] Thrombolysis increases risk of death, but reduces dependency in survivors so that, overall, risk of death or dependency is reduced.[260] By the end of follow-up, thrombolysis administered within 6 hours of onset of stroke resulted in a 17% reduction in the odds of death of dependency. Indirect comparison of the different thrombolytic agents that have been used in trials suggests that recombinant tissue Plasminogen Activator is associated with fewer deaths and greater chance of a good outcome (alive and independent) (quality of evidence: B1).[260] Interpretation of the data on thrombolysis remains controversial. In the US, thrombolysis is more widely accepted as a 'proven' treatment on the basis of the National Institute of Neurological Disorders and Stroke (NINDS) trial, which found a better chance of a good outcome in patients treated with tissue Plasminogen Activator (tPA) at both 3[261] and 12 months after the stroke.[262,263] However, other trials, such as the European Co-operative Acute Stroke trials (ECASS I and II), did not find that t-PA was effective.[264,265] The conclusion of the Cochrane review of this evidence was that:

> *The data are promising and may justify the use of thrombolytic therapy with intravenous recombinant tissue Plasminogen Activator in experienced centres in selected patients. However, the widespread use of thrombolytic therapy in routine clinical practice at this time cannot be supported. Further trials will be needed to identify which patients are most likely to benefit from treatment and the environment in which it may best be given, before thrombolytic therapy should be adopted on a wider scale.*[260]

Organisation of stroke care

Organised inpatient care in stroke units leads to better survival, less dependency, and greater likelihood of patients living at home after one year as compared to conventional inpatient care. The odds of death or institutionalised care at final follow-up (median one year) were reduced by 24% (greater than the effect of any individual drug), and the odds of death or dependency by 25% in patients who received stroke unit care.[169] Stroke unit care is not associated with any increase in length of hospital stay. There is no evidence that services which aim to avoid hospital admission for stroke patients can achieve the same benefits as in-patient stroke units.[165] A trial comparing stroke unit care with general ward care with stroke team support, or domiciliary stroke care with specialist team support, found significantly better outcomes for the group that received inpatient stroke unit care as compared to the other models of care (which loosely fit under the broad definition of 'organised' stroke care).[266]

There is no evidence from randomised trials as to how soon after their stroke patients should be admitted to stroke units. The poorer survival in UK hospitals, as compared to some European centres

which are associated with more intensive management of the early phases of acute stroke, has been cited as circumstantial evidence for the importance of more intensive acute stroke care (quality of evidence: B3).[267]

Models of care that support early discharge from hospital reduce length of stay, but the effects on patient and carer outcomes and on overall costs of this approach are unclear.[268,269] For example, a London study showed that community-based rehabilitation (after, on average, 34 days in hospital) can achieve similar outcomes in terms of activities of daily living at one year as slightly longer periods in hospital,(average 40 days), though patients in the early discharge group were found to have higher levels of anxiety.[270] There are similar uncertainties over the effects of day hospital rehabilitation.[271]

Stroke rehabilitation

The overall package of 'stroke unit care', as outlined in 'Acute management and rehabilitation of stroke' in section 5, is effective, which is evidence for the role of rehabilitation in stroke as a whole. This rehabilitation is multidisciplinary. The evidence for the individual components of the rehabilitation process is reviewed below. In general, the evidence for the individual components is a lot weaker than the evidence for the rehabilitation process as a whole. However, demonstrating that one part of the system looked at in isolation does not work is not evidence that that part is not necessary for the effective provision of rehabilitation.[272]

Treatment of swallowing difficulties

Observational studies using historical controls suggest that recognising and treating swallowing difficulties in stroke patients will reduce risk of pneumonia.[273] However, there is a lack of evidence available to guide care and feeding of these patients.[274] Percutaneous endoscopic gastrostomy (PEG) feeding may improve outcome and nutrition as compared with naso-gastric tube feeding, but this is based on two small trials only.[274,275]

Physiotherapy

A systematic review of randomised trials of physiotherapy after stroke identified seven trials involving 597 patients.[276] Patients who received more intensive physiotherapy did better in terms of a composite outcome of death or deterioration at the end of follow-up (OR 0.54; 95% CI: 0.34–0.85). A separate meta-analysis reached similar conclusions.[277] Since these reviews, a randomised trial of physiotherapy with three groups (arm training; leg training; and a control group) in 101 patients with severe disability following a middle cerebral artery stroke, demonstrated that greater intensity of rehabilitation improved functional recovery and health-related functional status.[278] There is a growing evidence base looking at specific interventions such as electrical stimulation for the prevention and treatment of post-stroke shoulder pain,[279] and electromyographic feedback to improve limb function,[280] but clear conclusions about the effectiveness or otherwise of these interventions cannot be drawn.

Speech and language therapy

There is too little evidence from randomised controlled trials about the effects of speech and language therapy after stroke to draw any conclusions as to whether it is effective or ineffective.[281] A systematic review of observational studies concluded that intensive targeted therapy is effective for some specific dysphasic syndromes (quality of evidence: B2).[282]

Occupational therapy

Recent randomised controlled trials have demonstrated the effectiveness of domiciliary occupational therapy for stroke, both in patients who stay at home[283] and patients after discharge from hospital.[284] A meta-analysis of controlled studies (including some randomised trials) of occupational therapy for older people (i.e. not just stroke patients) found some evidence in support of occupational therapy in other settings, such as nursing homes and psychogeriatric wards.[285]

Treatment of post-stroke depression

Trials have been performed of both pharmacological and psychological treatments of post-stroke depression. A recent systematic review concluded that patients with depressive symptoms after stroke do respond to short-term treatment with antidepressants, but that there is a lack of trials of sufficient size to draw conclusions as to the role of psychological treatments in post-stroke depression.[135]

Integrated care pathways

One approach to achieving co-ordinated care that has been tried is the integrated care pathway, in which a co-ordinator or case manager is responsible for ensuring that patient care follows a pre-defined template. In one trial, this approach was compared to a conventional multidisciplinary approach in which individualised care objectives were set depending upon patient progress. However, the integrated care pathway approach was found to be associated with slower recovery and poorer quality of life scores.[286]

Late rehabilitation

Most research on rehabilitation has been directed at therapy in the first few months following stroke. One trial of physiotherapy for patients who had a stroke at least a year earlier found that minimal late intervention could lead to small improvements in mobility, but the improvements were not maintained.[287] (quality of evidence: C1–2) A small trial of more intensive therapy found that this led to reduced dependence and increased social function – an effect that appeared to be sustained.[288]

Family support services

There is no evidence that family care workers can reduce the emotional impact of stroke for patients,[289] but there is consistent evidence from two randomised controlled trials that provision of such services can lead to significant psychosocial benefits for carers.[186,187]

Other services

Many other aspects of stroke care have been evaluated. For example, trials of information provision[290] and of educational programmes[291] for patients and carers have been performed, but have not demonstrated any clear benefits.[292] Two small trials provide some evidence that cognitive rehabilitation may improve alertness and sustained attention for patients with attention deficits, but there is insufficient data to conclude whether or not this leads to any improved functional independence.[293] It is unclear whether cognitive rehabilitation has any effects on memory deficits following stroke.[294]

There is little research to support the provision of most equipment such as walking sticks, frames or even wheelchairs. However, in many cases the benefits are so obvious that research is not likely to be sensible (e.g. provision of a wheelchair to someone unable to walk). Ankle/foot orthoses have been researched a

little, and there is some evidence from non-randomised studies that they facilitate walking.[295] However, this was not confirmed in a more recent randomised study.[296]

Sub-arachnoid haemorrhage

Investigations in sub-arachnoid haemorrhage

These have recently been reviewed by van Gijn and Rinkel.[297] CT scans detect the characteristic appearance of blood in the basal cisterns. However, false positive diagnoses are possible on CT if there is generalised brain oedema leading to venous congestion in the sub-arachnoid space. CT scanning within 12 hours is 98% sensitive (i.e. will miss 2% of patients with sub-arachnoid haemorrhage).[298] MRI scanning is as accurate as CT scanning in the early stages, but is better than CT at detecting extravasated blood later on.[297] Lumbar puncture can exclude sub-arachnoid haemorrhage in patients with a negative scan, but a traumatic tap (i.e. the lumbar puncture needle entering a vein) can be mistaken for blood in the sub-arachnoid space. The risks of this are reduced the later after the onset of symptoms that the lumbar puncture is performed, since this allows xanthochromia (caused by lysis of red cells in the cerebrospinal fluid) to develop, which gives a characteristic appearance to the fluid.[297]

Angiography is the gold standard for detecting aneurysms, but has a 1.8% rate of neurological complications.[299] Techniques such as MR angiography and CT angiography are nearly as accurate as angiography and are safer.[297]

Treatment of sub-arachnoid haemorrhage

Case series and a small randomised controlled trial suggest that surgical evacuation of large haematomas in the acute phase may improve survival and outcome (quality of evidence: B2).[297]

There are medical, surgical and endovascular approaches aimed at preventing re-bleeding. A review of antifibrinolytic therapy (e.g. tranexamic acid) found no evidence of benefit, with an odds ratio of poor outcome of 1.05 (95% CI: 0.72–1.26).[300] However, the reviewers noted that the trials were performed more than 10 years ago, and that new strategies might overcome the ischaemia-inducing potential of the treatment. Operative clipping of the aneurysm is standard practice (quality of evidence: B3). A Cochrane review identified one randomised controlled trial addressing the timing of surgery after aneurysmal sub-arachnoid haemorrhage.[301,302] Patients operated on late had more re-bleeding and delayed ischaemia, but this was not apparent if the patient was on nimodipine. The Cochrane reviewers concluded that timing of surgery was not a critical factor in determining outcome following sub-arachnoid haemorrhage, based on the limited evidence available. An alternative to surgery is the use of coil embolisation to pack the aneurysm.[303] To date, there is insufficient evidence to judge the value of coil embolisation as compared to surgical intervention.[297] One randomised trial ($n = 109$) has been published which compared coil embolisation to surgical ligation of ruptured intracranial aneurysm, and found no difference in clinical outcome at three months between the groups.[304] The ongoing MRC-funded International Sub-arachnoid Aneurysm Trial (ISAT) is a randomised trial comparing neurosurgical clipping with endovascular coil treatment for ruptured cerebral aneurysm causing acute sub-arachnoid haemorrhage. It is anticipated that this trial will report in 2002.

With regard to prevention of secondary cerebral ischaemia, a systematic review of calcium antagonists in sub-arachnoid haemorrhage found that nimodipine is effective in reducing risk of poor outcome (death or severe disability), achieving a risk reduction of 18% (95% CI: 7–28%).[305] Other neuroprotective agents have been evaluated, but no clear-cut evidence of benefit has been found for any of these.[304] Other aspects of the medical management of sub-arachnoid haemorrhage, such as avoidance of treatment of

hypertension in the acute phase and prevention of hypovolaemia through use of intravenous saline are currently justified on the basis of the underlying patho-physiology (quality of evidence: B3).[297]

Cost-effectiveness studies

Two systematic reviews have recently summarised the economic evaluations of stroke care that have been performed.[306,307] Both reviews commented that the overall quality of the evaluations tended to be poor. Two areas for which a number of cost-effectiveness studies were found were carotid endarterectomy and anticoagulation in atrial fibrillation.

Cost-effectiveness of carotid endarterectomy

Two studies were identified that examined the cost-effectiveness of carotid endarterectomy for symptomatic carotid artery stenosis. In one study, carotid endarterectomy was found to be the dominant strategy (i.e. to lead to cost savings and better outcome),[308] while in the other the cost per QALY was $4715, at 1998 prices.[309] However, neither of these studies took into account the cost of identifying which patients with symptoms are suitable for surgery. If this is taken into account, the cost per QALY rises to $46 746, at 1998 prices.[310]

Two studies looked at the cost-effectiveness of the procedure for asymptomatic carotid artery stenosis, but came up with very divergent estimates: $8484 and $60 605 per QALY, at 1998 prices.[309,311] Neither of these considered the additional costs of screening to identify carotid stenosis in asymptomatic patients. Four studies which have included these costs give very variable estimates of the cost-effectiveness, ranging from a simple injunction not to do it (on the basis that screening programmes are more costly and lead to worse outcomes than not screening) to a cost of $41 864 per QALY, at 1998 prices.[307]

Cost-effectiveness of anticoagulation in atrial fibrillation

Two cost-effectiveness analyses of anticoagulation in atrial fibrillation both concluded that warfarin was highly cost-effective, except in people at low risk of stroke, with a cost per QALY of $9200, at 1998 prices, in patients at medium risk of stroke, and was cost saving (i.e. better outcome at lower cost) in patients at high risk of stroke.[312,313] Lightowlers and McGuire, whose study was based in the UK, estimated that the cost per life-year gained free from stroke over 10 years ranged from −£400 (i.e. resource saving) to £13 000. The frequency of anticoagulation monitoring was the factor that most influenced the results.[313]

An economic evaluation of primary care-based anticoagulation management as compared to traditional hospital-based care found that it was more expensive (£170 per annum per patient compared to £69),[314] but the higher cost needs to be set against the potential for improved control.[148]

7 Models of care and recommendations

In a rational health care system, need for stroke services is dictated by how common stroke is, and what can be done to either prevent it, and treat, rehabilitate or care for people who suffer a stroke. In this section, the interpretation of the evidence base for stroke services is considered by reviewing the various guidelines that have recently been published in the UK for stroke. The National Service Framework recommendations conform to these guidelines, and are summarised at the end of each relevant sub-section. Secondly, the implications of full implementation of these guidelines are considered by outlining the number of patients that might be expected in a given population. Next, priorities for stroke service development are

considered, taking into account current uptake of services, how effective they are, and the population to which they are applicable.

Guidelines for stroke care

Evidence-based guidelines have been produced by a number of different organisations in the UK. These include the North of England evidence-based guideline development project,[315] the Scottish Intercollegiate Guidelines Network (SIGN),[316] the Royal College of Physicians of Edinburgh Consensus Conferences (ECC) on stroke,[317] and the Intercollegiate Working Party (IWP) for stroke which produced the National Clinical Guidelines.[11] There have been no UK-based guidelines on primary prevention of stroke, but there has been a recent statement from the Stroke Council of the American Heart Association, so this has been included in this analysis.[43] While there are some differences in detail, these guidelines are broadly in agreement with each other. They are summarised below, and differences are discussed.

Primary prevention of stroke

For the primary prevention of stroke, the guidelines of the American Heart Association, which are summarised in Table 27, are mostly uncontroversial. The recommendations in the top half of the table are

Table 27: Summary of guidance for primary prevention of stroke.

Hypertension	'Regular screening for hypertension (at least every two years in adults) and appropriate management.' (AHA)
Smoking	'Smoking cessation for all current smokers is recommended.' (AHA)
Diabetes	'Careful control of hypertension in both type 1 and type 2 diabetics is recommended. Glycemic control is recommended to reduce microvascular complications.'
Asymptomatic carotid stenosis	'Endarterectomy may be considered in patients with high grade asymptomatic carotid stenosis performed by a surgeon with < 3% morbidity/mortality rate.' (AHA)
Atrial fibrillation	'Antithrombotic therapy (warfarin or aspirin) should be considered for patients with non-valvular atrial fibrillation based on an assessment of their risk of embolism and risk of bleeding complications.' (AHA) 'Higher risk patients should be considered for warfarin at a target INR of 2.5. Aspirin may be a safer alternative to warfarin in some of these patients.' (SIGN)
Hyperlipidaemia	'Patients with known coronary heart disease and elevated LDL cholesterol levels should be considered for treatment with a statin.' (AHA)
Obesity	'Weight reduction in overweight persons in recommended.' (AHA)
Physical inactivity	'Regular exercise (30 minutes of moderate intensity activity daily).' (AHA)
Poor diet/nutrition	'At least five daily servings of fruit and vegetables.' (AHA)
Alcohol abuse	'No more than 2 drinks per day for men and 1 drink per day for non-pregnant women.' (AHA)
Hyperhomocysteinaemia	'Use of folic acid and B vitamins may be considered.' (AHA)
Oral contraceptive use	'Oral contraceptives should be avoided in women with additional risk factors (e.g. cigarette smoking or prior thromboembolic events).' (AHA)

Notes: AHA: American Heart Association;[43] SIGN: Scottish Intercollegiate Guidelines Network.[324]

derived from randomised controlled trial evidence; in the lower half of the table reasonable extrapolations from observational studies are made.

One area where the guideline differs from UK practice is carotid surgery for asymptomatic carotid artery stenosis. Cost-effectiveness studies have demonstrated that it is not cost-effective to screen for asymptomatic lesions,[307] so the issue is really whether patients who incidentally are found to have carotid artery stenosis should be operated on. The operation, while effective, only confers a small reduction in absolute risk. Therefore, the skill of the surgeon is critically important, since a high complication rate would outweigh the potential benefits of surgery. UK guidelines such as SIGN and the Edinburgh Consensus Conferences have avoided making specific recommendations about carotid artery surgery in this circumstance.[318,319]

Another area of controversy is the optimal treatment of atrial fibrillation. A recent review has challenged the accepted orthodoxy that warfarin is the preferred treatment to aspirin.[212] Warfarin is more effective than aspirin, but the latter is safer. Therefore, the treatment decision depends upon assessment of both stroke risk and haemorrhage risk in individual patients. Decision analysis can be a useful tool to guide therapeutic decisions in individual patients.[320] However, there are important gaps in the evidence, most notably with regard to treatment in the elderly, who are both at higher risk of stroke and at higher risk of haemorrhage.[321] The Birmingham Atrial Fibrillation Treatment of the Aged (BAFTA) randomised controlled trial has been set up to address this issue.[322] The wording of both the AHA and SIGN statements reflect this uncertainty, though other guidelines have been more forceful in advocating warfarin therapy.[323]

Guidelines will need to be updated once the results of the MRC/BHF heart protection study have been published, to reflect the wider indications for statins.[207]

INSF implementation

The NSF for older people requires that general practices should build on registers developed for the coronary heart disease NSF, and develop a systematic approach for:

- identifying those at high risk of stroke
- identifying and recording modifiable risk factors of people at high risk of stroke
- providing and documenting the delivery of appropriate advice, support and treatment
- offering a regular review to those at risk of stroke.

Prevention in people who have had a TIA or stroke

The guidance issued by SIGN, the Intercollegiate Working Party (IWP) and the Edinburgh Consensus Conferences (ECC) for secondary prevention are mostly in agreement with each other (*see* Table 28).

These guidelines were produced prior to both the publication of the PROGRESS trial[222] and the completion of the MRC/BHF heart protection study.[207] One implication of PROGRESS is that it is worth lowering blood pressure in people who have had a stroke whether or not they are defined as being hypertensive. While the PROGRESS trial used two specific agents (the diuretic indapamide and the ACE inhibitor perindopril), the reductions in stroke risk observed are of the order of magnitude that would be anticipated given the blood pressure reductions that were achieved, so the result is probably generalisable to blood pressure-lowering regimes in general (including non-pharmacological approaches). A second implication is that it may be worth lowering blood pressure as much as can be tolerated. Once the MRC/BHF heart protection study has been published, statin use in stroke patients will need to be incorporated into guidelines.

All patients should have their blood pressure checked, and be started on an antiplatelet agent. There is some controversy over what dose of aspirin should be used. There is no evidence that higher doses (e.g. 300 mg/day) are any more effective than lower doses (e.g. 75 mg/day).[326] There is also some disagreement

Table 28: Summary of guidance for secondary prevention of stroke.

Hypertension	'All patients should have their blood pressure checked, and hypertension persisting for over one month should be treated.' (IWP) 'Control of hypertension . . . should be advocated once the initial event has stabilised.' (SIGN)[325]
Antiplatelet therapy	'All patients not on anticoagulation should be taking aspirin (50–300 mg) daily, or a combination of low dose aspirin and dipyridamole modified release. Where patients are aspirin-intolerant an alternative antiplatelet agent (clopidogrel 75 mg daily or dipyridamole MR 200 mg twice daily) should be used.' (IWP) 'Antiplatelet therapy, normally aspirin (75–300 mg/day), should be prescribed as early as possible.' 'Dipyridamole or clopidogrel should be considered as an alternative to aspirin in patients with contraindications to aspirin, or who are intolerant of aspirin.' 'Dipyridamole should be considered in addition to aspirin, especially in patients with recurrent stroke or TIA despite aspirin.' (SIGN) 'Treatment should be with 75–150 mg aspirin, continued long term.' 'Clopidogrel and the combination of aspirin and modified release dipyridamole are . . . alternatives.' 'Insufficient evidence in view of cost to justify clopidogrel or dipyridamole as first line treatment.' (ECC)
Anticoagulation	'In the presence of atrial fibrillation, mitral valve disease, prosthetic heart valves or within 3 months of myocardial infarction, anticoagulation should be considered for all patients who have ischaemic stroke.' (IWP) 'Warfarin should be considered for use in patients with non-valvular atrial fibrillation . . . after cardio-embolic stroke from valvular heart disease and recent myocardial infarction.' (SIGN) 'Patients who have had a TIA or ischaemic stroke and are in atrial fibrillation should be considered for long-term treatment with warfarin (Target INR 2.5).' (ECC)
Carotid endarterectomy	'Any patient with a carotid artery area stroke, and minor or absent residual disability, should be considered for carotid endarterectomy.' (IWP) 'Carotid endarterectomy has a role in preventing stroke in patients with recent (within 6 months) carotid territory symptoms in association with severe stenosis of the ipsilateral carotid artery, and who are fit for surgery. Surgery should be targeted at patients at highest risk of further stroke, and performed as soon as possible after the initial event.' (ECC)
Other risk factors	'All patients should be assessed and treated for other vascular risk factors and advised about lifestyle factors.' (IWP)

Notes: IWP: Intercollegiate Working Party for Stroke National Clinical Guidelines;[11] SIGN: Scottish Intercollegiate Guidelines Network; ECC: Edinburgh Consensus Conferences on stroke.

as to the role of alternative antiplatelet agents. While the guidelines agree that the high cost of clopidogrel excludes it from being an appropriate first line agent, recommendations on the use of aspirin in combination with dipyridamole differ. It would seem sensible to await the conclusions of the Antithrombotic Trialists Collaboration[239] before recommending combination therapy on the basis of one trial which has been subject to some criticism.[327] It is plausible that combination therapy of clopidogrel and aspirin will have a role, given the success of this combination in ischaemic heart disease, for example in 'aspirin failures' – i.e. people who suffer recurrent strokes/TIAs while on aspirin. The

different guidelines are in agreement as to the role of warfarin post-stroke (indicated in atrial fibrillation, recent myocardial infarction and in the presence of valvular heart disease), and on the role of carotid endarterectomy. With regard to this latter procedure, the guidelines appropriately emphasise the importance of early investigation after a TIA or minor stroke because of the high risk of early recurrence in a patient with a significant carotid artery stenosis.

Acute treatment of stroke

Recommendations on acute management of patients with stroke are summarised in Table 29. Despite the absence of direct research evaluating the role of brain imaging, the guidelines all recommend that CT (or MRI) scans should be performed on all patients, ideally within 48 hours (or 24 according to the Edinburgh Consensus statement). The rationale for early CT scanning is to identify non-stroke pathology, differentiate haemorrhage from infarct, and identify possible indications for neurosurgical intervention. CT scanning cannot make a reliable positive diagnosis of stroke.[248] Early CT scanning is essential to exclude haemorrhage where acute medical interventions such as thrombolysis are being considered. The necessity to perform a CT scan before administering aspirin is uncertain and opinion varies, though aspirin is likely to do some harm if given to someone who has had an intracerebral haemorrhage.

Use of aspirin in acute stroke is uncontroversial. Trials have demonstrated efficacy using both 160 mg and 300 mg doses.[259] The UK recommendations on thrombolysis are conservative compared to North American practice, but are an appropriate reflection of the available evidence (N.B. thrombolysis is not currently licensed for use in acute stroke in Europe).[260] The SIGN and IWP guidelines differ on the role of neurosurgery for cerebral haemorrhage. There are insufficient data from trials to recommend whether neurosurgery should or should not be used.[258] The recommendation on compression stockings by the IWP is an extrapolation from evidence on the role of compression stockings to prevent deep vein thrombosis (DVT) in patients undergoing various kinds of surgery, and not based on trials in stroke patients.[328]

There is a general consensus that in order to treat people with acute stroke in a way that is consistent with the guidelines, patients should be urgently referred to specialist secondary care services, and that patients with moderate or severe symptoms should be admitted to hospital (to a stroke unit). Within hospital, there is consensus on the basis of physiological principles, that stroke patients should be monitored and treated for fever, hyperglycaemia, dehydration and hypoxia, and that their airways should be maintained and risks of aspiration minimised.[267]

NSF implementation

The NSF makes specific recommendations for the management of acute stroke:

- a brain scan within 48 hours
- aspirin, if a diagnosis of haemorrhage is unlikely.

It also makes more general observations about the importance of appropriate management of the general condition of a stroke patient (such as hydration; hyperglycaemia; blood pressure, etc.).

Organisation of stroke care

A key component of recommendations on organisation of stroke care is the importance of stroke units. This recommendation has a strong evidence base.[169] However, the stroke unit trials included a heterogeneous set of patterns of care, and so it is difficult to be prescriptive about what constitutes 'stroke unit care', and a range of models are available that probably meet the relevant criteria (*see* 'Stroke unit care' in section 5). There is a difference in emphasis between the IWP and the ECC regarding the appropriate setting for acute care and rehabilitation. This will in part have been influenced by the publication of a trial of alternative strategies for

Table 29: Summary of guidance on acute treatment of stroke.

Diagnosis	'Stroke is primarily a clinical diagnosis. Confirmation, using imaging, will be needed if there are unusual clinical features.' 'The diagnosis should always be reviewed by a neurologist or physician with special interest in stroke.' (IWP)
Setting for acute care	'Patients should only be managed at home if: acute care guidelines can be followed; care services are able to provide adequate and flexible support within 24 hours; the services delivered at home are part of a specialist stroke service. Otherwise, patients should be admitted to hospital for initial care and assessment.' (IWP)
CT scanning/brain imaging	'Brain imaging is required as a matter of urgency if: there is a clinical deterioration in the patient's condition; sub-arachnoid haemorrhage is suspected; hydrocephalus secondary to intracerebral haemorrhage is suspected; trauma is suspected; the patient is on anticoagulant treatment, or has a known bleeding tendency.' 'Brain imaging should be undertaken in all patients within 48 hours unless there are good clinical reasons for not doing so.' (IWP) 'All patients with acute stroke should undergo CT brain scanning as soon as possible – preferably within 48 hours – and no later than seven days.' (SIGN) 'All patients with symptoms suggestive of a stroke should be referred to the stroke service for assessment, including CT brain scan, ideally within 24 hours.' (ECC)
Aspirin	'300 mg should be given as soon as possible after the onset of stroke symptoms (if a diagnosis of haemorrhage is considered unlikely).' (IWP) 'Early treatment with aspirin (150–300 mg daily) is recommended, starting as soon as intracranial haemorrhage is excluded by CT brain scanning.' (SIGN) 'Should be commenced within 48 hrs, or as soon as the diagnosis of cerebral infarction has been made (dose: 150–300 mg).' (ECC)
Thrombolytic therapy	'Thrombolytic treatment with tissue Plasminogen Activator (tPA) should be given only in a specialist centre, within 3 hours of stroke onset (when haemorrhage has been definitely excluded).' (IWP) 'It is reasonable to use thrombolytic therapy (for example rtPA) in highly selected patients in a carefully monitored environment.' (ECC)
Other drug therapies	'No other drug treatment aimed at treatment of the stroke should be given unless a part of a randomised controlled trial.' (IWP)
Neurosurgery	'Neurosurgical opinion should be sought for cases of hydrocephalus.' (IWP) 'Urgent neurosurgical assessment should be available for selected patients, such as those with large cerebellar infarcts or hydrocephalus, and for selected cases of cerebral haemorrhage.' (SIGN)
Compression stockings	'Where stroke has caused weak or paralysed legs, full length compression stockings should be applied (unless contraindicated) to prevent venous thrombosis.' (IWP) 'Physical methods of preventing DVT in stroke patients should be evaluated.' (ECC)
Other	'There should be local policies for the early management of hypertension, hyperglycaemia, hydration and pyrexia.' (IWP)

Notes: IWP: Intercollegiate Working Party for Stroke; SIGN: Scottish Intercollegiate Guidelines Network; ECC: Edinburgh Consensus Conferences on stroke.

stroke care,[266] which preceded the November 2000 Edinburgh Consensus meeting, but came after the IWP had published its report. The general consensus now, echoed in the NSF for older people, is that people with acute stroke should be admitted to hospital.

With regard to setting for subsequent specialist rehabilitation, the trials of early discharge provide some evidence that community-based rehabilitation can achieve similar results to hospital-based care. Community-based rehabilitation services are an important part of a comprehensive service for stroke patients, but need to be linked to the specialist stroke services.

Both SIGN and ECC make recommendations on the importance of early assessment of patients with suspected TIAs in order to identify patients who might benefit from carotid endarterectomy (*see* Table 30).

Table 30: Summary of guidance on organisation of stroke care.

Services for patients with suspected TIAs	'Patients with suspected TIA or minor stroke who are not admitted to hospital should have rapid access for urgent assessment and investigation (CT brain scanning, carotid doppler examination and echocardiography).' (SIGN) 'For patients with symptoms suggestive of TIA, all clinicians should have rapid access to specialist advice and investigation. If assessment in a neurovascular clinic is agreed to be appropriate by the referring clinician and the specialist, this should be carried out within a week.' (ECC)
Stroke services	'Every organisation involved in the care of stroke patients over the first six months should ensure that stroke patients are the responsibility of and are seen by services specialising in stroke and rehabilitation.' 'The stroke service should comprise: a geographically identified unit; a co-ordinated, multidisciplinary team; staff with specialist expertise in stroke and rehabilitation; education programmes for staff, patients and carers; agreed protocols for common problems.' (IWP) 'We emphasise the importance, and urge the further development, of well organised and co-ordinated stroke services.' (ECC)
Hospital services	'Acute in-patient care for patients with major stroke should be organised as a multidisciplinary stroke service based in designated units.' (SIGN) 'Any patient with moderate or severe symptoms should be referred with the expectation of admission to a stroke unit.' 'Strong evidence exists in favour of care being provided in dedicated stroke units.' (ECC)
Community services	'Specialist day hospital rehabilitation or specialist domiciliary rehabilitation can be offered to outpatients with equal effect.' 'Patients not admitted to hospital should be seen by a specialist rehabilitation team.' (IWP) 'Community-based rehabilitation services should develop partnerships with stroke services.' (ECC)
Setting for rehabilitation	'Specialist stroke services can be delivered to patients, after the acute phase, equally effectively in hospital or in the community, provided that the patient can transfer from bed to chair before going home.' (IWP) 'Management in a stroke unit which combines both acute assessment and the full range of rehabilitation should be the pathway of choice.' 'For those patients able to be rehabilitated at home . . . this is preferred by some patients.' (ECC)

Notes: IWP: Intercollegiate Working Party for Stroke; SIGN: Scottish Intercollegiate Guidelines Network; ECC: Edinburgh Consensus Conferences on stroke.

This model of care has not been formally evaluated, but has logic given that surgery is of greatest benefit the earlier that it is performed.

NSF implementation

The NSF recommends:

- urgent referral of patients with suspected TIA to a rapid response neurovascular clinic, managed by a clinician with expertise in stroke for investigation and treatment
- that all patients who may have had a stroke will usually require urgent hospital admission; that they should be treated by specialist stroke teams within designated stroke units.

Stroke rehabilitation

Of the guideline groups, the IWP is the only one so far to have focused on the specifics of rehabilitation (Table 31). While the evidence base for some of the recommendations is lacking (*see* section 6), they reflect a broad based consensus of opinion.

Table 31: Summary of guidance on rehabilitation.

Multidisciplinary assessment	'A multidisciplinary assessment using a formal procedure or protocol should be undertaken and documented in the notes within 24–48 hours of admission. The protocol should include assessment of: consciousness level; swallowing; pressure sores risk; nutritional status; cognitive impairment; communication; the patient's needs in relation to moving and handling.' (IWP) 'Rehabilitation following stroke is an interdisciplinary process.' (ECC)
Management	'Protocols should be adhered to for: management of urinary and faecal incontinence and constipation; nutritional support and enteral feeding; prevention and management of shoulder pain; discharge planning.' 'Goal-setting should involve the patient, and family if appropriate.' (IWP)
Therapists	'Patients with specific communication difficulties should be assessed by a speech and language therapist for their suitability for intensive therapy.' (IWP) 'A physiotherapist with expertise in neurodisability should co-ordinate therapy to improve movement performance of patients with stroke.' (IWP) 'All patients with difficulties in activities of daily living should be assessed by an occupational therapist with specialist knowledge in neurological disability.' (IWP)
Mood	'Patients would be screened for emotionalism, depression and anxiety within the first month of stroke, and their mood kept under review. When diagnosed, an antidepressant should be considered.' (IWP) 'There is evidence to support an individual intervention which could be drawn from the following: antidepressants for depression or emotionalism; psychological therapies; support approaches (including patient and carer support groups).' (ECC)

Notes: IWP: Intercollegiate Working Party for Stroke; ECC: Edinburgh Consensus Conferences on stroke.

NSF Implementation

The NSF recommends:

- early, expert and intensive rehabilitation in a hospital stroke unit
- that a stroke care co-ordinator should:
  - co-ordinate assessment and individual care plans
  - ensure arrangement for support and secondary prevention are in place prior to discharge
  - ensure efficient flow of relevant information to community-based professionals
  - ensure smooth transfer between care settings
  - ensure needs for home adaptations are identified and met prior to discharge.

While the actions and tasks specified by the NSF are important, there is no evidence that making use of a specialist stroke care co-ordinator is the best way of achieving them. Indeed, the limited evidence available suggests that some models that use a stroke co-ordinator may be harmful.[286] Stroke care co-ordinators have not been evaluated in this role, and alternative approaches adopted by district stroke services may be as effective at lower cost.

Carers and families

NSF recommendations

The NSF recommends:

- patients and carers should be involved in planning their care and safe discharge from hospital
- patients and carers should be provided with a named stroke care co-ordinator they can contact.

Again, there is no evidence to support the NSF's recommendation of using a stroke care co-ordinator to support patients and carers after transfer out of hospital. What is needed is an organisation or service or contact point to enable patients and carers to access support services after leaving hospital.

Continuing care

The NSF recommends: 'Recovery from stroke can continue over a long time, and rehabilitation should continue until it is clear that maximum recovery has been achieved. Some patients will need ongoing support, possibly for many years. These people and their carers should have access to a stroke care co-ordinator who can provide advice, arrange reassessment when needs or circumstances change, co-ordinate

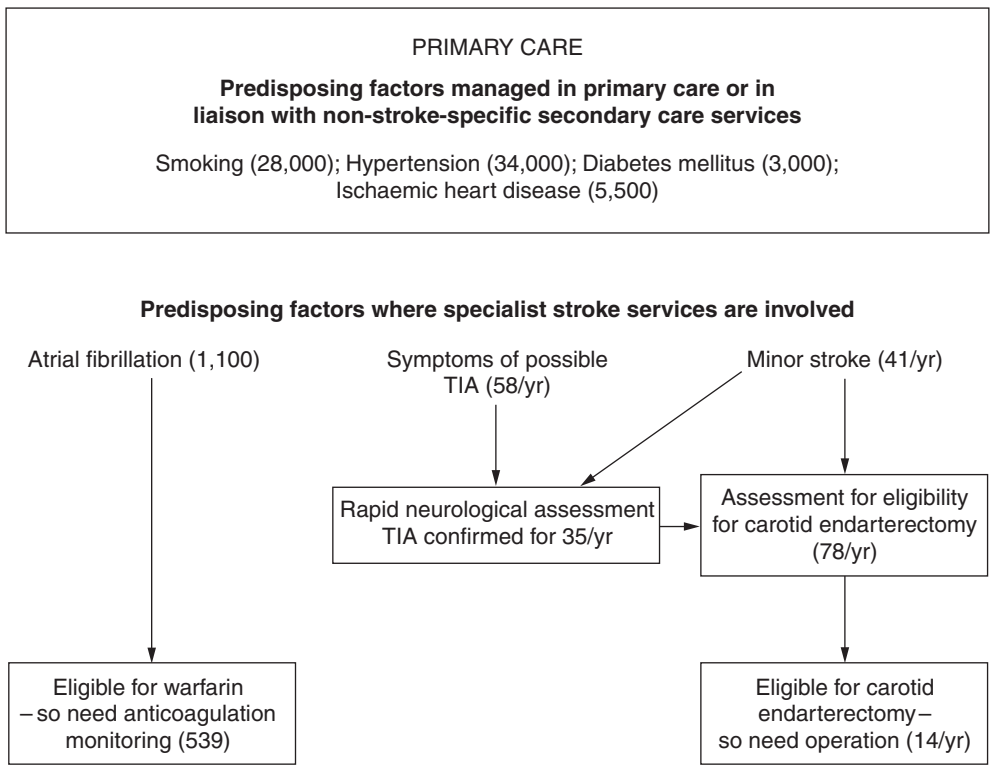
Table 32: Summary of guidance on services for carers and families.

Management	'Carers should receive all necessary equipment and training in moving and handling, in order to position and transfer the patient safely in the home environment.' (IWP)
Information	'Families should be given information on the nature of stroke and its manifestations and on relevant local and national services, and patients and carers should be involved in decisions.' (IWP)
Carer stress	'Stroke services must be alert to the likely stress on carers.' (IWP)
Family support	'Family support workers should be involved to help reduce carer distress.' (IWP) 'Carers may experience considerable stress and there is evidence that this can be reduced by interventions such as family support services.' (ECC)

long-term support, or arrange for specialist care. Following a stroke, any patient reporting a significant disability at six months should be reassessed and offered further targeted rehabilitation if this can help them to recover further function.'[9]

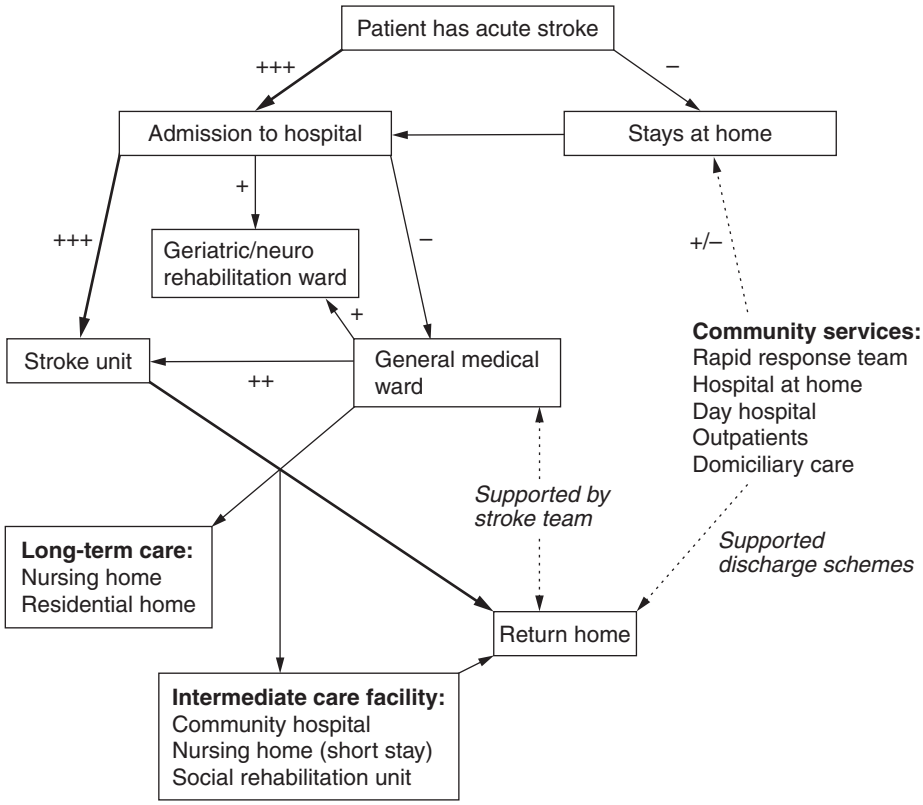
Towards a quantified model for stroke care

Synthesising the epidemiology of stroke with the recommendations of the various expert committees that have reviewed the evidence on stroke care, it is possible to define what the ideal level of service provision might be for stroke care for a given population. This is summarised in Figures 5 and 6 for a 'typical' population of 100 000 based on UK data. Figure 5 focuses on services to prevent stroke (both primary and secondary prevention), and Figure 6 (*see* overleaf) on the treatment and rehabilitation needs of people with stroke.



Numbers in brackets indicate likely number of prevalent or incident (per year) patients.
See 'Summary of epidemiology of stroke at level of Primary Care Group' above for numbers.
See text for further explanation.

Figure 5: Estimate of ideal level of service provision for a population of 100,000: prevention of stroke.



Bold arrows reflect desired pathway.
+ indicates that the proportion of patients who follow this pathway should be increased.
– indicates that the proportion of patients who follow this pathway should be reduced.

Figure 6: Ideal service provision for a population of 100,000: acute treatment and rehabilitation of stroke.

Prevention services

Much of the disease prevention activity that is carried out in primary care is not specific to stroke, though it has an important impact on stroke incidence as discussed in section 4. The specific areas of disease prevention that impinge upon specialist services are atrial fibrillation and assessment of suitability for carotid endarterectomy (*see* Figure 5). From a prevalence survey of atrial fibrillation performed in Northumberland, it was estimated that 49% of people in atrial fibrillation were eligible for anticoagulation based upon criteria from a pooled analysis of trial results.[50] Therefore, of the estimated 1100 people with atrial fibrillation in a population of 100 000, approximately 561 should be on aspirin and 539 on warfarin. Thus, provision should be available to monitor the anticoagulation (whether in primary care or in hospital anticoagulation clinics) of 540 patients per 100 000 population. It is difficult to estimate how many patients in primary care present with a possible TIA, given that the epidemiological data are based on confirmed TIAs. However, if a 40% misdiagnosis rate of GPs is assumed,[97] then a rapid access neurological assessment clinic would need to see 58 patients per year with suspected TIA (and possibly more with minor stroke if these were not admitted to hospital). Using the methodology of Ferris *et al.*[160] applied to the population estimates summarised in 'Summary of epidemiology of stroke at level of Primary Care Group'

in section 4, it can be estimated that 14 carotid endarterectomies per 100 000 population would represent optimum provision.

Treatment and rehabilitation services

It is more difficult to present a single model of treatment and rehabilitation services. While there is strong consensus on the importance of stroke units and the value of a co-ordinated, multidisciplinary approach, the optimum mix of hospital- as opposed to community-based services will depend upon the locality (urban or rural), and on what services are already present. While the current evidence favours inpatient rehabilitation, there have been few trials that have directly compared inpatient to outpatient rehabilitation.[268] The emphases of the guidelines are shown in Figure 6. In essence, they recommend that a greater proportion of patients should be admitted to hospital, and of those, more should receive their rehabilitation on a stroke unit. With regard to the numbers involved, 221 people per 100 000 might be expected to have a stroke per annum (including recurrent strokes) – *see* 'Summary of epidemiology of stroke at level of Primary Care Group' in section 4. If 20% of these are assumed to die early, and if 70% of the remainder are assumed to have a moderate or severe stroke (i.e. will require admission to a stroke unit for rehabilitation), and if the average length of stay is assumed to be 30 days,[172] then this equates to a need for a 12-bedded stroke unit per 100 000 population, assuming 85% bed occupancy (which will allow for some fluctuation in numbers). Most of the stroke units included in the systematic review of their effectiveness were of similar size (6–15 beds),[170] but are likely to have served far larger catchment populations (300 000+). Therefore, a model of care whereby the majority of stroke patients are admitted to a stroke unit is not sustainable without radical organisational change within the hospital sector. This raises the question of whether locality-based rehabilitation in intermediate care facilities might not be an appropriate model of care. Such intermediate care facilities would need to specialise in stroke, and would need to treat sufficient numbers of patients to develop and maintain that expertise, which in turn means that the locality service would need to have a sufficiently large catchment area. Such models have not been evaluated, and trials of this pattern of care versus stroke units in district general hospitals need to be performed.

A stroke service also requires access to neurosurgical expertise for the management of patients with subarachnoid haemorrhage, and those with stroke who develop complications such as hydrocephalus that require neurosurgical intervention.

Continuing care

Most of the research on models of care is directed at treating 'incident' cases of stroke – i.e. the acute treatment and rehabilitation needs of people in the early phases after stroke (perhaps up to one year). However, from a primary care perspective, the needs of incident cases are dwarfed by those of prevalent cases. How best to meet the long-term needs of patients with stroke is an under-researched area, and models of care that address these needs should be developed and evaluated. As noted above, the NSF recommends use of stroke co-ordinators. The National Clinical Guidelines for Stroke make the following recommendations.[11]

- Any patient with disability at 6 months or later after stroke should be assessed for a period of further targeted rehabilitation to be given where appropriate.
- Patients and their carers should have their individual psychosocial and support needs reviewed on a regular basis.
- Health and social services professionals should ensure that patients and their families have information about the statutory and voluntary organisations offering services specific to these needs.

Standard three of the National Service Framework for older people relates to intermediate care.[9] The standard is that: 'Older people will have access to a new range of intermediate care services at home or in designated care settings, to promote their independence by providing enhanced services from the NHS and councils to prevent unnecessary hospital admission and effective rehabilitation services to enable early discharge from hospital and to prevent premature or unnecessary admission to long-term residential care.'

It is difficult to quantify the longer term needs of stroke survivors, but on the basis of data from the OCSP (*see* 'Survival following stroke' and 'Incidence of disability following stroke' in section 4) that 70% of stroke patients survive to one year, and that 35% of these patients remain functionally dependent, it can be estimated that about 54 new stroke patients per 100 000 population will require continuing care (either institutional or domiciliary) one year after their stroke. The actual level of service needed will be greater than this, since it relates to prevalent rather than incident cases. Prevalence surveys of disability suggest that in a population of 100 000 one might anticipate 1000 stroke survivors with residual disability. In the absence of an evidence base, it is difficult to be prescriptive about what services should be available. Such services need to be considered within the broader context of disability management and services for elderly people.

Priorities for stroke care

The quantified model described in 'Towards a quantified model for stroke care', above, is of an 'ideal' service, which ignores financial constraints and cost-effectiveness. These aspects cannot be ignored when considering what should be the highest priorities in developing local services. What is most relevant in this context is the marginal benefit (i.e. the impact of moving from the current service provision to the optimum) of each service development. This can be approximated by estimating the gap between current service provision and the optimal service, what it would cost to fill that gap, and what would be the outcome in terms of health benefits.

Stroke prevention

In Table 33, the effects of each intervention, in terms of number of strokes that would be prevented, is estimated by using the typical rate of stroke that occurred in the control groups of the trials on which evidence of effectiveness is based. The table does not directly try to evaluate the relative cost-effectiveness of different interventions, but rather, the impact of full implementation of current recommendations.

Table 33 can only offer a crude estimate of the relative value of prioritising each of the intervention strategies, since it would be possible to increase the relative cost-effectiveness of each of the interventions by targeting them at individuals who had the most to gain. For example, while the average number needed to operate on to prevent a stroke with carotid endarterectomy in the European Carotid Surgery Trial was 14, this could be reduced to 3, if operations were only performed on particular high risk individuals.[331] Secondly, only some of the direct costs are included. Thus, for hypertension, only the cost of the drugs are considered, and not the costs of assessment and monitoring. Similarly, for carotid endarterectomy, only the costs of the operation itself are taken into account. The costs of anticoagulation, on the other hand, are derived from studies that will have given a more accurate assessment of total costs. Thirdly, the table does not take account of the costs of treating strokes. Thus, it is not possible to draw any conclusions as to the overall cost-effectiveness of each of the interventions as compared with not implementing them. Nevertheless, it is possible to draw some tentative conclusions from the table as to the relative priority that should be accorded to increasing uptake of each of the stroke prevention strategies.

In terms of cost per stroke averted, optimising uptake of aspirin is much the most cost-effective strategy. Next comes use of anticoagulation in atrial fibrillation, followed by treating hypertensive patients with

Table 33: Estimate of marginal costs and benefits of optimising service provision to prevent stroke.

Intervention	Current uptake* /100,000	Estimated optimal uptake* /100,000	Shortfall /100,000	Cost of treatment per person/year	Risk of stroke off treatment (p.a.)	Number of strokes prevented p.a. if switch from current to optimal care**	Cost per stroke prevented
Achieve tight control of BP of people already on treatment	2,718[47]	9,591	6,873	†Low £19 High £116[329] (drug costs only)	0.3%[84]	7.2	£18,095 £110,476
Treat hypertension in people not on treatment	9,591	36,545	26,954	Low £19 High £116 (drug costs only)	0.3%	38.4	£18,095 £110,476
Anticoagulate eligible patients in AF	253	539	286	£70–80[314,320]	3.3%[330]	5.6	£3,850
Aspirin for patients with CHD or AF not on warfarin	4,410	7,000	2,590	£1	2.9%[215]	15.8	£164
Aspirin post-stroke	945	1,500	555	£1	6%[55]	9.0	£62
Carotid endarterectomy	9	14	5	£1,940 (costs of operation only)	17% over 5 yrs[331]	0.35 over 5 yrs	£27,700

Notes: *Derived from data in sections 4 and 5; **derived from risk reductions quoted in section 6; †low estimate: derived from cost of generic 'old' antihypertensive agents: thiazides and beta-blockers; high estimate: derived from newer antihypertensive agents.

low-cost generic agents (beta-blocker or thiazide), per the British Hypertension Society guidelines (low-cost option in Table 32).[332] The costs of identifying and following up such people are not taken into account. The former could be minimised if best use is made of the potential for opportunistic screening. The next priority would be improving access to carotid endarterectomy. Optimising treatment of hypertensives using newer agents (high-cost option in Table 32) would appear to be a much lower priority. The most important strategy in terms of reducing the number of strokes is the initiation of treatment in hypertensive people not currently on medication.

Maximal implementation of all these strategies might be estimated to reduce the incidence of stroke by about 0.74/1000, which would reduce the total age-adjusted incidence of stroke by about a third. This is less than the 40% target that has been set by government.[8] To achieve these targets, lifestyle factors such as smoking, physical activity and diet (*see* Tables 9 and 12) must also be tackled. Population-based approaches that aim to reduce the level of a risk factor in the whole population rather than simply in high risk individuals also need to be considered. For example, Rose estimated that a 5% lowering of blood pressure in the UK population would result in a 30% reduction in stroke incidence, whereas treating everyone with a diastolic blood pressure above 100mmHg would only reduce incidence by 15%.[147]

An analysis of secondary prevention of stroke strategies performed by Hankey and Warlow suggested that in terms of cost per stroke prevented, simple advice to stop smoking was the most cost-effective strategy, and carotid endarterectomy the least cost-effective.[333] Table 34 summarises their results. In the table, the relative cost-effectiveness of clopidogrel and carotid endarterectomy have been reversed as compared with how they appeared in the original publication. This is to compensate for the fact that endarterectomy is a one-off procedure with long-term benefit, whereas medical therapies need to be long-term to sustain benefit.

Stroke treatment and rehabilitation

Hankey and Warlow looked at acute treatment strategies – also shown in Table 34. They concluded that the highest priority should be to establish a stroke unit that delivers organised stroke care through a

Table 34: Summary of Hankey and Warlow's analysis of cost (in Aus$) per stroke prevented (secondary prevention) or per death/dependency avoided (acute stroke treatment) – adapted from Hankey and Warlow.[333]

		Cost
Acute stroke treatment	Stroke unit	?0
	Aspirin	83
	Thrombolysis with tPA	36,000
Secondary stroke prevention	Smoking cessation: advice	0
	Diuretics for hypertension	1,350
	Aspirin for sinus rhythm	2,000
	Anticoagulation for AF	> 1,200
	ACE inhibitor for hypertension	18,000
	Aspirin and dipyridamole for sinus rhythm	18,500
	Smoking cessation: nicotine patches	19,600
	Statins for hypercholesterolaemia	41,000
	Carotid endarterectomy for severe symptomatic stenosis to prevent one stroke per year for three years	182,000
	Clopidogrel for all in sinus rhythm	74,000

multidisciplinary team. Since they postulate (rather optimistically) that a stroke unit could be set up by redistributing existing secondary care resources, this strategy comes out as highly cost-effective, since it has no additional costs attached to it.

With regard to treatment and rehabilitation, it is more difficult to identify relative priorities, since a more sophisticated outcome measure than strokes avoided needs to be used, and the data that are available tend to focus on discrete medical treatments rather than patterns of care. Nevertheless, the establishment of stroke units, as emphasised in the guidelines considered earlier in this section and recommended by Hankey and Warlow, can be considered a first priority.

Conclusions

The key components of a strategy for primary stroke prevention include: identification and treatment of hypertension; identification and treatment of atrial fibrillation; careful control of hypertension in diabetes; lifestyle advice with regard to smoking, diet, weight, and exercise; and treatment with a statin of patients with known coronary heart disease and elevated cholesterol.

The same issues apply to secondary prevention, but because the risks of subsequent strokes are high, each is of relatively greater importance and effectiveness. In addition, patients should be on aspirin, or another antiplatelet agent if aspirin-intolerant. Patients with a TIA or minor stroke should be assessed rapidly for carotid endarterectomy, which should be performed in a centre with a low complication rate. This might necessitate use of regional or sub-regional units.

There is consensus that the vast majority of patients with acute stroke should initially be assessed in hospital. Aspirin is an effective acute treatment for ischaemic stroke, and is preferably administered after brain imaging has been performed to rule out intracerebral haemorrhage. Thrombolytic therapy is a reasonable treatment to give in selected patients, but only in specialist centres in a carefully monitored environment. Further research is required before such a model of care can be 'rolled out' to a wider population.

There is strong evidence that acute care and rehabilitation of stroke patients is best carried out in stroke units that offer an organised, multidisciplinary approach to care. All stroke patients should have access to such care. The extent to which rehabilitation should be performed in central stroke units and the extent to which it can be performed as effectively in community settings has to be resolved. Community-based rehabilitation has not been demonstrated to be as effective as stroke unit care, but it is impractical to expect existing models of stroke unit care (with an average unit size of 6–15 beds) to cater for the needs of a typical DGH catchment area. Therefore, locality-based models of intermediate care need to be developed and evaluated.

8 Approaches to audit and outcome measures

Several publications have given advice on the appropriate mechanisms of audit of stroke care, and what measures to use for this. The purpose of this section is to summarise these recommendations and targets.

Saving Lives: Our Healthier Nation

The target of this government white paper is to reduce the death rate from coronary heart disease and stroke and related diseases in people under 75 years by at least two-fifths by 2010 – saving 200 000 lives in total.[8]

This is a useful target for monitoring the overall impact on health of a wide variety of factors. The value of this indicator is that it broadens the perspective beyond the health services to other factors that influence health, such as lifestyle and socio-economic circumstances.

The National Service Framework for older people

This includes milestones that the NHS is required to meet in developing stroke services.

- April 2002: Every general hospital which cares for people with stroke will have plans to introduce a specialised stroke service model from 2004.
- April 2003: Every hospital which cares for people with stroke will have established clinical audit systems to ensure delivery of the National Clinical Guidelines for stroke care.
- April 2004: PCG/Ts will have ensured that:
  - every general practice, using protocols agreed with local specialist services, can identify and treat patients identified as being at risk of a stroke because of high blood pressure, atrial fibrillation or other risk factors
  - every general practice is using a protocol agreed with local specialist services for the rapid referral and management of those with transient ischaemic attack (TIA)
  - every general practice can identify people who have had a stroke and is treating them according to protocols agreed with local specialist services
  - every general practice has established clinical audit systems for stroke.
- April 2004: 100% of all general hospitals which care for people with stroke will have a specialised stroke service as described in the stroke service model.

Outcome indicators for stroke

A working group for the Department of Health reviewed the possible value of a series of 24 health outcome indicators for stroke.[334] Their recommendations are summarised in Table 35. They categorised the indicators into five types:

- A: to be implemented generally on a routine basis
- B: to be implemented generally by periodic survey
- C: to be implemented where local circumstances allow on a routine basis
- D: to be implemented where local circumstances allow by periodic survey
- E: to be developed further either because the link with effectiveness is not clear or because the indicator specification is incomplete.

When interpreting variations in health outcome indicators, four major categories of explanation need to be considered: differences in measurement technique; chance; differences in case-mix; and differences in quality of care. Process measures (such as use of aspirin) are more sensitive to genuine differences in the quality of care than outcome measures (such as hospital specific mortality), and are easier to interpret, provided that there is a proven link between process and outcome.[335]

Table 35: Summary of recommendations of working group on health outcome indicators for stroke.

Topic area	Indicator	Cat
Reduction/avoidance of risk of first/subsequent stroke	Incidence of hospitalised stroke	A
	Population-based incidence of stroke	C
	Percentage of GP patients with BP recorded in previous 5 years	A
	Median and inter-quartile range of systolic BP within a GP population	B
	Percentage of GP patients identified as hypertensive whose most recent systolic BP is less than 160 mmHg	C
	Percentage of GP patients who have a prescription for aspirin therapy at six months after non-haemorrhagic stroke	B
	Percentage of GP patients with atrial fibrillation who have a prescription for anticoagulant therapy	D
Reduction of death from stroke	Case fatality rate within 30 days of a hospital admission for stroke	A
	Case fatality rate within 30 days of stroke (in-patient or community-based treatment)	C
	Population-based mortality rates	A
Reduction/avoidance of complications from stroke	Percentage of patients for whom a formal swallowing assessment is undertaken within 24 hrs of stroke	E
	Incidence of pressure sores during in-patient stay within a hospital population with stroke	A
	Percentage of patients within a community provider population who, six months following stroke, have one or more pressure sores	B
	Rate of emergency re-admissions within 30 days of discharge with a diagnosis of stroke	D
Improving function and well-being after stroke	Multiprofessional involvement in the week following admission with stroke	B
	Distribution of Barthel ADL score at discharge form hospital with stroke	A
	Distribution of Barthel ADL score six months after stroke	B
	Assessment of aphasia six months after stroke	E
	Assessment of outdoor mobility six months after stroke	E
	Assessment of social functioning six months after stroke	E
	Assessment of depression six months after stroke	E
	Change in Barthel ADL score between discharge and six months after stroke	D
	Percentage of people admitted with stroke who return to pre-admission category of residence	A
	Percentage of people who live in pre-admission category of residence six months after stroke	B
	Percentage of people not hospitalised living in pre-stroke category of residence six months after stroke	D
	Patients' or carers' knowledge of available health and social services – six months after stroke	E
	Patient satisfaction six months after stroke	E
	Carer burden six months after stroke	E

The National Sentinel Audit for stroke

The Royal College of Physicians developed an audit tool for stroke under the guidance of the Intercollegiate Working Party.[10] This audit covered the organisation and facilities for treating stroke, the case-mix of admitted patients, and the process of care with regard to initial assessment, rehabilitation, secondary prevention, discharge planning, communication with carers, and follow-up and review. This model of audit provides a useful tool for monitoring the hospital care of stroke patients, offering the opportunity for comparative data between trusts (as in the national audit that the Royal College of Physicians carried out), or comparisons within the same trust over time.

9 Research priorities

Prevention of stroke

The NSF is promoting the introduction of care pathways which enable rapid investigation of patients with possible TIA and minor stroke. Such models have an underlying rationale, but have not been evaluated. Formal testing would enhance plans to implement this initiative.

Acute stroke treatments

As noted in the Edinburgh Consensus statement: 'While trials of the efficacy of novel drugs in acute stroke and secondary prevention are vital, there is an urgent need for greater funding for non-drug treatment and, in particular, into aspects of stroke service delivery and organisation.'[317] While acute drug treatments for stroke are emerging, such as aspirin and thrombolysis in specific circumstances, there are major non-pharmacological questions to address. These include issues around the general management of acute stroke patients, such as how intensively they should be monitored, and how early rehabilitation should start. Cost-effectiveness of different intensities of acute care needs to be evaluated.

Rehabilitation

There is a growing evidence base for stroke rehabilitation. Some of the most important evidence comes from evaluations of complex packages of care, such as stroke units. It has been argued that studies that are focused on the specific components of rehabilitation, which include precise definitions of what is involved, are needed to complement this research.[336] Thus, rather than simply asking general research questions such as: 'Does physiotherapy improve outcome following stroke?', more specific questions that detail the amount and type of physiotherapy, the specific nature of the problem that the physiotherapy is to address (e.g. shoulder pain), need to be answered.

However, there is just as significant a role for research that focuses on the overarching activities and processes that are central to the nature of rehabilitation.[337] Thus, the research agenda should aim to:

- investigate ways to improve goal-setting and assessment
- understand the interrelationships between disease, impairment and contextual factors, and the interrelationship between disability and participation
- investigate ways of modifying behaviour (i.e. optimising activity) in the context of disabling illness.

Organisation and models of stroke care

While it is clear that stroke units are an effective model for the delivery of hospital-based care for patients with stroke, stroke units as currently constituted (5–15 bedded units) will not be able to cope with the stroke workload of a typical DGH (25–35 stroke inpatients at any one time).[10] Therefore, new models need to be developed and evaluated that can offer alternatives to stroke unit care of equal efficacy. These might include intermediate care facilities, such as community hospitals, locality-based stroke rehabilitation units, or other community-based facilities such as domiciliary teams and day hospital services. The one trial that compared hospital stroke unit care to alternative models of multidisciplinary care found that outcome was significantly worse in those patients not randomised to stroke unit care, but this trial cannot be generalised to all settings, or indeed all non-stroke unit models of care. Further trials are needed comparing different models against what is now the recognised standard of care in an inpatient stroke unit.

Research has tended to focus on treatment of incident rather than prevalent stroke patients, i.e. care in the first year following stroke, rather than long-term support. Models need to be developed and tested that provide long-term support to stroke patients. These should include models that are not stroke-specific, but focus on the more general issues of disability management. The stroke co-ordinator promoted by the NSF for older people is one such model, but it needs formal evaluation. Another model that has been promoted is regular patient reassessment.[338] However, the frequency and nature of these contacts need to be defined.[339] Other models might include general practice-based packages of care for patients identified as having had past strokes. Development of such models would be timely, given the requirement of the NSF for general practices to develop stroke registers.

Level of funding of stroke research

Rothwell points out that there are major disparities in the level of research funding, comparing the three major causes of death and disability in the world: heart disease, cancer and stroke.[340] Most research funding comes from disease-specific charity organisations, non-disease-specific funding bodies (government or charity) and from industry (pharmaceutical). Between them, these funding bodies spend significantly more on research into heart disease and cancer than into stroke. He recommends that non-disease-specific research funding bodies, such as the Medical Research Council, the Wellcome Trust and the National Co-ordinating Centre for Health Technology Assessment, should take these disparities into account when deciding upon their own priorities.

Appendix 1: The WHO ICIDH-2 model of illness, now the ICF model

The WHO ICIDH model

In 1980 the World Health Organisation (WHO) published an International Classification of Impairments, Disabilities and Handicaps (ICIDH) which was based upon earlier work.[1–3] It was conceived of as being complementary to the International Classification of Diseases (ICD), which is essentially a classification of disease (pathology). The ICIDH classification has not been as widely used as the ICD, but there certainly have been publications both researching into it and using it; Badley[4] stated that over 1000 articles had been published relating to its use at that time.

In 2000 a new revision was finalised, and the new classification is known as the International Classification of Functioning, Disability and Health (ICF) but is still also referred to as the ICIDH-2. It does not differ greatly in most respects, but it does add one further dimension and it has changed some of the terminology. The new dimension is one of **context**; it emphasises that all ill people must be seen within a context – as described below. The new terminology is to use the words 'activities' and 'participation' in place of disability and handicap respectively.

The model is still an incomplete model of illness, especially in missing out the whole domain of 'quality of life'. It is also not easy to draw distinctions between the levels using the definitions, and the classification itself is probably not usable in any routine sense. The model currently on the web site (http://www3.who.int/icf/icftemplate.cfm accessed 29/11/01) has an overview table shown below (Table A1.1).

Table A1.1: The ICF overview table.

	Functioning and disability		**Contextual factors**	
Components	Body structures and functions	Activities and participation	Environmental factors	Personal factors
Domains	Body structures Body functions	Life areas Tasks, actions	External influences on functioning and disability	Internal influences on functioning and disability
Constructs	Change in body functions (physiological) Change in body structures (anatomical)	Capacity: Executing tasks in a standard environment Performance: Executing tasks in current environment	Facilitating or hindering impact of features of the physical, social and attitudinal world	Impact of the attributes of the person
Positive aspects	Functional and structural integrity	Activities Participation	Facilitators	Not applicable
	Impairment	Activity limitation Participation limitation	Barriers/hindrances	Not applicable

This appendix elaborates on the model, hopefully clarifying it so that it is easily understood. The ideas put forward here were used as the basis for the National Clinical Guidelines for Stroke, and have been discussed in other articles[5] (Wade 2001). Tables A1.2 and A1.3 give the overview.

Although not explicitly published as a framework for rehabilitation, the WHO ICIDH has been developed as such (*see* Tables A1.2, below and A1.3 overleaf). The WHO ICIDH model considers that any disease (i.e. pathology) may cause or be associated with abnormalities at three higher levels: abnormalities of the person; alterations in behaviour; and changes in social position. These are referred to respectively as: impairments; disabilities; and handicaps. (**In the ICF they are referred to as: impairments; activity limitations; and participation limitations.**) To make the model more complete one must incorporate disease or pathology, which refers to abnormalities at the level of the organ. A brief description and discussion of the four descriptive levels follows. Next the model should incorporate the environment or context and the ICF does this. Finally quality of life is included in the amended model, drawing on ideas discussed by Post *et al.*[6]

Table A1.2: Rehabilitation model – the WHO ICIDH-2 framework.

Level of illness		
Term	**Synonym**	**Comment**
Pathology	Disease/diagnosis	Refers to abnormalities or changes in the structure and/or function of an **organ or organ system**
Impairment	Symptoms/signs	Refers to abnormalities or changes in the structure and/or function of the **whole body** set in **personal context**
Activity (was disability)	Function/observed behaviour	Refers to abnormalities, changes or restrictions in the interaction between a person and his/her environment or **physical context** (i.e. changes in the **quality or quantity of behaviour**)
Participation (was handicap)	Social positions/roles	Refers to changes, limitations, or 'abnormalities' in the **position** of the person in their **social context**
Contextual factors		
Domain	**Examples**	**Comment**
Personal	Previous illness	Primarily refers to **attitudes, beliefs and expectations** often arising from previous experience of illness in self or others, but also to personal characteristics
Physical	House, local shops, carers	Primarily refers to local physical **structures** but also includes people as **carers** (not as social partners)
Social	Laws, friends, family	Primarily refers to **legal** and local **cultural** setting, including expectations of important others

Note: This model is usually prefaced with the words: 'In the context of illness, . . . '.

Table A1.3: Expanded model of illness.

System	Experience/location:	
	Subjective/internal	**Objective/external**
Level of illness		
Person's organ *pathology*	**Disease** Label attached by person, usually on basis of belief	**Diagnosis** Label attached by others, usually on basis of investigation
Person's body *impairment*	**Symptoms** Somatic sensation, experienced moods, thoughts, etc.	**Signs** Observable abnormalities (absence or change), explicit or implicit
Person in environment *behaviour*	**Perceived ability** What person feels they can do, and feeling about quality of performance	**Disability/activities** What others note person does do, quantification of that performance
Person in society *roles*	**Role satisfaction** Person's judgement (valuation) of their own role performance (what and how well)	**Handicap/participation** Judgement (valuation) of important others (local culture) on role performance (what and how well)
Context of illness		
Internal, personal context	**Personality** Person's beliefs, attitudes, expectations, goals, etc.	**Past history** Observed/recorded behaviour prior to and early on in this illness
External, physical context	**Salience** Person's attitudes towards specific people, locations, etc.	**Resources** Description of physical (buildings, equipment, etc.) and personal (carers, etc.) resources available
External, social context	**Local culture** The people and organisations important to person, and their culture, especially family and people in same accommodation	**Society** The society lived in and the laws, duties and responsibilities expected from and the rights of members of that society
Totality of illness		
Quality of life *Summation of effects*	**Happiness** Person's assessment of and reaction to achievement or failure of important goals and sense of being a worthwhile person	**Status** Society's judgement on success in life; material possessions

Pathology

Much illness can be traced to abnormalities within organs in the body. Organs may function abnormally for several reasons. Trauma may cause destruction of part or all of the organ. Disruption of the blood supply may cause reduced function or complete death of some of the organ. Micro-organisms may damage or destroy part or all of the organ. The cells of the organ may change their function due to alterations in their genetic control, causing (for example) tumour formation or the production of more or less of their normal product. In nerve cells especially, the properties of the cell membrane might be altered subtly so that the cell changes its behaviour. In all these ways, and in many other ways, the function of the organ can be disturbed.

Within this level there are of course many sub-divisions and categorisations. Some of the categories relate to presumed aetiology: congenital or acquired; due to infectious agents or physical agents, etc. Some classifications give biochemical detail, others give structural detail, and yet others give macroscopic details. However the common feature is that all these sub-categories are within the organ, and often within the cell.

Impairment

Just as cells and tissues come together to form unitary structures known as organs, so organs and organ systems (such as the cardiovascular system or endocrine system) come together to form a single structure, the organism or body. Abnormalities that arise at the level of the organism are referred to as impairments. Individual impairments may arise from more than one pathology. More importantly, some patients may only experience an impairment when they have two or more pathologies; this appearance of abnormalities independent of specific components is the essence of a higher order system. For example osteoarthritis of a hip may be asymptomatic until there is extra stress upon the hip, as might occur if the patient has a stroke (a second pathology) or moves to live somewhere where she can only have a bath, not a shower (an environmental or contextual change).

Disability, or functional limitations

The third level to be affected is the interaction that occurs between a person and his or her environment. This interaction is best described as behaviour. The WHO ICIDH refers to change in the third level as disability (or now refers to it more accurately as **activity limitations**). The other phrase used by many people to refer to changes in behaviour is the functional consequences of a disease. In practice the changes are almost always measured or conceived of in terms of dependence, either upon other people or upon special equipment.

Disability is therefore considered to refer to alterations in the quality or quantity of an individual's goal-directed behaviour, or their activities. In other words, a person may need to change the way they achieve their goals, or may achieve them more slowly, or may depend upon special equipment, or may not be able to achieve them at all. All these changes are 'disabilities', although they are more accurately and appropriately referred to as changes in behaviour or activity **at the level of** disability.

Handicap

Handicap is the most difficult concept to define and measure. It is best considered as referring to changes in or restrictions on the person's social position and social role functioning in some way. Handicap is ultimately a personal matter. How someone feels changed or restricted by their illness in terms of their social position and social role functioning can only be judged by that individual in conjunction with the people who are directly involved with that person.

The revised ICIDH refers to this level as the level of **participation**, and this also emphasises the fact that this level refers to or describes the person's participation in or involvement in social (culturally determined, personally important) activities.

A simplified analysis

This model can easily be simplified, and perhaps clarified in the following way. The fundamental unit of behaviour is the individual (human) person. Abnormalities in that person's organs or an abnormality of the organism itself therefore directly affect the 'behavioural unit', restricting or altering its abilities. Therefore pathology and impairment form one level concerning the individual person who then interacts with his/her environment.

The observed behaviour (i.e. the interaction between the person and his/her environment) can then be analysed in two ways. The first is **descriptively**, usually focusing on independence and normality, where change is referred to as disability. The second is in terms of the **meaning attached** to that behaviour by the person and by others, where any change in the meaning attributed to behaviour (which may itself have changed) may be referred to as handicap. The ICF implicitly recognises this distinction, putting body structures and functions together and activities and participation together (Table A1.1).

Context

The revised ICIDH has added a vital further dimension, that of context. As soon as one considers behaviour and participation in society, it is necessary to consider not only the individual but their environment. Furthermore, one cannot only consider the physical environment but one must also consider the personal environment (other people), the legal environment, and the cultural environment (expectations of relevant other people). The WHO ICIDH also considers, correctly, that the person's own personal history is an important part of the context.

Thus, for simplicity, the context of an illness can be divided into three:

- **personal**: the individual's own previous experiences and current expectations
- **physical**: the structures around the person, both near and far
- **social**: the influence of other people including the influence of society as manifest in its laws and customs.

This may be too simple, but it does cover the main areas and it does emphasise that one must look well beyond the disease itself when considering its management.

Summary and conclusion

In summary, illness can be analysed thus. A person is a behavioural unit, and changes within the person (i.e. pathology) may affect the person's range of intrinsic functions and skills (i.e. give impairments), thereby influencing and constraining his behaviour and behavioural repertoire. However, while the person lives, s/he will interact with the environment. The behaviour can be observed and described, which constitutes the description at the level of 'disability'; furthermore, that behaviour will have meaning attributed to it by the person and by relevant others, which then constitutes the person's state at the level of handicap.

It must be emphasised that the WHO ICF is a descriptive model. Its whole intention is to allow a description and classification of an individual's state or circumstances. This is necessary for rehabilitation, but not sufficient. Several other factors need to be considered when analysing a patient's situation. These include the context of the illness (i.e. the past history of the illness, the patient's stage in life, the family's involvement), the patient's desires or life philosophy, and the patient's reactions to the illness.

Furthermore, the clinicians must take into account the context of the person: the physical environment, the personal environment, the local social facilities, financial considerations, the legal situation, etc. A comprehensive awareness of illness needs to recognise these 'hidden variables'.

General insights from the model

This model is not simply of academic interest: it leads to many useful insights. Although hopefully many of these will be apparent, a brief resume of the more important lessons will be given here.

Time, and the focus of attention

Initially, in managing any illness, it is both necessary and correct to devote most resources to establishing the underlying pathology (if any), because there may be specific treatments available. Furthermore, the pathology has a major influence on determining prognosis. However, even in the initial stages changes in behaviour are important; for example, the patient may need care (usually nursing care) because of dependence (i.e. disability).

Once the pathology is established and treated, attention should rapidly switch to the level of disability. At first, this attention may relate to the patient, but soon attention must broaden to include the patient's normal (home) environment (family, house, etc.). Later still, the focus of attention should be move on to consider social roles (i.e. handicap) and to investigate the social environment.

An important corollary of this change in focus over time is an exponential increase in timescales. Pathologically-centred processes occur in short timescales – minutes, hours or, at most, days. Processes relating to behaviour take weeks, months or years to be complete. And processes relating to handicap may take years, decades or even centuries to finish, because they often involve changing society as much as changing the person.

Patient and environment

This model forcibly reminds us that patients are people, coming from their own physical and social environment. Therefore, as attention moves from pathology to handicap, so attention must move from the ill individual to the physical, personal and social environment of that individual. Disability and handicap can only be considered in the context of the individual person's own environment – their family, their friends, their workmates, their home, etc. Rehabilitation must take this into account.

Hospital systems

Hospitals have increasingly had to cope with a mixture of processes, some relating to pathology and some relating to disability. This mixing of pathologically-centred processes with behaviour-centred processes leads to an obvious conflict between two different systems, because the former takes place in a short timescale, the latter in a long timescale. In other words, there are two systems (pathological diagnosis/treatment, and disability diagnosis/treatment) trying to run at greatly different speeds within a single system (the hospital). The conflicts are obvious; patients are usually labelled 'bed-blockers' or 'patients with social problems'.

Furthermore, hospitals provide an environment quite alien to most people, and certainly divorced from a patient's reality. Therefore, it is difficult to judge or treat disability accurately in a hospital setting, especially when considering any behaviour beyond the most basic, such as feeding.

One solution may be for hospitals to disentangle the two major processes occurring here, having relatively few beds devoted to high-speed, high-tech medicine and surgery and a much greater number of beds in a separate location devoted to recuperation and (where needed) active rehabilitation. These might be termed 'complex care wards'.

Interventions

It seems logical, and it is probably true, that interventions will be more effective the closer they are to the root cause of an illness. In other words, where an illness can be traced to a specific pathology, it is considered more efficient to 'cure' that pathology than to give symptomatic treatment (i.e. to treat impairments). However, it is important to remember that the price of achieving a cure of the pathology may sometimes be a much higher level of impairment, disability or handicap.

The model also reminds us that interventions should not only be directed at the patient. It is often more important and more effective to alter the environment. This might include: rehousing; providing a wheelchair; teaching relatives how to transfer the patient; and teaching work colleagues how to communicate with the individual. It may also include changing the environment to reduce or remove factors causing the illness itself, for example, increasing the tax on cigarettes or alcohol.

Loose relationships

It must be emphasised that, though the various systems interact with each other, the relationships are only general and are not tight. In other words, in most instances a fixed pathological lesion does not equate with a defined impairment; a defined impairment does not equate with a definite level of dependence; nor does a specific level of disability equate to a fixed handicap. There are major opportunities for clinically silent pathology, impairment or disability.

Equally importantly, the effects of abnormalities can jump levels. For example, a right hemianopia (an impairment) may cause no disability, but if the person is a car driver then the person may lose their driving licence and hence their job. The fact that the effects of any specific pathology, impairment or disability can vary so much means that there is ample opportunity for intervention to ameliorate the consequences.

The nature and strength of the interrelationships between the different levels of illness has only recently been investigated to a significant degree.[7–10] There is an urgent need to investigate these relationships systematically, especially to study the importance and effects of any interaction between different impairments, so that rehabilitation interventions can be more rationally targeted.[11,12] The effects of intervening variables also need to be researched.[13]

Measures

Many measures used in health care consist of two or more items which are amalgamated to form a single scale or score. Much has been written about the process of constructing health measures.[14–16] This model emphasises two specific considerations.

The component items of a measure should all relate to (come from) the same level. Some measures fail to observe this rule, and their validity and utility must be questionable. One widely used measure illustrates this. The Oxford Handicap Scale[17] contains one question on impairment ('Does the patient have any residual symptoms?') and most of the other questions concentrate upon reduced mobility (a disability). The scale does not touch on handicap despite its name. Any measure which mixes items from different levels, for example, pathology items with impairment items, or impairment items with disability items, must be considered intrinsically invalid.[14]

Secondly, when evaluating a service, one must choose measures that assess outcome at the appropriate level. The levels of interest to most patients are those of handicap and disability. Another area of interest is that of well-being, which is probably close to quality of life.

Observation versus implication

Another way to consider the model is in terms of those characteristics of an illness that can be observed, and are externally verifiable, and those characteristics which are simply deduced or implied.

All behaviour is externally observable and thus objective and verifiable. We can state whether someone does actually dress independently, walk fast, talk, undertake work, etc. Opinions may vary on the quality of the behaviour (e.g. its standard), but there is external evidence which can (for example) be recorded on a videotape.

Opinions may differ significantly about the reasons for the observed abnormalities and also about whether someone 'should' be more or less competent. Nonetheless, measures of disability are usually objective, provided those measures record actual behaviour observed in the relevant setting and do not attempt to qualify the observations or to interpret them.

Handicap, in contrast, is almost all implied; most of the ideas are externally imposed constructs. We may say externally that we believe that an individual is acting the roles of mother, wife and housekeeper. The person concerned, however, may see herself as a servant and slave, or as a boss, or in other ways (e.g. as a daughter). There is no externally verifiable truth.

A few impairments may be externally observable. For example, a reduced range of passive movement or a facial disfigurement are both easily verified externally. However, most are implied constructs, particularly in the field of neurology. Weakness (reduced voluntary motor power) is perhaps objective but the label applied (e.g. upper motor neurone weakness) is often a construct deduced from other evidence. Often, there is little disagreement with such an obvious label as weakness (though pain in the limb may contribute to the weakness), but other frequently used labels such as spastic weakness, apraxia, spasticity, or neglect are all much less certain.

Furthermore, in neurological practice, many of the impairments are deduced from behavioural observations, even if the behaviour is controlled and constrained so as to highlight postulated impairments. For example, neglect may be diagnosed as a result of performance (behaviour) on a series of tests (a test battery), or aphasia after performance on another series of tests. However, it is well recognised that other impairments can cause failure on the tests: blindness is an obvious example; neglect can cause a reduced score on some tests of aphasia;[18] and aphasia makes it difficult to test visual fields and many other areas.

Thus, this model suggests that, contrary to popular belief, measures of disability are generally objective, whereas statements about pathological diagnosis and symptoms and signs are often much more subjective, depending upon deductions made by an observer who may be biased. Studies on the reliability of objective neurological examination of patients after stroke emphasise the unreliable (subjective) nature of many of these observations.[19,20]

Normality

Most measures assume a normal state, usually as a standard against which the patient is judged. However, it is often difficult to know what is normal in many situations. At the level of disability, the concept of normal becomes almost redundant. In Western culture at least, most people take personal responsibility for dressing, feeding, toileting and walking, but the individual chooses almost all other behaviour, and may choose not to undertake many behaviours (e.g. cooking, driving a car). At the level of handicap, it must be accepted that role performance is unique and can only be compared with the individual's past roles and with the expectations of the person and their social circle (family, friends, colleagues, etc.).

Therefore, the term normal is difficult to use. It may be better to talk instead of change, and sometimes the actual state will fall outside generally accepted normal limits for that individual. For some items no normal limits will exist; for some they will depend upon personal, cultural or other characteristics; and for some the limits will be quite closely defined and will be common to more or less everyone.

Prognosis

Prognosis is usually related to the pathology because the pathology determines the prognostic field for that illness. If two people have foot drop, the prognosis will be different if one has motor neurone disease and the other a recent stroke. Within a disease group there will be differences between patients, but knowing the pathology will enable one to determine the correct prognostic items.

Therefore, it is essential to know pathology when giving a prognosis, both because it determines the prognostic field and because it often determines which observations can be used as specific prognostic factors. Thus, in terms of the model, a change in one system (at one level) may not determine specific changes at other levels but may nonetheless have a pervasive influence upon future performance in other levels.

The rehabilitation team

The successful management of an illness requires involvement and intervention at all levels affected by that illness. Once a stroke has stabilised, all other factors up to and including housing and employment need to be considered and acted upon. If not, the management of the illness will not be considered successful by the patient.

Therefore this model shows that the team of people needed to help anyone with an illness is likely to include a wide range of professions so that all aspects of the illness can be covered. Furthermore, in chronic illness it is likely that any effective team will normally span a variety of agencies and departments, such as health, social services, employment, education and housing (depending upon the country).

Patient goals

This model reminds us that, when considering rehabilitation, it is vital to take into account the goals of the patient. Indeed, it is often also important to take into account the goals of the family and sometimes the goals of other carers, funding agencies, etc.

The vocabulary

It is noticeable that the terms used (pathology, impairment, disability and handicap) are all negative. They all relate to the abnormal state. They do not have positive counterparts. None of the terms used now started with their current meaning.

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Appendix 2: Summary of reviews of Cochrane Stroke Group

Includes reviews on Cochrane Library up to and including issue 4, 2001. The date after each statement represents the last time a substantial update of this review was performed.

Review	Reviewers' conclusion
Prevention of first stroke	
Effective/promising treatments	
Antiplatelet therapy for preventing stroke in patients with non-valvular atrial fibrillation and no previous history of stroke or transient ischaemic attacks	'Considering all randomised data, aspirin modestly (by about 20%) reduces stroke and major vascular events in non-valvular AF. For primary prevention among AF patients with an average stroke rate of 4.5%/year, about 10 strokes would be prevented yearly for every 1000 given aspirin.'[1] (8/99)
Carotid endarterectomy for asymptomatic carotid stenosis	'There is some evidence favouring CEA for asymptomatic carotid stenosis, but the effect is at best barely significant, and extremely small in terms of absolute risk reduction.'[2] (8/99)
Oral anticoagulants for preventing stroke in patients with non-valvular atrial fibrillation and no previous history of stroke or transient ischaemic attacks	'Adjusted-dose OAC (achieved INRs between 2–3) reduces stroke as well as disabling/fatal stroke for patients with non-valvular AF, and these benefits were not substantially offset by increased bleeding among participants in randomised clinical trials. Limitations include relatively short follow-up and imprecise estimates of bleeding risks from these selected participants. For primary prevention in AF patients who have an average stroke rate of 4%/year, about 25 strokes and about 12 disabling fatal strokes would be prevented yearly for every 1000 given OAC.'[3] (8/99)
Thienopyridine derivatives (ticlopidine, clopidogrel) versus aspirin for preventing stroke and other serious vascular events in high vascular risk patients	'The available randomised evidence shows that the thienopyridine derivatives are modestly but significantly more effective than aspirin in preventing serious vascular events in patients at high risk (and specifically in TIA/ischaemic stroke patients), but there is uncertainty about the size of the additional benefit. The thienopyridines are also associated with less gastrointestinal haemorrhage and other upper gastrointestinal upset than aspirin, but an excess of skin rash and diarrhoea. The risk of skin rash and diarrhoea is greater with ticlopidine than with clopidogrel. Ticlopidine, but not clopidogrel, is associated with an excess of neutropenia and of thrombotic thrombocytopenic purpura.'[4] (8/99)
Ineffective/unproven treatments	
Antithrombotic drugs for carotid artery dissection	'There were no randomised trials comparing either anticoagulants or antiplatelet drugs with control. There is, therefore, no evidence to support their routine use for the treatment of extracranial internal carotid artery dissection. There were also no randomised trials, that directly compared anticoagulants with antiplatelet drugs, and the reported non-randomised studies did not show any evidence of a significant difference between the two. We suggest that a randomised trial including at least 1000 patients in each treatment arm with this condition is clearly needed.'[5] (7/00)

Review	Reviewers' conclusion
Treatment of acute stroke	
Effective/promising treatments	
Antiplatelet therapy for acute ischaemic stroke	'Antiplatelet therapy with aspirin, 160 to 300 mg daily, given orally (or per rectum in patients who cannot swallow), and started within 48 hours of onset of presumed ischaemic stroke reduces the risk of early recurrent ischaemic stroke without a major risk of early haemorrhagic complications and improves long-term outcome.'[6] (5/99)
Thrombolysis for acute ischaemic stroke	'Thrombolytic therapy increases deaths within the first 7 to 10 days, and deaths at final follow-up. Thrombolytic therapy also significantly increases symptomatic and fatal intracranial haemorrhage. These risks are offset by a reduction in disability in survivors, so that there is, overall, a significant net reduction in the proportion of patients dead or dependent in activities of daily living. The data from trials using intravenous recombinant tissue Plasminogen Activator (tPA), from which there is the most evidence on thrombolytic therapy so far, suggest that it may be associated with less hazard and more benefit. There was heterogeneity between the trials and the optimum criteria to identify the patients most likely to benefit and least likely to be harmed, the agent, dose, and route of administration, are not clear. The data are promising and may justify the use of thrombolytic therapy with intravenous recombinant tPA in experienced centres in selected patients. However, the widespread use of thrombolytic therapy in routine clinical practice at this time cannot be supported. Further trials will be needed to identify which patients are most likely to benefit from treatment and the environment in which it may best be given, before thrombolytic therapy should be adopted on a wider scale.'[7] (7/99)
Ineffective/unproven treatments	
Anticoagulants for acute ischaemic stroke	'Immediate anticoagulant therapy in patients with acute ischaemic stroke is not associated with net short- or long-term benefit. The data from this review do not support the routine use of any type of anticoagulant in acute ischaemic stroke.'[8] (2/99)
Calcium antagonists for acute ischaemic stroke	'No evidence is available to justify the use of calcium antagonists in patients with acute ischaemic stroke.'[9] (10/99)
Cooling therapy for acute stroke	'There is currently no evidence from randomised trials to support the routine use of physical or chemical cooling therapy in acute stroke. Since experimental studies showed a neuroprotective effect of hypothermia in cerebral ischaemia, and hypothermia appears to improve the outcome in patients with severe closed head injury, trials with cooling therapy in acute stroke are warranted.'[10] (5/99)
Corticosteroids for acute ischaemic stroke	'There is not enough evidence to evaluate corticosteroid treatment for people with acute presumed ischaemic stroke.'[11] (10/98)
Fibrinogen-depleting agents for acute ischaemic stroke	'Although ancrod appears to be promising, it is not possible to draw reliable conclusions from the available data.'[12] (11/96)
Gangliosides for acute ischaemic stroke	'There is not enough evidence to conclude that gangliosides are beneficial in acute stroke. Caution is warranted because of reports of sporadic cases of Guillain-Barré syndrome after ganglioside therapy.'[13] (8/00)

Review	Reviewers' conclusion
Treatment of acute stroke	
Ineffective/unproven treatments Continued.	
Glycerol for acute stroke	'This systematic review suggests a favourable effect of glycerol treatment on short-term survival in patients with probable or definite ischaemic stroke but the magnitude of the treatment effect may be minimal (as low as a 3% reduction in odds). Due to the relatively small number of patients and that the trials have been performed in the pre-CT era, the results must be interpreted cautiously. The lack of evidence of benefit in long-term survival does not support the routine or selective use of glycerol treatment in patients with acute stroke.'[14] (5/00)
Haemodilution for acute ischaemic stroke	'The overall results of this review are compatible both with a modest benefit and a moderate harm of haemodilution therapy for acute ischaemic stroke. As used in the randomised trials, this therapy has not been proven to improve survival or functional outcome.'[15] (8/99)
Interventions for deliberately altering blood pressure in acute stroke	'There is not enough evidence to evaluate the effect of altering blood pressure on outcome during the acute phase of stroke. Oral CCBs, ACE inhibitors and glyceryl trinitrate all appear to lower blood pressure in patients with acute stroke.'[16] (2/01)
Interventions for dysphagia in acute stroke	'Too few studies have been performed, and these have involved too few patients. PEG feeding may improve outcome and nutrition as compared with NGT feeding. Further research is required to assess how and when patients are fed, and the effect of swallowing or drug therapy on dysphagia.'[17] (3/99)
Low molecular weight heparins or heparinoids versus standard unfractionated heparin for acute ischaemic stroke	'Low molecular weight heparin or heparinoid appear to decrease the occurrence of deep vein thrombosis compared to standard unfractionated heparin, but there are too few data to provide reliable information on their effect on other important outcomes, including death and intracranial haemorrhage.'[18] (8/01)
Mannitol for acute stroke	'There is currently not enough evidence to decide whether the routine use of mannitol in acute stroke would result in any beneficial or harmful effect. The routine use of mannitol in all patients with acute stroke is not supported by any evidence from randomised controlled clinical trials. Further trials are needed to confirm or refute the routine use of mannitol in acute stroke.'[19] (10/00)
Nitric oxide donors (nitrates), L-arginine, or nitric oxide synthase inhibitors for acute ischaemic stroke	'There is currently no evidence from randomised trials on the effects of nitric oxide donors, L-arginine, or nitric oxide synthase inhibitors in patients with acute ischaemic stroke.'[20] (8/97)
Pentoxifylline, propentofylline and pentifylline for acute ischaemic stroke	'There is not enough evidence to assess the effectiveness and safety of methylxanthines after acute ischaemic stroke.'[21] (6/96)
Piracetam for acute ischaemic stroke	'There is some suggestion of an unfavourable effect of piracetam on early death, but this may have been caused by baseline differences in stroke severity in the trials. Piracetam does not appear to reduce dependency for stroke patients.'[22] (1/99)
Prostacyclin and analogues	for acute ischaemic stroke

'Too few patients have been studied in randomised trials to allow conclusions to be drawn about the effect of prostacyclin treatment on survival of people with acute stroke.'[23] (1/98)

Review	Reviewers' conclusion
Treatment of acute stroke	
Ineffective/unproven treatments Continued.	
Surgery for primary supratentorial intracerebral haemorrhage	'There is not enough evidence to evaluate the effect of craniotomy or stereotactic surgery, or endoscopic evacuation in patients with supratentorial intracerebral haematoma.'[24] (12/98)
Theophylline, aminophylline, caffeine and analogues for acute ischaemic stroke	'There is not enough evidence to assess whether theophylline or its analogues reduce mortality or morbidity, or are safe, in people with acute ischaemic stroke.'[25] (3/99)
Thrombolysis (different doses, routes of administration and agents) for acute ischaemic stroke	'There is not enough evidence to conclude whether lower doses of thrombolytic agents might be safer or more effective than higher doses in acute ischaemic stroke. It is not possible to conclude whether one agent might be better than another, or which route of administration might be best. No comparative data for streptokinase have been found.'[26] (4/98)
Tirilazad for acute ischaemic stroke	'Tirilazad mesylate increased the combined end-point of 'death or disability' by about one-fifth, but did not alter case fatality, when given to patients with acute ischaemic stroke. Although further trials of tirilazad are now not warranted, analysis of individual patient data from the trials may help elucidate why tirilazad appears to worsen outcome in acute ischaemic stroke.'[27] (7/01)
Vasoactive drugs for acute stroke	'There is not enough evidence reliably to evaluate the effect of altering blood pressure on outcome after acute stroke. CCBs, beta-blockers, and probably ACE inhibitors, prostacyclin and nitric oxide, each lowered BP during the acute phase of stroke. In contrast, magnesium, naftidrofuryl and piracetam had little or no effect on BP.'[28] (4/00)
Vinpocetine for acute ischaemic stroke	'There is not enough evidence to evaluate the effect of vinpocetine on survival or dependency of patients with acute stroke.'[29] (7/97)
Treatment of sub-arachnoid haemorrhage	
Effective/promising treatments	
Calcium antagonists for aneurysmal sub-arachnoid haemorrhage	'Calcium antagonists reduce the proportion of patients with poor outcome and ischaemic neurological deficits after aneurysmal SAH; the risk reduction for case fatality alone is not statistically significant. The results for 'poor outcome' are statistically robust, but depend mainly on trials with oral nimodipine; the evidence for nicardipine and AT877 is inconclusive. The intermediate factors through which nimodipine exerts its beneficial effect after aneurysmal SAH remain uncertain.'[30] (7/99)
Ineffective/unproven treatments	
Antifibrinolytic therapy for aneurysmal sub-arachnoid haemorrhage	'Antifibrinolytic treatment does not appear to benefit people with aneurysmal sub-arachnoid haemorrhage. However, the trials were all done more than 10 years ago. New strategies may counteract the ischaemia-inducing potential of antifibrinolytic treatment and lead to improved outcome. A trial of combined antifibrinolytic and anti-ischaemia treatment is underway.' (7/98)
Circulatory volume	expansion for aneurysmal sub-arachnoid haemorrhage

The effects of volume expansion therapy have not been studied properly in patients with aneurysmal sub-arachnoid haemorrhage. At present, there is no sound evidence for or against the use of volume expansion therapy in patients with aneurysmal sub-arachnoid haemorrhage.[31] (7/99)

Review	Reviewers' conclusion
Treatment of sub-arachnoid haemorrhage	
Ineffective/unproven treatments	*Continued.*
Timing of surgery for aneurysmal sub-arachnoid haemorrhage	'Based upon the limited randomised controlled evidence available, the timing of surgery was not a critical factor in determining outcome following a sub-arachnoid haemorrhage. Since the publication of the only randomised controlled study in 1989, techniques for the treatment of sub-arachnoid haemorrhage have progressed, questioning the validity of the conclusions in the modern era. Currently, most neurovascular surgeons elect to operate within 3 or 4 days of the bleed in good grade patients to minimise the chances of a devastating re-bleed. However, the treatment of patients in poorer grades warrants further scrutiny in a randomised controlled trial.'[32] (11/00)
Secondary prevention of stroke	
Effective/promising treatments	
Anticoagulants for preventing stroke in patients with non-rheumatic atrial fibrillation and a history of stroke or transient ischaemic attacks	'The evidence suggests that anticoagulants are beneficial, without serious adverse effects, for people with non-rheumatic atrial fibrillation and recent cerebral ischaemia.'[33] (2/95)
Anticoagulants versus antiplatelet therapy for preventing stroke in patients with non-rheumatic atrial fibrillation and a history of stroke or transient ischaemic attacks	'The evidence from one trial suggests that anticoagulant therapy can benefit people with non-rheumatic atrial fibrillation and recent cerebral ischaemia. Aspirin may be a useful alternative if there is a contraindication to anticoagulant therapy. The risk of adverse events appears to be higher with anticoagulant therapy than aspirin.'[34] (2/95)
Antiplatelet therapy for preventing stroke in patients with non-rheumatic atrial fibrillation and a history of stroke or transient ischaemic attacks	'Aspirin may reduce the risk of vascular events in people with non-rheumatic atrial fibrillation, but the effect shown in the single trial was not statistically significant.'[35] (2/95)
Carotid endarterectomy for symptomatic carotid stenosis	Carotid endarterectomy reduced the risk of disabling stroke or death for patients with stenosis exceeding ECST-measured 70% or NASCET-measured 50%. This result is generalisable only to surgically fit patients operated on by surgeons with low complication rates (less than 6%).[36] (3/99)
Ineffective/unproven treatments	
Anticoagulants for preventing recurrence following ischaemic stroke or transient ischaemic attack	'There appears to be no clear benefit from long-term anticoagulant therapy in people with non-embolic presumed ischaemic stroke or transient ischaemic attack. There appears to be a significant bleeding risk associated with anticoagulant therapy.'[37] (9/97)
Anticoagulants (oral) versus antiplatelet therapy for preventing further	vascular events after transient ischaemic attack or minor stroke of presumed arterial origin

'For the secondary prevention of further vascular events after transient ischaemic attack or minor stroke of presumed arterial origin, there is insufficient evidence to justify the routine use of low intensity oral anticoagulants (INR 2.0 – 3.6). More intense anticoagulation (INR 3.0 – 4.5) is not safe and should not be used in this setting.'[38] (12/99)

Review	Reviewers' conclusion
Secondary prevention of stroke	
Ineffective/unproven treatments Continued.	
Eversion versus conventional carotid endarterectomy for preventing stroke	'Eversion CEA may be associated with low risk of arterial occlusion and re-stenosis. However, numbers are too small to definitively assess benefits or harms. Reduced re-stenosis rates did not appear to be associated with clinical benefit in terms of reduced stroke risk, either perioperatively or later. Until further evidence is available, the choice of the CEA technique should depend on the experience and familiarity of the individual surgeon.'[39] (8/00)
Local versus general anaesthesia for carotid endarterectomy	'There is not enough evidence from randomised trials comparing carotid endarterectomy performed under local as opposed to general anaesthetic. Non-randomised studies suggest potential benefits with local anaesthetic. However these studies are likely to be significantly biased.'[40] (8/96)
Patch angioplasty versus primary closure for carotid endarterectomy	'Limited evidence suggests that carotid patch angioplasty may lower the risk of perioperative arterial occlusion and re-stenosis. It is unclear whether this reduces the risk of death or stroke.'[41] (5/96)
Patches of different types for carotid patch angioplasty	'There is not enough evidence to differentiate between venous and synthetic patches in carotid endarterectomy.'[42] (5/96)
Percutaneous transluminal angioplasty and stenting for vertebral artery stenosis	'There is no evidence as yet to assess the effects of percutaneous transluminal angioplasty for vertebral artery stenosis.'[43] (5/97)
Percutaneous transluminal angioplasty and stenting for carotid artery stenosis	'There is no evidence as yet to assess the relative effects of carotid percutaneous transluminal angioplasty in people with carotid stenosis.'[44] (7/97)
Routine or selective carotid artery shunting for carotid endarterectomy (and different methods of monitoring in selective shunting)	'The data presently available are too limited to either support or refute the use of routine or selective shunting in carotid endarterectomy. Large scale randomised trials using no shunting as the control group are required. No one method of monitoring in selective shunting has been shown to produce better outcomes.'[45] (12/94)
Organisation of stroke care	
Effective/promising treatments	
Organised inpatient (stroke unit) care for stroke	'Stroke patients who receive organised inpatient care in a stroke unit are more likely to be alive, independent, and living at home one year after the stroke. The apparent benefits are not restricted to any particular sub-group of patients or model of stroke unit care. No systematic increase was observed in the length of inpatient stay.'[46] (10/98)
Ineffective/unproven treatments	
Services for helping acute stroke patients avoid	hospital admission

'There is currently no evidence from clinical trials to support a radical shift in the care of acute stroke patients from hospital-based care.'[47] (5/99)

Services for reducing duration of hospital care for acute stroke patients

'ESD services provided for a selected group of stroke patients can reduce the length of hospital stay. However, the relative risks and benefits and overall costs of such services remain unclear.'[48] (5/99)

Review	Reviewers' conclusion
Rehabilitation following stroke	
Effective/promising treatments	
Cognitive rehabilitation for attention deficits following stroke	'There is some indication that training improves alertness and sustained attention but no evidence to support or refute the use of cognitive rehabilitation for attention deficits to improve functional independence following stroke.'[49] (5/00)
Ineffective/unproven treatments	
Cognitive rehabilitation for memory deficits following stroke	'There is insufficient evidence to support or refute the effectiveness of cognitive rehabilitation for memory problems after stroke.'[50] (2/00)
Electrical stimulation for preventing and treating post-stroke shoulder pain	'The evidence from randomised controlled trials so far does not confirm or refute that electrical stimulation around the shoulder after stroke influences reports of pain, but there do appear to be benefits for passive humeral lateral rotation. A possible mechanism is through the reduction of glenohumeral subluxation. Further studies are required.'[51] (4/99)
Information provision for stroke patients and their care givers	'The results of the review are limited by the variable quality of the trials and the wide range of outcome measures used. The general effectiveness of information has not been conclusively demonstrated. Future work should address the expressed needs of patients and carers and seek to identify appropriate teaching strategies which can be successfully implemented within clinical practice'[52] (1/01)
Pharmacological treatment for aphasia following stroke	'The main conclusion of this review is that drug treatment with piracetam may be effective in the treatment of aphasia after stroke. Further research is needed to explore the effects of drugs for aphasia, in particular piracetam. If a trial is done, this must be large enough to have adequate statistical power. The safety of the drug should be of primary interest. Researchers should examine the long-term effects of this treatment, and whether it is more effective than speech and language therapy.'[53] (7/01)
Speech and language therapy for aphasia following stroke	'The main conclusion of this review is that speech and language therapy treatment for people with aphasia after a stroke has not been shown either to be clearly effective or clearly ineffective within a RCT. Decisions about the management of patients must therefore be based on other forms of evidence. Further research is required to find out if effectiveness of speech and language therapy for aphasic patients is effective. If researchers choose to do a trial, this must be large enough to have adequate statistical power, and be clearly reported.'[54] (7/99)
Speech and language therapy for dysarthria due to non-progressive brain damage	'There is no evidence of the quality required by this review to support or refute the effectiveness of Speech and Language Therapy interventions for dysarthria following non-progressive brain damage. There is an urgent need for good quality research in this area.'[55] (9/00)

Citations of Cochrane Reviews

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