The Burden of Stroke White Paper

Raising awareness of the global toll of stroke-related disability and death

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About the authors

Professor Charles Wolfe

Professor Charles Wolfe is a Professor of Public Health at King's College London and heads a team of 20 researching the epidemiology of stroke and evaluating health service delivery models for stroke care. For the past 12 years he has co-ordinated the South London Stroke Register, which provides unique data on the supply of stroke care and needs of a multi-ethnic population. With his colleague Dr Tony Rudd, he has undertaken trials of early supported discharge after stroke, family support workers and trials of secondary prevention. He is involved in the development of the stroke strategy for the Department of Health in England and Wales and contributed to the UK National Audit Office Health Economics Report in 2005. He supervises postgraduate students in stroke research and has written over 130 papers on stroke.

Dr Tony Rudd

Dr Tony Rudd qualified from Cambridge University and King's College Hospital. He was appointed Consultant Physician in the Department of Medicine for the Elderly at St Thomas' Hospital in 1988 and since 1992 has been the lead physician for stroke. He became a full-time stroke physician in 2003. He has chaired the Royal College of Physicians' London Intercollegiate Stroke Working Party since its inception in 1995 — the group has been responsible for the National Clinical Guidelines for Stroke and the National Sentinel Audit of Stroke. He is Programme Director for Stroke in the Clinical Effectiveness and Evaluation Unit at the Royal College of Physicians and was President of the British Association of Stroke Physicians until 2006. He is the Chair of the National Institute for Health and Clinical Excellence (NICE) Guidelines Development Group for Acute Stroke and Transient Ischaemic Attack (TIA) and is a member of the group at the Department of Health developing a national stroke strategy. He has published over 100 research papers and 4 books about stroke. He is part of the South London Stroke Research group, which has interests in stroke epidemiology, genetics, acute management, service delivery and rehabilitation.

1.0 Introduction

Stroke is a brain attack. It is the world's third-biggest killer and the leading cause of adult physical disability. Stroke is a major global public health issue that prematurely claims millions of otherwise healthy and productive lives each year.

Stroke can be devastating at many levels — physical, emotional and economic. Although a stroke takes just minutes or hours, the effects can continue for years. Many stroke survivors are left disabled and dependent. The huge burden of stroke is carried by individuals, societies and healthcare systems.

For those involved in stroke care, evidence is emerging on new strategies for stroke prevention and treatment. There is a need to better understand what a stroke is and for strategies to speed up access to medical care, increase the availability of stroke units and thrombolysis, and improve prevention and early rehabilitation measures.

New drugs are on the horizon to treat stroke in the acute phase. Understanding the longer-term rehabilitation and social needs of stroke patients remains a critical goal for the future.

2.0 Executive summary

Worldwide, 15 million people suffer a stroke each year; one-third die and one-third are left permanently disabled. One in every 10 deaths is caused by stroke; only coronary heart disease and cancer claim more lives.

As a disease of the elderly, stroke will affect an increasing number of people as the global population ages. The World Health Organization (WHO) predicts that disability-adjusted life years (DALYs) lost to stroke (a measure of the burden of disease) will rise from 38 million in 1990 to 51 million in 2020.

For many stroke survivors the outlook is dismal. Speech, movement, co-ordination and cognition can all be affected. After a stroke, many people are left disabled and dependent on others; many never return home. Beyond the physical after-effects, depression and mood swings are common.

The costs of stroke are substantial — the loss to families and friends of a loved one, and the loss to society of the potential contributions of an important and valuable person. In economic terms, the costs of stroke are borne by individuals and families, by governments and by nations.

Stroke accounts for 2–4% of total healthcare expenditure in developed countries. In 2006, total and indirect costs were approximately €25 billion in Europe and US$57.9 billion in the USA. Most costs are incurred in the months and years after stroke by people left disabled and unable to care for themselves.

At present, there are just two treatments for stroke that significantly improve outcomes — clot-busting drugs (thrombolysis) and stroke units. Most patients receive neither. There is an urgent need for new treatments that are safe, effective and available to a large proportion of patients.

Reducing the burden of stroke must be a global health priority. Action is required at many levels: global monitoring of stroke patterns and trends; scientific research into treatment and prevention strategies; a greater understanding of the long-term needs of stroke survivors; and widening access to established, effective treatments.

Better stroke care is imperative to stem the loss of valuable members of society through stroke — a preventable catastrophe.

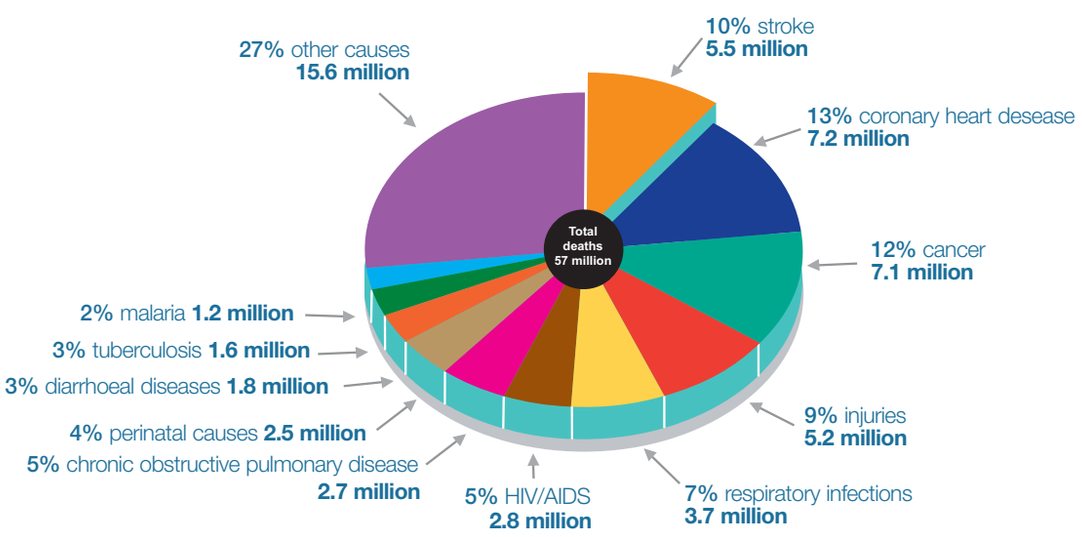
3.0 The global burden of stroke

Stroke is the brain equivalent of a heart attack. It occurs when the blood supply to part of the brain is suddenly interrupted or damaged. Without an adequate blood supply, the brain cells are starved of oxygen and nutrients and rapidly begin to die.

Worldwide, 15 million people suffer a stroke each year. Of these, more than 5 million die and another 5 million are left permanently disabled [WHO 2004]. Stroke is a major cause of premature death and long-term disability, placing a burden on the individual, on families and on society.

Today, stroke is the third most common cause of death worldwide, accounting for 10% of all deaths and exceeded only by coronary heart disease and cancer (Figure 1) [WHO 2004].

Figure 1:
Stroke compared with other causes of death (2002) [WHO 2004]



Reproduced from The Atlas of Heart Disease and Stroke, Mackay J, Mensah G (eds). Geneva: WHO; 2004 with kind permission from the World Health Organization

The spectrum of cerebrovascular disease

Stroke is just one of a spectrum of disorders affecting the arteries in the brain, collectively known as cerebrovascular disease. The medical consequences of cerebrovascular disease cover a broad spectrum: symptoms may be brief and reversible (such as transient ischaemic attack [TIA]), severe and life-threatening (such as stroke), or involve a gradual decline in cognitive function (such as dementia). TIA and stroke syndromes are described below.

Defining stroke

The WHO defines stroke as:

"A focal (or at times global) neurological impairment of sudden onset, and lasting more than 24 hours (or leading to death), and of presumed vascular origin."

In simple terms, this means that a stroke:

- stops the brain from working properly
- occurs without warning
- lasts for at least 24 hours and/or causes death
- is caused by an abnormality of the blood vessels

Stroke subtypes

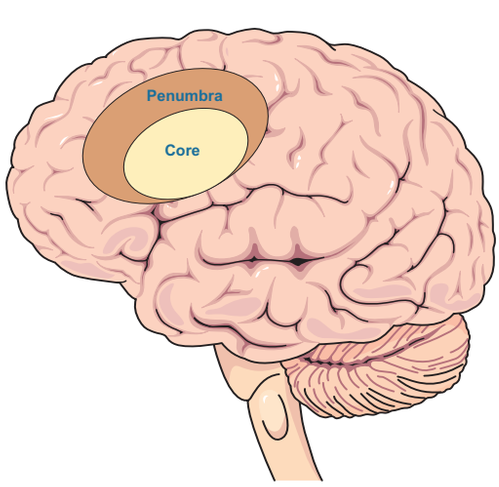
There are different types of stroke (Table 1). The commonest type is caused by a blockage in the blood supply to the brain. This is known as an ischaemic stroke and accounts for approximately 85% of all strokes. A less common form is caused by bleeding into the brain from a ruptured blood vessel. This is known as a haemorrhagic stroke and accounts for the remaining 15% of strokes.

Table 1:
Traditional stroke classification

Subtype	Features and subtypes
Ischaemic	◆ A sudden obstruction in an artery supplying blood to the brain ◆ Symptoms last at least 24 hours ◆ Can affect the very small arteries in the brain (lacunar stroke) ◆ May be caused by: – narrowing of the artery (atherosclerotic stroke) – a blood clot forming in the artery (thrombotic stroke) – a blood clot or other tissue fragment travelling to the brain from elsewhere in the body (embolic stroke)
Haemorrhagic	◆ Bleeding in the brain from a ruptured blood vessel ◆ Symptoms last at least 24 hours ◆ The vessel may rupture because it is: – weakened (e.g. by an aneurysm) – abnormally formed (e.g. arteriovenous malformation) – subjected to trauma (e.g. a head injury) ◆ Sometimes the bleeding occurs in the soft tissues of the brain (intracerebral haemorrhage or ICH) ◆ Bleeding may also occur in the space between the surface of the brain and the skull (subarachnoid haemorrhage or SAH)

Both types of stroke have the same effect: they starve the brain of oxygen and nutrients, causing the brain cells to die (Figure 2).

Figure 2:
How stroke affects the brain



During a stroke the brain is starved of oxygen, eventually leading to irreversible tissue damage and death. Cell death begins in the 'core' region and progressively enlarges over time into a surrounding region, known as the 'penumbra'. Unlike the core, the penumbra is considered to be salvageable since the damage can be reversed if the blood supply is restored quickly enough.

Transient ischaemic attack

A related condition is known as TIA. In a similar way to ischaemic strokes, TIAs are caused by a blockage in the arteries supplying blood to the brain, or less frequently by small bleeds. The symptoms of TIA are similar to those of stroke, involving sudden weakness of the face, arm or leg. However, TIAs are only temporary and typically last less than 2 hours, although the definition is up to 24 hours. Indeed, doctors use the duration of symptoms, rather than their nature or severity, to distinguish between TIA and ischaemic stroke.

Although TIAs may not cause lasting damage to the brain, they act as a warning sign of more serious strokes in the future. In the first 3 months following a TIA, the likelihood of suffering a stroke is nearly 18% [Coull et al. 2004]. Because of the high risk of stroke, TIAs must be viewed as a medical emergency. Typically, someone who has suffered a TIA will be treated with blood-thinning medication to help reduce the likelihood of future strokes.

Classification of stroke

Traditionally, doctors classified stroke according to pathology (i.e. the type of abnormality affecting the blood supply) (Table 1). However, with the introduction of increasingly sophisticated diagnostic tests, doctors are now able to pinpoint the specific mechanisms underlying the stroke. Nowadays, strokes are routinely classified according to aetiology (i.e. what actually caused the stroke), the location and type of blood vessels affected, and clinical features that help predict the patient's likely outcome. Examples of modern classification systems include the TOAST criteria [Adams et al. 1993] and the Oxfordshire Community Stroke Project Classification [Bamford et al. 1991].

Recognising the warning signs

Recognising that someone is having a stroke is the first step towards obtaining rapid specialist medical treatment. Unfortunately, public awareness and recognition of the symptoms of stroke are very low. In a survey of nearly 2000 members of the public, just under half were unable to list any of the common warning signs of stroke (see box) [Pancioli et al. 1998].

Stroke symptoms

The most common symptom of stroke is sudden weakness of the face, arm or leg, most often on one side of the body.

Other symptoms include sudden onset of:

- numbness of the face, arm or leg
- confusion, difficulty speaking or understanding speech
- difficulty seeing with one or both eyes
- difficulty walking, dizziness, loss of balance or co-ordination
- severe headache with no known cause
- fainting or unconsciousness

The Face Arm Speech Test

Accident & Emergency
Facial weakness
Arm & leg weakness
Speech problems
Test these signs

To help people recognise the symptoms of stroke quickly, The Stroke Association (UK) has funded research into the Face Arm Speech Test (FAST). This is used by paramedics to diagnose stroke prior to a person being admitted to hospital, allowing appropriate treatment to be given as quickly as possible.

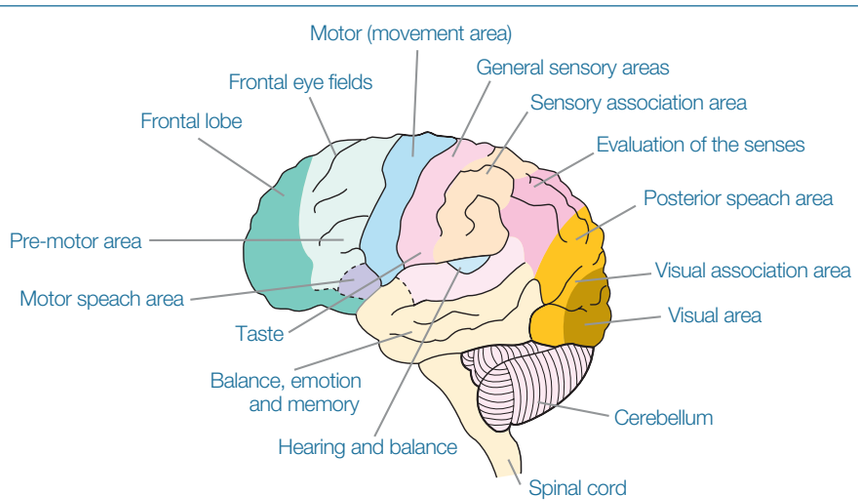
FAST requires an assessment of three specific symptoms of stroke:

Facial weakness — can the person smile? Has their mouth or eye drooped?
Arm weakness — can the person raise both arms?
Speech problems — can the person speak clearly and understand what you say?
Test all three symptoms

What are the consequences?

The brain is a highly complex organ that controls many of the body's functions. Different parts of the brain control different functions. The consequences of stroke are wide-ranging because they depend on the region of the brain affected (Figure 3).

Figure 3:
Map of the brain showing functional areas [ABPI 1999]



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The No. 1 cause of adult physical disability in the developed world

Stroke is the leading cause of permanent adult physical disability in developed countries [Wolfe 2000]. Depending on the part of the brain affected and how widespread the damage is, stroke can affect:

- walking
- swallowing
- balance
- co-ordination
- eyesight
- movement
- speaking
- dressing
- feeding
- bladder and bowel control

Time lost is brain lost

While the part of the body affected by a stroke depends on the location of the brain injury, the nature and severity of this damage are determined by how much brain tissue is injured, which is critically dependent on time. In other words: 'time is brain'.

Unlike some other parts of the body, brain cells have no emergency energy reserve and depend on a continuous flow of blood to function properly. In this respect, a stroke is similar to a heart attack. The longer the blood supply is interrupted, the greater the damage and the worse the patient's outcome. If the blood supply is cut off for more than a few minutes then a stroke can have very serious consequences, including permanent disability and death.

Consequences of stroke depend on:

- which part of the brain is affected
- how many brain cells die
- whether any of the damaged cells can recover
- whether healthy parts of the brain can take over the function of the parts that died

Case studies: Experiencing stroke

Case 1:

Mrs X is a 40-year-old woman who came to the Emergency Department after suffering her third TIA in 2 days. When she first developed weakness of her left arm and leg she did not seek medical attention as all the symptoms disappeared within 10 minutes. However, with the third attack, her husband became concerned and brought her to hospital.

At the initial assessment, she did not have any symptoms; however, approximately 20 minutes after arrival she developed severe paralysis of the left face, arm and leg, and blindness in the left eye. A brain scan showed that she had suffered a devastating stroke in the right middle cerebral artery, which presumably occurred at the time of her earlier TIAs.

After the stroke, she was unable to walk and found it hard to hold her baby or do even the most basic tasks. When she was eventually discharged home she could walk a few steps but still needed help with most basic activities, and needed a full-time carer for her baby daughter and 2-year-old son. It is likely that she will remain severely disabled for the rest of her life.

Case 2:

During her 75 years of life, Mrs BC had never had to attend a hospital. She had been diagnosed with hypertension 2 years earlier but had relied on homeopathic medicines rather than the ones her doctor had recommended. She woke one morning with weakness in her right arm and leg; her speech and vision were unaffected. A brain scan confirmed that she had suffered a small stroke. Her symptoms improved gradually and she was discharged from hospital after 4 days, able to function independently. She has returned to her former levels of activity and now takes her prescribed medication.

Who gets stroke?

Strokes are rare in younger people and become increasingly common with older age. At 45 years, the chance of having a stroke in the next 20 years is approximately 1 in 30. However, the *lifetime risk* of stroke is 1 in 4 for men and 1 in 5 for women [Wolfe 2000].

Importantly, stroke has many similarities with heart disease. Both are diseases of the blood vessels that mainly affect older people and are strongly associated with the 'Western' lifestyle, characterised by poor eating habits, physical inactivity, and alcohol and tobacco use. The risk factors for stroke and heart disease are virtually identical.

Stroke: a preventable catastrophe

Doctors view stroke as a preventable catastrophe rather than an inevitable consequence of ageing.

Major risk factors for stroke are:

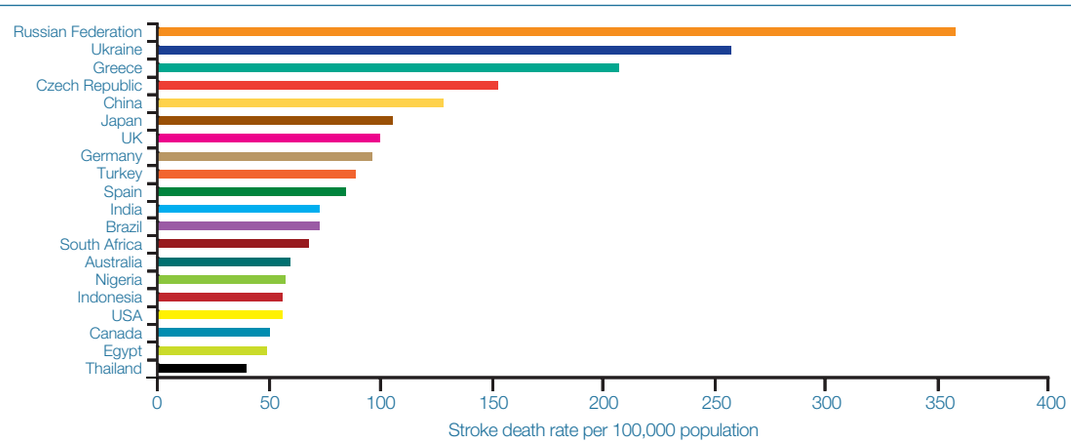
- high blood pressure
- tobacco use
- physical inactivity
- diet (low fruit and vegetable intake)
- heavy alcohol consumption
- high blood cholesterol
- being overweight
- diabetes
- atrial fibrillation (an abnormal heart rhythm)

Deaths due to stroke

The global death rate from stroke is 93 per 100,000 people [Moon et al. 2003]. However, the rate varies widely at a country level (Figure 4), as does the proportion of total deaths caused by stroke. In regions with low overall mortality rates, death rates from stroke range from 59 per 100,000 in the Americas to 114 per 100,000 in Europe [Moon et al. 2003].

Figure 4:

Stroke death rates in 20 countries [WHO 2004]



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A major public health issue

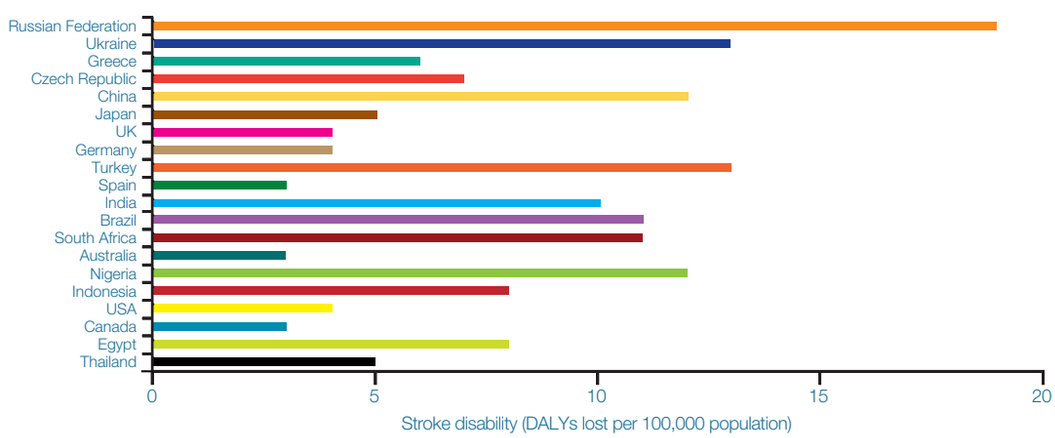
The WHO recently identified stroke as a major public health problem for both developed and developing countries. According to the WHO, stroke is associated with the fourth highest burden of disease worldwide [Millán and Dávalos 2006]. In 1990, stroke was responsible for 38 million DALYs around the globe [WHO 2004].

What is a DALY?

The burden of disease is measured in DALYs, which combine years of potential life lost due to premature death with years of productive life lost due to disability. One DALY represents the loss of 1 year of full health.

Figure 5 shows stroke disability per 100,000 population due to stroke in individual countries.

Figure 5:
Stroke disability in 20 countries [WHO 2004]



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Why the geographical variations?

Geographical variations in the stroke death rate and burden reflect differences in:

- stroke incidence (i.e. the number of new cases relative to the population size)
- the proportion of the population at risk of stroke (i.e. cardiovascular risk factors, including age)
- stroke severity
- access to — and effectiveness of — treatment and rehabilitation
- health status before the stroke
- death rates from other diseases (resulting in a lower proportion of the elderly in the population)

Global trends: what does the future hold?

Since stroke predominantly affects older people, the number of people suffering a stroke is likely to rise as the global population ages. The WHO predicts the total stroke burden will increase from approximately 38 million DALYs in 1990 to 51 million DALYs in 2020 [WHO 2004]. However, trends in stroke incidence and fatality vary markedly in different populations, making predictions difficult.

In many developed countries, including western Europe, North America and Japan, deaths from stroke have fallen dramatically in the past 30 years. This decline may be due, at least in part, to better control of high blood pressure, a leading risk factor for stroke. The rate of decline has slowed in the past decade or so, however. Conversely, in several eastern European and eastern Asian countries, including China, mortality from stroke has risen, particularly in the last 5 years [Sarti et al. 2000; Truelsen et al. 2003]. Furthermore, in both developed and developing nations, there is a trend towards stabilising or increasing stroke incidence, especially in the elderly population [Feigin et al. 2003].

Key points

- Stroke is the brain equivalent of a heart attack and occurs when the blood supply to the brain is suddenly interrupted or damaged
- There are different types of stroke but all starve the brain of oxygen and nutrients, causing brain cells to die
- The most common symptom of stroke is sudden weakness of the face, arm or leg, often on one side of the body
- Stroke affects 15 million people globally each year
- Approximately one-third of stroke sufferers die and one-third are left permanently disabled
- The WHO has identified stroke as a major public health problem facing both developed and developing countries

4.0 The personal impact of stroke

Stroke can be a devastating event. Even with the best medical care, approximately two-thirds of stroke victims will die or be disabled and dependent on others for the rest of their lives. Little wonder the WHO has described the outlook for stroke victims as 'dismal' [WHO 2004].

Table 2 shows the proportion of patients who have died 30 days, 3 months and 1 year after a stroke. The ranges reflect different populations and subtypes of stroke: fatality rates are higher for intracerebral haemorrhage and subarachnoid haemorrhage than for ischaemic stroke, and higher in Caucasian than in African–Caribbean patients.

Table 2:
Death rates after 30 days, 3 months and 1 year [Feigin et al. 2003; Wolfe 2000]

Time after stroke	Death rate (%)
30 days	16–42
3 months	19–32
1 year	27–41

Far-reaching effects

Stroke has a major impact on people's lives. Severe strokes can result in lifelong disability and dependence on others for the most basic needs. Even mild strokes tend to affect almost every aspect of people's daily lives — from physical health and emotional wellbeing to family life, social functioning and vitality. In a 4-year study of stroke survivors, not one person reported that their life had returned to normal [Duncan et al. 1997].

Getting the measure of stroke-related disability

The modified Rankin Scale (mRS) is used to assess disability in people who have suffered a stroke. Patients are graded from 0 (no symptoms at all) to 5 (severely disabled, bedridden). This indicates the level of support and care that the person is likely to need and is useful for monitoring changes in their condition over time.

Table 3 defines each of the mRS scores and shows the percentage of patients in each category 90 days after suffering an ischaemic stroke. These figures came from a recent research study in which all patients received the best available medical care [Lees et al. 2006]; despite this, nearly 60% died or were left moderately or severely disabled.

Table 3:

Disability at 90 days following ischaemic stroke (NB: all patients received best available medical care)

mRS score	Level of disability	Patients in this category 90 days post-stroke (%)[a]
0	No stroke-related disability or symptoms	11.0
1	No significant disability, despite symptoms; able to perform all usual duties and activities	20.0
2	Slight disability; unable to perform all previous activities but able to look after own affairs without assistance	11.7
3	Moderate disability; requires some help, but able to walk without assistance	12.7
4	Moderately severe disability; unable to walk without assistance and unable to attend to own bodily needs without assistance	20.6
5 or death	Severe disability; bedridden, incontinent, and requires constant nursing care and attention	24.0

[a]Figures derived from placebo group efficacy analysis in the SAINT I trial [Lees et al. 2006]

Case studies: The Rankin score

Case 1:

Mrs Y was independent (Rankin score 0) before her stroke. Her stroke initially resulted in left-sided weakness affecting the face, arm and leg. She was treated with thrombolysis (see Section 5.0) and improved rapidly, but a brain scan revealed an area of dead tissue. Three months after her stroke she was walking, although not entirely normally. The strength in her arm was slightly reduced and her hand movements were a little clumsy. She was able to perform basic day-to-day activities but was no longer able to walk the mile to her nearest shop and had difficulty carrying all her shopping without using a trolley.
She therefore has a Rankin score of 2, as she can look after herself without help but suffers a slight residual disability.

Case 2:

Following her stroke, Mrs N was able to get out of bed by herself and move to her chair or commode. Because this takes time and effort, and she is often incontinent of urine, she therefore wears pads. She has been provided with special cutlery and is able to feed herself but has to have meals provided for her. Her Rankin score is 4 as, although there are some activities that she can manage independently, she needs help for many of her bodily needs.

Beyond the physical… the emotional toll of stroke

The impact of stroke goes beyond physical abilities. Stroke also gives rise to significant emotional and intellectual problems. Approximately 1 in 3 stroke survivors suffer from depression — far more than in the general population [Hackett and Anderson 2005]. Having a stroke doubles the likelihood of developing dementia [Leys et al. 2005]. In addition, stroke is associated with other emotional disorders, including mood swings, personality changes, anxiety and irritability [Murray et al. 2003].

Key problem areas identified by stroke survivors

Table 4:

Research involving approximately 6000 stroke patients identified five key problem areas [Murray et al. 2003]:

Problem area	Details	Proportion of patients affected (%)[a]
Social and emotional changes	Social, emotional, attitude to recovery, relationships and self-perception	11–62
Services	Social, health, multidisciplinary issues	18–46
Transfer of care	Process, preparation for living at home, abandonment	13–77
Communication	Written, verbal	33–100
Hospital experience	Therapy, critical events	32–81
Other	Incontinence, pain, falls	10–73
[a]Range reflects findings from different studies		

Reproduced from Murray J, Young J. Developing a primary care-based stroke model: the prevalence of long-term problems experienced by patients and carers. Br J Gen Pract 2003;53:803–807 with kind permission from the British Journal of General Practice

Rehabilitation and long-term care

After a stroke, some patients return straight home and resume their normal lives. However, most need specialist care to help them regain lost skills and reduce long-term disability. This is known as stroke rehabilitation.

Stroke rehabilitation tends to involve experts from a number of different disciplines, from nursing and social care to speech, occupational and physical therapy. Stroke rehabilitation may involve help and support with:

- basic activities such as bathing, dressing, eating and going to the toilet
- more complex tasks such as housework, cooking, using the telephone and driving
- speech, reading and writing
- specific physical disabilities
- exercising safely
- living independently
- organising medical and social care and follow-up
- counselling and advice on money, legal and business affairs.

What can stroke survivors expect?

Among ischaemic stroke survivors aged >65 years in the USA [Kelley-Hayes et al. 2003]:

- one-quarter were resident in a nursing home
- one-third required help with walking
- one-quarter were dependent in activities of daily living

Case studies: Life after stroke

Case 1:

My friends think I have done brilliantly after my stroke but there is a lot that they don't see. Yes, I can walk and talk but I feel tired all the time and just don't have the energy to live the life I used to lead. I also think my memory has gone a bit. I find it much harder to remember people's names, even people who I know really well. It can be so embarrassing. I'm also frightened that it's going to happen again and am therefore not keen on going too far from home. I think the stroke has ruined my life. I was so looking forward to retirement, doing all the things I couldn't do when I worked but now I can't see much point in being here.

Case 2:

I always said that I wanted to die in my own home and that under no circumstances would I go into an old people's home. But my wife died last year and then I had this stroke and it just wouldn't have been fair to ask my children to look after me. So I'm stuck here.
The nurses are quite nice but they are always busy and don't have time to talk. The other residents are not really my type and so I spend most of the day watching television.
I did learn to walk a few steps when I was in hospital but the nurses find it much easier to wheel me around in a chair so now I find it difficult to even stand. I feel as though I'm getting worse and I am so bored. But at least my children try and visit when they can, but they are so busy with their jobs and children. Things could be worse.

Key points

- Stroke can be a devastating event with far-reaching consequences
- Stroke is the leading cause of permanent physical disability worldwide
- Most stroke survivors need specialist supportive care and rehabilitation
- Many stroke survivors never return home
- Stroke can also result in emotional problems such as depression, anxiety and mood swings

5.0 The huge and diverse costs of stroke

The costs of stroke are huge and diverse (Table 5). Many costs can be estimated in economic terms: the cost to the individual and their family of healthcare and time off work; the cost to the government of healthcare; and the cost to the country of lost productivity.

Other costs are harder to calculate and yet equally important: the cost to society of losing an important and valuable person through premature incapacity or death; and the emotional cost to family and friends of caring for a loved one who can no longer live independently.

Table 5:
Economic costs of stroke

Short term	Long term	Other
◆ Emergency transportation ◆ Diagnosis ◆ In-patient stay ◆ Surgery ◆ Drugs	◆ Outpatient visits ◆ Transportation ◆ GP visits ◆ Physiotherapy ◆ Occupational therapy ◆ Speech/language therapy ◆ Drugs ◆ Tests and investigations ◆ Orthoses/incontinence pads ◆ Institutional care (including board and lodgings)	◆ Income lost by informal carers ◆ Income lost due to death ◆ Income lost due to disability ◆ Benefit payments

◆ Money talks — the economics of stroke

Stroke accounts for between 2% and 4% of the total healthcare expenditure in developed countries [Moon et al. 2003]. In addition, stroke incurs substantial costs outside the healthcare system, reflecting the high rates of disability and dependence experienced by stroke survivors.

In 2006, the total direct and indirect costs associated with stroke are estimated at approximately €25 billion per year in Europe [Safe Implementation of Thrombolysis in Stroke: online] and US$57.9 billion in the USA [Millán and Dávalos 2006]. The vast majority of costs are incurred in the months and years after the patient has been discharged from hospital (Figure 6) [Caro and Huybrechts 1999].

Cost of stroke in the first 12 weeks:

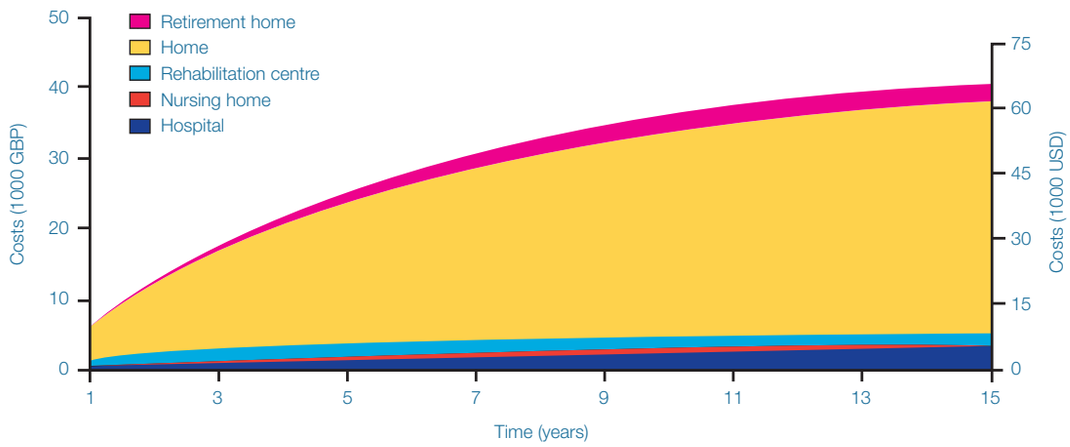
- US$13,649 per patient

Lifetime cost of a patient who survives the first 12 weeks:

- US$124,564 (major stroke)
- US$45,893 (minor stroke with complete or nearly complete recovery)

Figure 6:

Cumulative costs of stroke beyond 1 year according to patient location [Caro and Huybrechts 1999]



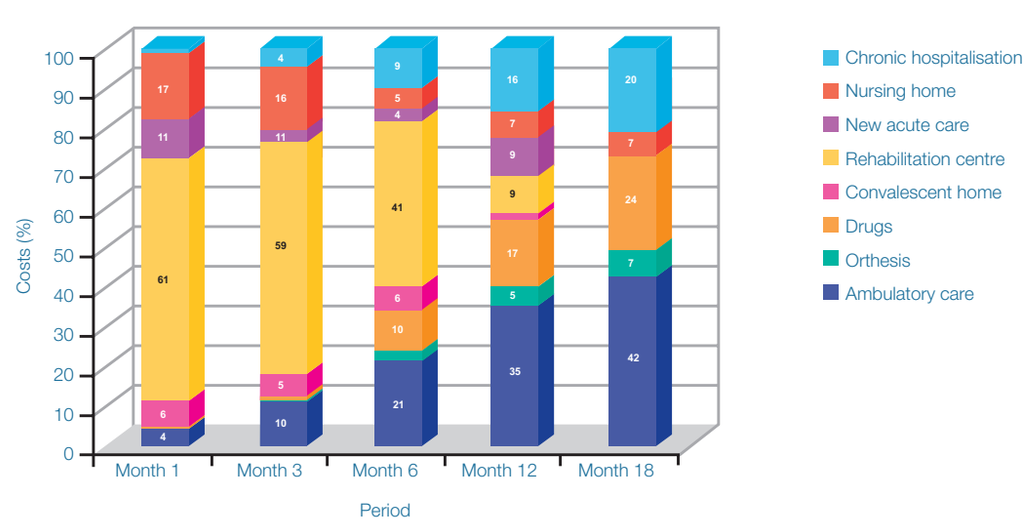
Reproduced from Caro JJ, Huybrechts KF. Stroke Treatment Economic Model (STEM). Predicting long-term costs from functional status. Stroke 1999;30:2574–2579 with kind permission from Lippincott Williams & Wilkins

The huge cost of stroke care is largely driven by the high rates of disability and dependence among stroke survivors: one-third of all stroke patients are left permanently disabled and dependent on others for care, support and rehabilitation.

Figure 7 details the direct costs of stroke over an 18-month period.

Figure 7:

Breakdown of direct costs of stroke over an 18-month period [Spieler et al. 2004]

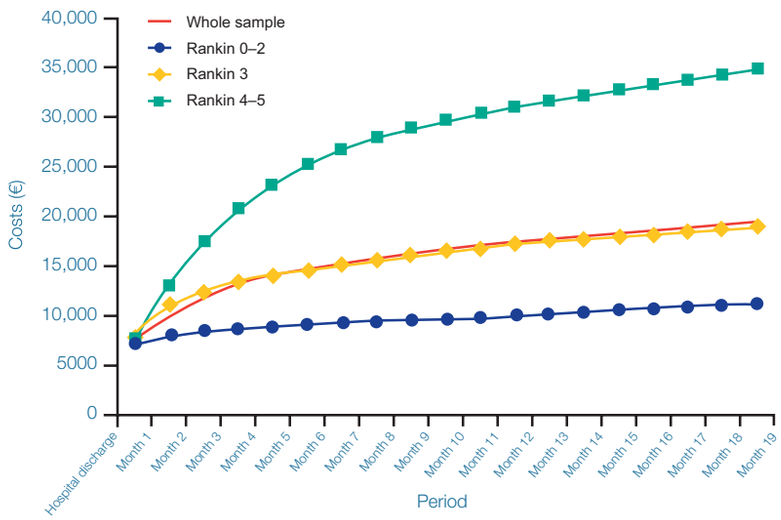


Reproduced from Spieler JF, Lanoe JL, Amarenco P. Costs of stroke care according to handicap levels and stroke subtypes. Cerebrovasc Dis 2004;17:134–142 with kind permission from S Karger AG, Basel

Stroke severity is largely determined by the extent of permanent brain damage; the level of disability following stroke can be classified using the mRS, where 0 indicates no symptoms and 5 indicates severe disability (see Section 3.0). Figure 8 illustrates how the cost of stroke is strongly tied to stroke severity.

Figure 8:

Cost of stroke according to handicap level [Spieler et al. 2004]



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Comparison with other chronic conditions

Table 6 illustrates the disparities in resourcing and status between stroke and coronary heart disease, using data from the UK [National Audit Office/Department of Health 2005].

Table 6:

Benchmarking stroke against coronary heart disease reveals disproportionate differences in resourcing and status in England and Wales [National Audit Office/Department of Health 2005]

	Stroke	Coronary heart disease
Annual direct healthcare costs	£2.8 billion	£1.9 billion
Number of in-patient hospital bed days annually	2.6 million	3 million
Average length of stay (days)	28	7
Proportion of deaths in England and Wales caused in 2002 (%)	11	19
Approximate prevalence of people disabled or dependent as a result	300,000	N/A
Status in the Joint Council for Higher Medical Training	As of 2004, stroke is a sub-speciality	A speciality
Number of trainees registered in England	6	430
Charity research funding in the United Kingdom in the financial year 2000–2001	£2.6 million	£43 million
Number of research posts funded by charities and government agencies in the United Kingdom in the financial year 2000–2001	7	455
Department of Health Research funding 2003–2004	£9.4 million	£52 million
Respondents to NAO public awareness survey who listed the disease in the top four causes of death (%)	21	77
Number of points in the GP contract allocated specifically to secondary prevention of this condition (plus points awarded for hypertension)	31 (+105)	121 (+105)
Proportion of GPs that have no system or are unsure if they have a system for identifying repeat events (%)	15	26
Proportion of GPs with a special interest in the condition (%)	16	39
Proportion of GPs that would refer a patient with this condition within a few minutes (%)	55	94
Proportion of GPs that have local protocols in place for rapid referral and management of acute cases (%)	73	86
Proportion of GPs that have local protocols in place for rapid referral and management of minor cases (%)	71	92
Percentage of hospitals with protocols with the ambulance service for managing patients (over and above the regular system) (%)	16	100
Percentage of patients seen as an outpatient within 14 days (%)	37	95
Percentage of patients treated at some time on a specialist unit (%)	47	100
Number of patients per consultant	640	360
Patients discharged with an identified help contact point (%)	48	86

Key points

- Stroke is an extremely costly condition, accounting for 2–4% of healthcare budgets
- The costs are borne by the patient, their family and caregivers, society, the government and the country
- The high cost of stroke reflects the high rates of disability and dependence
- The majority of costs are incurred after the patient has left hospital
- The greater the level of disability, the higher the cost

6.0 Stroke treatment today

At present, there are just three interventions that are proven to improve the outlook for people with acute ischaemic stroke:

- Treatment in a specialist stroke unit
- Thrombolysis (clot-busting drugs)
- Aspirin

For haemorrhagic stroke, the options are even fewer:

- Treatment in a specialist stroke unit
- Surgery (only for SAH)

Stroke units

Stroke units are treatment facilities staffed by multidisciplinary teams of medical, nursing and allied health staff. They incorporate best-practice stroke treatment protocols and are equipped, staffed and organised in such a way as to give stroke patients optimal medical care. Patients treated in stroke units are significantly less likely to die, be left disabled or dependent, or to need institutional care compared with patients treated on general medical wards [Stroke Unit Trialists' Collaboration 1997a, b, 2002].

There is widespread agreement that all patients with suspected stroke should be treated in stroke units. Some stroke units treat people immediately after the onset of stroke, some offer rehabilitation and some offer both types of treatment. The availability of stroke units varies widely among different countries, from none to several hundred. The main reason for lack of stroke units is underfunding.

Case study: A successful stroke unit

The stroke unit at Guy's and St Thomas' NHS Foundation Trust in London, UK was established 17 years ago. The key features that are important for its success are:

- All stroke patients admitted directly from the emergency department
- A designated area with monitored beds for the management of acute stroke
- A minimum of 2 specialist nurses per 4 acute stroke patients at all times
- Protocols for the management of common post-stroke complications which can be implemented by the nurses
- A team of rehabilitation staff (physiotherapy, occupational therapy, speech therapy, dietetics) who work with the nursing staff to ensure that rehabilitation starts from Day 1
- Daily medical review by a stroke specialist of all patients in the early stages of a stroke
- Sufficient rehabilitation beds to ensure that it is always possible to create an acute bed in an emergency
- Involving the patients in setting goals
- Nurses who use an enabling philosophy of care, encouraging patients to do as much for themselves as they can (even if it is more time-consuming than the nurses doing it themselves)
- Easy access to imaging and all the other medical and surgical specialities that a patient might require during their hospital stay
- Information provided to all patients and carers about stroke, its consequences and treatment
- Involvement of carers in the rehabilitation process
- Close collaboration with community services to ensure a smooth transition of care from the hospital
- Access to the right equipment for dependent patients to ensure effective rehabilitation

Thrombolysis — potent but with many limitations

Thrombolysis means the use of 'clot-busting' drugs to dissolve the blockage in the artery and restore blood flow to the brain. The thrombolytic drug used to treat ischaemic stroke is known as recombinant tissue plasminogen activator (rt-PA). Thrombolytic treatment is effective in reducing the risk of death and disability in patients with ischaemic stroke if given within 3 hours of the onset of symptoms [Mielke et al. 2004; Wardlaw et al. 2003a, b; Hacke et al. 2004a, b; Graham 2003].

As with aspirin, however, thrombolysis has a number of limitations (see box) [Barber et al. 2001; Goldstein et al. 2001; Grotta et al. 2001]. A key concern is that thrombolysis can cause bleeding in the brain — a potentially fatal complication. In reality, the vast majority of stroke patients do not receive thrombolysis. Even in countries with the most advanced stroke care, fewer than 5% of stroke patients typically receive thrombolytic treatment [Riopelle et al. 2001; Chiu et al. 1998], with rates of less than 1% being observed in the UK.

Limitations of thrombolysis

- Must be given within 3 hours of the onset of symptoms
- Only suitable for ischaemic stroke (i.e. caused by a clot)
- A brain scan is required before starting treatment to confirm diagnosis
- The main risk associated with thrombolysis is bleeding within the brain (intracerebral haemorrhage)

A modest benefit with aspirin

Aspirin reduces the likelihood of death and disability in patients with ischaemic stroke if given within 48 hours of the onset of symptoms [Chinese Acute Stroke Trial Collaborative Group 1997; International Stroke Trial Collaborative Group 1997]. Aspirin is called an antiplatelet therapy because it stops cell fragments in the blood from sticking together and forming a clot.

Unfortunately, the benefit of aspirin is small: treating 1000 people with ischaemic stroke prevents just 9 deaths or non-fatal strokes [Chinese Acute Stroke Trial Collaborative Group 1997; International Stroke Trial Collaborative Group 1997]. The limitations of aspirin are summarised in the box below.

Limitations of aspirin

- Not appropriate for haemorrhagic stroke
- Ideally, should be given within 48 hours of symptom onset
- Should only be given after a brain scan
- Should not be used until 24 hours after thrombolysis
- Other exclusion criteria (e.g. aspirin should be used cautiously in patients with gastric bleeding or other bleeding disorders)

Stroke treatment guidelines

Various expert groups publish evidence-based recommendations for the treatment of patients with stroke. The main ones are issued by:

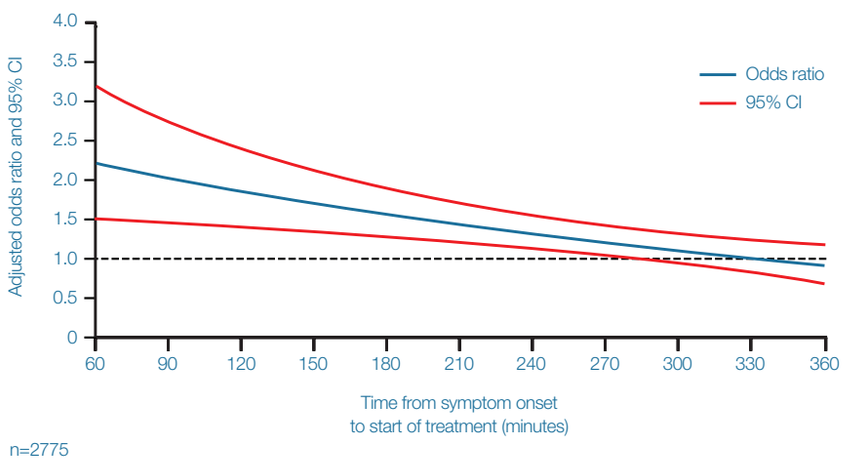
- The American Stroke Association (last updated 2003) [Adams et al. 2003]
- The European Stroke Initiative (last updated 2003) [Hacke et al. 2003]
- The Royal College of Physicians (last updated 2004) [Intercollegiate Stroke Working Party 2004]

Every second counts

The relationship between timing of treatment and patient outcomes is shown in Figure 9. Based on information from 2775 patients with ischaemic stroke, those treated with a thrombolytic within 3 hours of their symptoms appearing were significantly more likely to have a good outcome (i.e. complete or nearly complete recovery at 3 months) than those treated within 3–6 hours [Hacke et al. 2004a, b].

The sooner the patient is treated, the greater the benefit.

Figure 9:
Delays in starting treatment reduce the chance of a good outcome [Hacke et al. 2004a]



Reproduced from Hacke W, Donnan G, Fieschi C, et al. Association of outcome with early stroke treatment: pooled analysis of ATLANTIS, ECASS, and NINDS rt-PA stroke trials. Lancet 2004;363:768–774 with kind permission from Elsevier

Case studies: Delays in stroke diagnosis and treatment

Case 1:

I had just travelled from France and was getting off the train when my left leg gave way beneath me and I fell. The train guard realised something was seriously wrong and an ambulance was there within just a few minutes. Within half an hour, I was in the scanner and the stroke doctor and nurse were assessing me. They explained about the need for urgent treatment with the clot-busting drug. The nurses on the stroke unit kept me awake most of the night checking my blood pressure and asking me to try to move my arms and legs. By the next morning I think I was pretty much back to normal, although they wouldn't let me get up and walk. Without the quick actions of the guard and paramedics, I was told I would probably have been left with a big stroke.

Case 2:

When my arm and leg went weak I thought I'd probably just drunk too much so I went to bed. The next morning I couldn't move my left side at all and couldn't get out of bed. I live alone and it was hours before someone found me and got me into hospital. I was put on the admissions ward and had a brain scan the next day. I'm only 42 and have ended up with a really weak leg and an arm that is useless. If only I had known what a stroke was and not ignored what was happening then perhaps they could have prevented me ending up like this. I can't see myself ever getting back to work.

Key points

- There are few treatment options for patients with stroke
- Aspirin has only a modest impact on stroke outcomes
- Thrombolysis is more potent than aspirin, but is given to fewer than 5% of patients
- The main limitations of thrombolysis are the 3-hour treatment window, the need for a brain scan before treatment and concerns over the bleeding risk
- Stroke units are highly effective in streamlining stroke treatment but are not universally available due to underfunding

7.0 Challenges for the future

Stroke is the leading cause of long-term disability and poses a major disease burden worldwide. As the global population ages, stroke will represent an increasing public health problem in both developed and developing countries. There is an urgent need for new treatments that are effective and safe for use in a large proportion of stroke patients.

Widening the net: which stroke intervention offers the greatest community benefit?

The benefit of stroke treatment is defined not only by how effective it is under ideal conditions but also by how likely patients are to be treated with it in the real world.

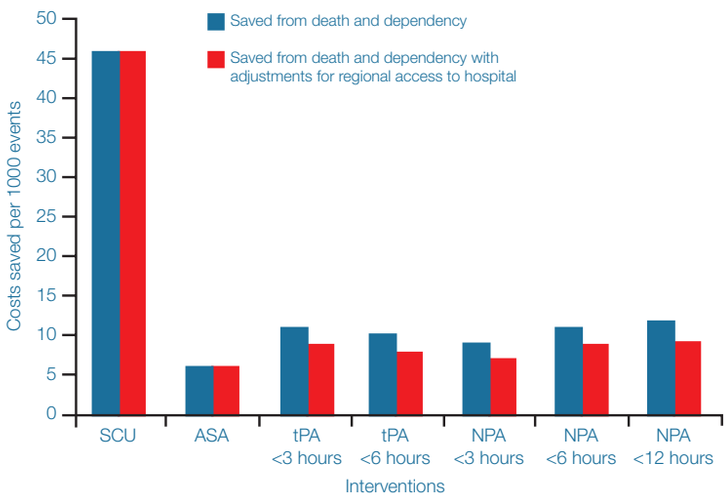
As UK stroke experts recently noted [Barber et al. 2001]:

"Thrombolysis for acute ischaemic stroke, for instance, may have substantial effect on stroke outcome but has no more overall effect in the population than a much less potent treatment such as aspirin unless it can be given safely to more than a small minority of patients."

Figure 10 compares the potential benefits of four different stroke interventions: stroke units, aspirin, thrombolysis and neuroprotective agents (neuroprotection is an experimental approach and no neuroprotective drugs are approved for use) [Gilligan et al. 2005]. Although thrombolysis is the most potent treatment, stroke units offer the greater population benefit and, according to the study authors, should be given priority.

Figure 10:

The potential benefits of stroke units (SCU), aspirin (ASA), thrombolysis (tPA) and neuroprotective (NPA) agents per 1000 strokes in the community [Gilligan et al. 2005]



NB: The data on neuroprotective agents are theoretical as none is approved for use
Reproduced from Gilligan AK, Thrift AG. Stroke units, tissue plasminogen activator, aspirin and neuroprotection: which stroke intervention could provide the greatest community benefit? Cerebrovasc Dis 2005;20:239–244 with kind permission from S Karger AG, Basel

New therapies — what's on the horizon?

The ideal treatment for stroke would:

- reduce the risk of death and disability
- be safe and well tolerated
- have an extended therapeutic window
- be given without the need for a brain scan
- offer benefit to the majority of stroke patients

Neuroprotectant drugs target the injured brain tissue and aim to reduce the extent and severity of brain damage, thereby improving the outlook for the patient. They could potentially be used to treat both ischaemic and haemorrhagic strokes, possibly before imaging and even in the ambulance setting. Several neuroprotective drugs are currently being studied.

Beyond thrombolysis with rt-PA, other ways of restoring blood flow to the brain are being developed. Known as reperfusion strategies, they include new thrombolytic drugs, new antiplatelet drugs, enhancing thrombolysis with ultrasound, and mechanical devices to remove the clot from the brain.

The need for action now

Stroke is an important cause of disability and death worldwide. Better stroke care is needed now to reduce suffering for patients and their families and to limit the disease burden on healthcare systems and budgets. Better stroke care is imperative to stem the loss of valuable members of society through stroke — a preventable catastrophe.

According to a multidisciplinary panel representing stroke physicians, paramedics, emergency medical and nursing staff, the goals for reducing the burden of stroke are as follows [Hacke et al. 2003, 2004b]:

1. Raise awareness of the symptoms of stroke among the general public
2. Build recognition among both the public and the healthcare profession that stroke is a medical emergency

3. Improve understanding that time is brain and early treatment of stroke improves outcomes
4. Co-ordinate acute stroke care through streamlined, multidisciplinary pathways
5. Widen availability and access to specialist stroke units
6. Increase use of available treatments
7. Develop safe, effective and widely applicable new treatments

Ongoing stroke initiatives

Initiatives are underway around the world, with the aim of meeting one or more of the goals listed above.

STEPS-Stroke is a WHO framework for stroke surveillance and data collection from WHO member states [WHO 2006]. The project gathers data on three different groups of stroke patients: those admitted to health facilities; fatal strokes occurring in the community; and non-fatal strokes occurring in the community.

The purpose of STEPS-Stroke is to provide health workers and policy-makers with a standardised tool to assess the magnitude of stroke, describe populations at risk, identify associated risk factors, monitor trends over time, provide the basis for designing and implementing interventions, and monitor and evaluate the effectiveness of interventions.

The Helsingborg Declaration 2006 on European Stroke Strategies was adopted in March 2006 by the International Stroke Society, the European Stroke Council, the International Stroke Society, and the WHO Regional Office for Europe [Kjellström et al. 2006]. The meeting was arranged in collaboration with the European Region of the World Confederation for Physical Therapy, the European Association of Neuroscience Nurses and the patients' organisation Stroke Alliance for Europe.

The Helsingborg Declaration covers five aspects of stroke management — organisation of stroke services, management of acute stroke, prevention, rehabilitation, evaluation of stroke outcome and quality assessment — to be achieved by 2015. The document outlines aims and goals for each of the five areas and also identifies research and development priorities.

SAFE: Stroke Alliance for Europe represents a range of patient groups from across Europe whose mutual goal is to drive stroke prevention up the European political agenda [SAFE: online].

The aims and objectives of SAFE, a non-profit-making organisation, are to promote awareness and understanding of stroke, promote prevention, identify those at risk, improve access to appropriate treatment and care, improve the quality of life of people affected by stroke and their families and carers, promote better access to accurate and understandable information, increase the priority given to stroke by policy- and decision-makers and by healthcare providers, promote research on stroke and related areas, and to co-ordinate the efforts of national stroke patient groups in Europe.

Launched in May 2006, the Global Stroke Survey is the world's most comprehensive stroke survey, aiming to provide a detailed understanding of the true burden of stroke and to build a comparative picture of standards in stroke care worldwide. The survey is being conducted in 10 countries (France, Germany, Italy, Spain, the UK, Sweden, Australia, China, Canada and the USA) in a total of 2400 patients and 2400 caregivers.

Key objectives of the Global Stroke Survey are to assess the true burden of stroke, including quality of life, disability, disruption of work, impact on the individual, family, carers and the wider community, to explore the realities of living with stroke and its debilitating effects, to fully understand the hidden costs associated with stroke, to identify inequalities in acute stroke care around the world, and to fully understand the current treatments available for stroke, including limitations of current treatments, access to treatment, treatment time windows and patient/physician choice.

EUSI: the European Stroke Initiative is a joint initiative of the European Stroke Council, the European Federation of Neurological Societies and the European Neurological Society [EUSI: online]. Its major objective is to reduce the incidence and impact of stroke by changing the ways in which stroke is viewed and treated.

In recent years, EUSI has published evidence-based recommendations for the management of stroke [Hacke et al. 2003] and organised medical education activities, including summer schools and conferences. EUSI is currently conducting a survey on the availability of key stroke service components in almost 1000 hospitals throughout all EU countries.

Key points

- Urgent action is necessary to improve the treatment and care of stroke patients and to reduce the burden of stroke on individuals and society as a whole
- There is a need for new stroke treatments that are safe, effective, broadly applicable and widely available
- A modest benefit for a majority of stroke patients would be more valuable to society than a substantial benefit derived by only a few
- Several initiatives are now underway with the aim of reducing the burden of stroke worldwide

The views expressed here are those of the authors and not necessarily those of AstraZeneca or the Stroke Alliance for Europe (SAFE). This document is sponsored by an unrestricted educational grant from AstraZeneca.

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