Deloitte Access Economics

The economic impact of stroke in Australia

National Stroke Foundation

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Contents

Charts

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Tables

Figures

Glossary of acronyms

ABS	Australian Bureau of Statistics
ASU	acute stroke unit
AIHW	Australian Institute of Health and Welfare
AWE	average weekly earnings
BCR	benefit-cost ratio
BEACH	Bettering the Evaluation and Care of Health
CVD	cardiovascular disease
DALY	disability adjusted life year
DCIS	Disease Costs and Impact Study
DWL	deadweight loss
GP	general practitioner
HRQoL	health related quality of life
KYN	Know Your Numbers
MRI	magnetic resonance imaging
mRS	modified Rankin Scale
NEMESIS	North East Melbourne Stroke Incidence Study
NPV	net present value
NSF	National Stroke Foundation
OBPR	Office of Best Practice Regulation
OT	occupational therapy
PBS	Pharmaceutical Benefits Scheme
PT	physical therapy
QASC	Quality in Acute Stroke Care
SDAC	Survey of Disability, Ageing and Carers
SES	socioeconomic status
TIA	transient ischaemic attack
VSL	value of a statistical life
VSLY	value of a statistical life year
WHO	World Health Organization
WTA	willingness to accept
WTP	willingness to pay
YLD	years of healthy life lost due to disability
YLL	years of life lost due to premature death

Executive summary

Deloitte Access Economics was commissioned by the National Stroke Foundation to investigate the economic impact of stroke in Australia, and the scope for cost effective prevention and health interventions. These interventions include stroke prevention awareness campaigns and delivering timely, best practice acute care and rehabilitation to those who have suffered stroke.

Prevalence

In 2012, there were over 420,000 people living with the effects of stroke. There were about 25% more males (233,171) than females (187,099). Two thirds of these people sustained a disability that impeded their ability to carry out activities of daily living unassisted. By 2032 there will be around 709,000 Australians living with stroke, or 2.4% of the population.

Table i: Stroke prevalence by age and gender, 2012

Age	Female	Male	Total
0-39	10,596	10,639	21,236
40-44	2,932	4,825	7,757
45-49	5,056	4,982	10,038
50-54	11,009	10,662	21,671
55-59	14,793	15,016	29,809
60-64	17,098	20,681	37,779
65-69	15,620	32,962	48,582
70-74	15,570	40,238	55,808
75-79	21,993	35,086	57,080
80-84	29,781	32,270	62,051
85-89	26,484	18,148	44,631
90+	16,167	7,662	23,829
Total	**187,099**	**233,171**	**420,271**

Source: Deloitte Access Economics derived from Australian Bureau of Statistics data (ABS 2012a; 2012b).

Costs

The total financial costs of stroke in Australia were estimated to be $5 billion in 2012. The largest cost component was productivity costs ($3 billion). Health costs also present a significant cost at $881 million. Carer costs were estimated as $222 million. Because taxes both reduce income and increase the price of goods and services, the deadweight loss (DWL) of the taxation needed to pay for health services, welfare and carer support for people with stroke is also significant, at $491 million.

Largely reflecting productivity costs, individuals bear the greatest financial burden of stroke ($2.2 billion in 2012). The Federal Government bore $1.5 billion of the costs, or $3,507 per person, while State Governments bore $233 million, families and friends bore $67 million, and employers bore $407 million. As the DWL is incurred by the whole population,

together with health costs borne in the private sector the cost of stroke to the 'rest of society' was $602 million in 2012.

However, the biggest impact of stroke is not the financial costs it causes, but the loss of healthy life. Using the market-based price of risk methodology required by the Commonwealth Department of Finance and Deregulation, which estimates the disability adjusted life years (DALYs) and multiplies these by the value of a statistical life year (VSLY), the total burden of disease cost in 2012 was $49.3 billion.

Table ii: Costs of stroke in Australia, 2012 ($m)

	Individuals	Family/ Friends	Federal Govt	State Govt	Employers	Society/ Other	Total
Health system costs	161	1	376	233	0	111	881
Productivity costs	1,742	0	838	0	407	0	2,987
Carer costs	0	149	73	0	0	0	222
Other costs	388	11					398
DWL	0	0	0	0	0	491	491
Transfers	-92	-94	186	0	0	0	0
Total financial cost	**2,198**	**67**	**1,474**	**233**	**407**	**602**	**4,979**
Burden of disease	49,319	0	0	0	0	0	49,319
Total cost	**51,517**	**67**	**1,474**	**233**	**407**	**602**	**54,299**

Source: Deloitte Access Economics calculations.

Cost effective prevention and intervention

Given the substantial financial and wellbeing costs of stroke, it is important to identify cost-effective means to prevent stroke or ameliorate its disabling consequences. While those best placed people to prevent stroke are those at risk themselves, the Know Your Numbers program demonstrated that very few at risk people are aware they have high blood pressure. For an estimated cost of $5 million per annum, this program has the capacity to inform 570,000 Australians per year of their blood pressure; if those at risk acted on this information once aware and successfully reduced their blood pressure to normal levels, over 500 strokes and over 400 cases of cardiovascular heart disease could be averted each year, potentially saving some $13.6 million in financial costs. Moreover, adopting best practice acute care and rehabilitation could avert thousands of cases of stroke-induced disability. For a cost of $4.3 million per annum, the StrokeLink program could prevent over 2,047 cases of stroke induced disability annually, potentially saving $28 million in financial costs. For a cost of $3.5 million, effective support under the StrokeConnect program could enable over 1,294 stroke survivors to regain functional independence each year, for a potential saving of $16.6 million.

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1 Background

This chapter outlines the risk factors that can lead to stroke, the main types of stroke, and available treatment pathways. There is also a discussion of the medical and financial impacts that having a stroke has on Australians, and an outline of the methodologies utilised in this report to measure these effects.

1.1 Definitions

A stroke is the rapid loss of brain functions due to disturbance in the blood supply to the brain. Strokes can be classified into two major categories: ischaemic and haemorrhagic (NINDS, 2012).

- **Ischaemic stroke:** This type of stroke occurs when blood supply to the brain is blocked, for example by a blood clot. A blot clot may form somewhere in the body and travel through the blood stream to the brain (embolic), or blood vessels may narrow as a result of atheroma or small vessel disease (thrombosis, arterial embolism). Ischaemic stroke is the most common type of stroke according to the Australian Institute of Health and Welfare (AIHW, 2010).
- **Haemorrhagic stroke:** This type of stroke occurs when a blood vessel in the brain breaks or bursts and results in bleeding within the brain tissue (intracerebral haemorrhage) or in the space around the brain (subarachnoid haemorrhage).

A transient ischaemic attack (TIA) or 'mini-stroke' is a related condition which results in temporary stroke-like symptoms and is an important predictor of stroke. A TIA results from temporary blockage of blood vessels that reduce blood supply to the brain, and may last only a few minutes, with symptoms disappearing within 24 hours (AIHW, 2011). Strokes and TIAs are sometimes collectively referred to as cerebrovascular events.

A silent stroke is a stroke that does not have any outward symptoms, and the patients are typically unaware they have suffered a stroke. Those who have suffered a major stroke are at risk of having silent strokes (Miwa et al, 2010). Silent strokes typically cause lesions which are detected via the use of neuroimaging such as MRI. Silent strokes are estimated to occur at five times the rate of symptomatic strokes (Leary and Saver, 2003).

As a result of stroke, the affected area of the brain cannot function, causing neurological damage or complications such as:

- weakness or lack of movement (paralysis) in legs and/or arms;
- communication problems (i.e. trouble speaking, reading or writing);
- perceptual problems;
- sensory problems;
- cognitive problems;
- incontinence;
- depression;
- problems controlling feelings;

- pain; and
- a significantly increased risk of death.

1.2 Risk factors

Modifiable risk factors for stroke include high blood pressure, high cholesterol, cigarette smoking, poor diet and lack of exercise, being overweight, and excessive alcohol intake. Non-modifiable factors include age, gender and family history. Medical risk factors include transient ischaemic attack, atrial fibrillation, diabetes, and fibromuscular dysplasia[1].

The Australian Institute of Health and Welfare (AIHW) (Begg et al, 2007) estimated that in Australia in 2003, high blood pressure, blood cholesterol and physical inactivity were leading causes for disability and mortality burden arising from stroke (Table 1.1).

Table 1.1: Stroke deaths attributable to various risk factors, Australia, 2003

Risk factor	Deaths	DALYs
Tobacco	577	11,812
high body mass	605	7,346
poor diet	1,528	22,218
diabetes*	1,853	20,245
blood cholesterol	1,980	24,986
physical inactivity	2,390	23,742
high blood pressure	6,602	59,962

Notes *Diabetes deaths are proportional estimates from 16,260 years of life lost due to premature mortality (YLL). Risk factors cannot be summed due to comorbidities.
Source: AIHW (Begg et al, 2007) – which also estimate 432 stroke deaths due to air pollution.

Blood pressure

There is a continuous relationship between blood pressure levels and the risk of stroke. World Health Organization (WHO) and the National Heart Foundation of Australia guidelines define 'high' blood pressure as systolic pressure (at or above 140mmHg), diastolic pressure (at or above 90mmHg), or anyone receiving medication for high blood pressure. Major contributors to high blood pressure include poor diet (especially high salt intake), being overweight, excessive alcohol consumption and insufficient physical activity.

Hypertension is thought to account for around 35%-50% of stroke risk (Whisnant, 1996), with epidemiological studies suggesting that even a small blood pressure reduction (5 to 6 mmHg systolic, 2 to 3 mmHg diastolic) would result in 40% fewer strokes (Collins et al, 1990). Lowering blood pressure has been conclusively shown to prevent both ischaemic and haemorrhagic strokes, and it is equally important in secondary prevention (Gueyffier et al, 1997).

[1] http://strokefoundation.com.au/prevent-stroke/risk-factors/

High cholesterol

There is a continuous relationship between total blood cholesterol levels and the risk of ischaemic stroke, with levels over 5.5mmol/L indicating increased risk. High-density lipoprotein ('good') cholesterol helps reduce cardiovascular disease (CVD) risk, while low-density lipoprotein ('bad') cholesterol can increase risk. Cholesterol comes from two sources – the food we eat (of which only 50% of the cholesterol may be absorbed) as well that synthesised and metabolised in the body, mainly the liver, which is by far the greater amount (Thomas, 1988). High cholesterol levels have been associated with (ischaemic) stroke (Demarin et al, 2010; Demarin et al, 2011). Statins are demonstrated to reduce the risk of stroke by about 20% (Taylor, 2011; Baigent et al, 2010; Brugts et al, 2009).

Lifestyle factors

The National Physical Activity Guidelines for Australians recommend "at least 30 minutes of moderate intensity physical activity on most, preferably all, days of the week" to obtain a health benefit. Insufficient physical activity may be linked to stroke, as well as to other risk factors such as overweight and obesity, diabetes, high blood pressure and high blood cholesterol.

Dietary guidelines for Australians recommend consumption of essential nutrients from a broad range of biologically diverse food groups. High intakes of saturated fats are associated with elevated blood cholesterol levels and increased risk of stroke (Ezekowitz, 2003). High salt intake may contribute to elevated blood pressure, while poor nutrition (eg, inadequate consumption of fruits and vegetables) and excessive consumption can affect other risk factors (eg, being overweight and diabetes). Indeed, nutrition, specifically the Mediterranean-style diet, has the potential for decreasing the risk of having a stroke by more than half (Spence et al, 2006).

Alcohol use could predispose to ischaemic stroke, and intracerebral and subarachnoid haemorrhage via multiple mechanisms such as hypertension, atrial fibrillation, rebound thrombocytosis, platelet aggregation and clotting disturbances (Gorlick, 1987). High consumption of alcohol (especially binge drinking) is associated with higher blood pressure and death from stroke. Low to moderate alcohol consumption can be a protective factor, although it is not recommended for a non-drinker to commence consumption to obtain health benefits.

Comorbidities

A variety of comorbid conditions can be associated with the presentation or increased likelihood of stroke development. Patients with atrial fibrillation have a risk of 5% each year to develop stroke, and this risk is even higher in those with valvular atrial fibrillation. Patients with diabetes mellitus are two to three times more likely to develop stroke, and they commonly have hypertension and hyperlipidaemia. Intensive disease control has been shown to reduce diabetes' microvascular complications such as nephropathy and retinopathy but not its macrovascular complications such as stroke (Dormandy et al, 2005).

1.3 Morbidity and mortality

Stroke is Australia's second biggest killer after coronary (ischaemic) heart disease, and a leading cause of disability. Stroke accounts for 75% of all cerebrovascular disease related deaths (AIHW, 2011). Australian mortality rates from stroke are higher than those in many other developed countries (AIHW, 2010), suggesting that improvements can be made in prevention and intervention. However, in 2010, funding for stroke research was 3% of the total investment in medical research by the Federal Government – far less than cancer (23%) (NSF, 2012a).

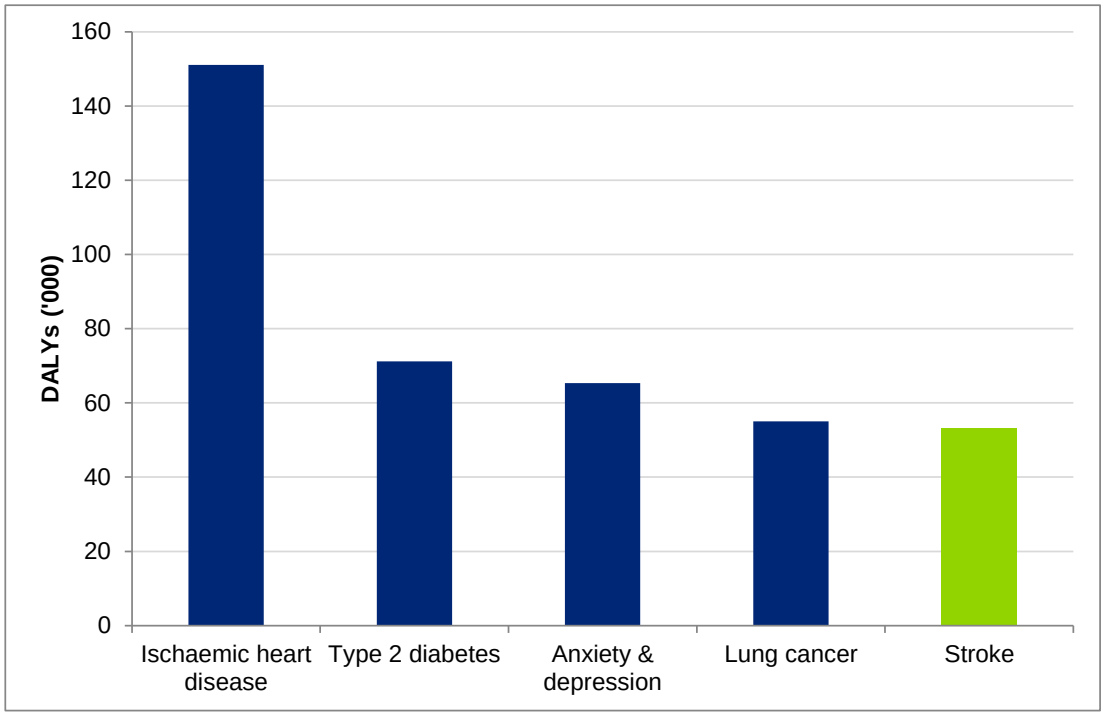
Disability affects 75% of stroke survivors enough to decrease their employability (Coffey et al, 2000). Stroke can affect patients physically, mentally and emotionally. The results of stroke vary widely depending on size and location of the lesion, with dysfunction corresponding with regions in the brain that have been damaged. Some of the physical disabilities that can result from stroke include muscle weakness, numbness, incontinence, apraxia (inability to perform learned movements), difficulties carrying out daily activities, speech loss, vision loss, and pain. If the stroke is severe enough, or in a certain location such as parts of the brainstem, coma or death can result.

Of stroke survivors, 30% suffer post-stroke depression, which is characterised by lethargy, irritability, sleep disturbances, lowered self-esteem, and withdrawal (Hackett et al, 2005). Depression can reduce motivation and worsen outcomes, but can be treated with antidepressants and or various psychological interventions.

Using the most recent AIHW data (Begg et al, 2007 – which relates to data from the year 2003), stroke is one of the main causes of death and disability in Australia. It is:

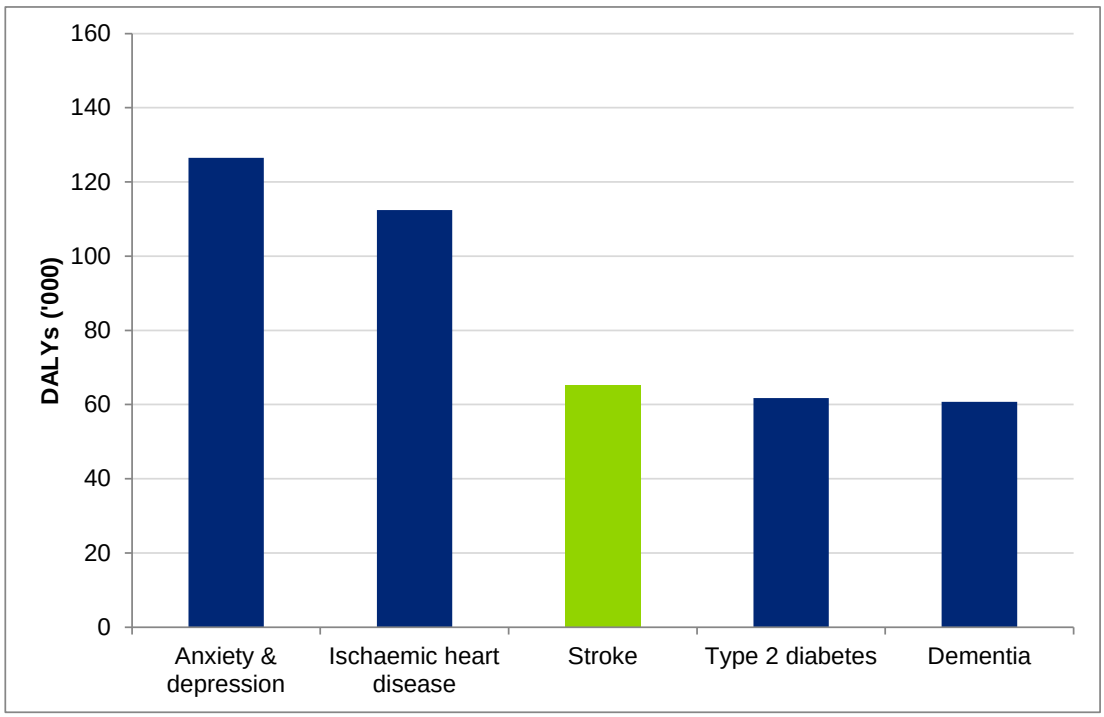
- the number five cause of combined mortality and morbidity in Australian men;
- the number four cause of fatalities in Australian men;
- the number three cause of combined mortality and morbidity in Australian women; and
- the number two cause of fatalities in Australian women.

Chart 1.1: Top five most burdensome diseases in males, Australia, 2003



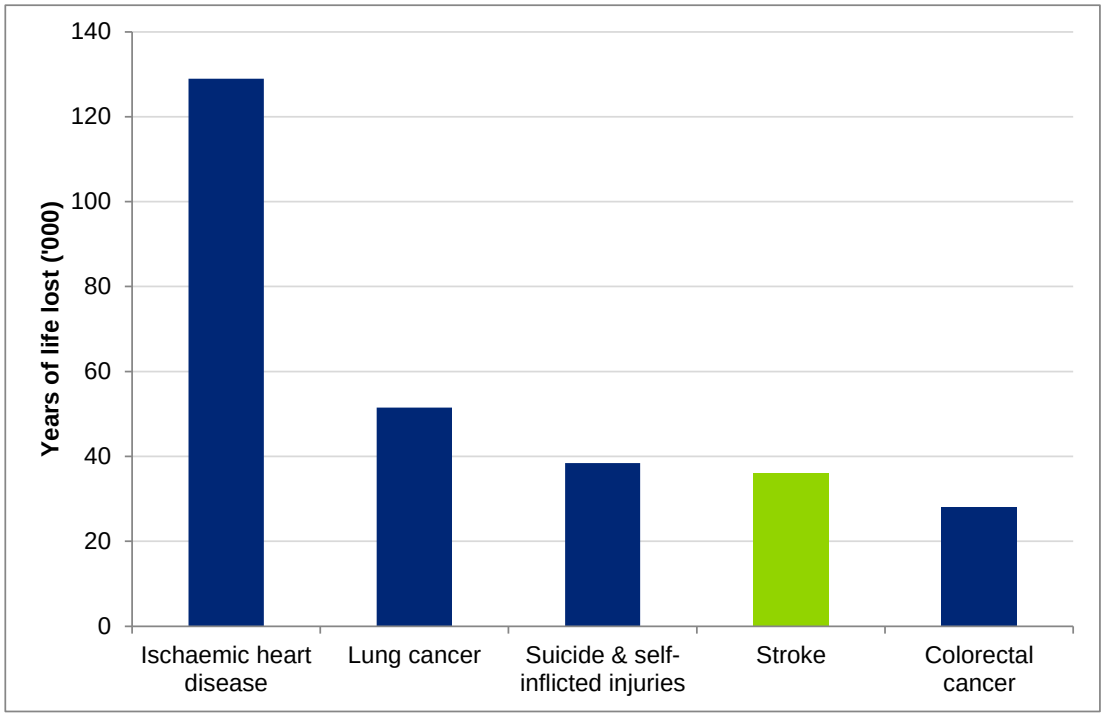
Note: DALYs = disability adjusted life years.
Source AIHW (Begg et al, 2007).

Chart 1.2: Top five most burdensome diseases in females, Australia, 2003



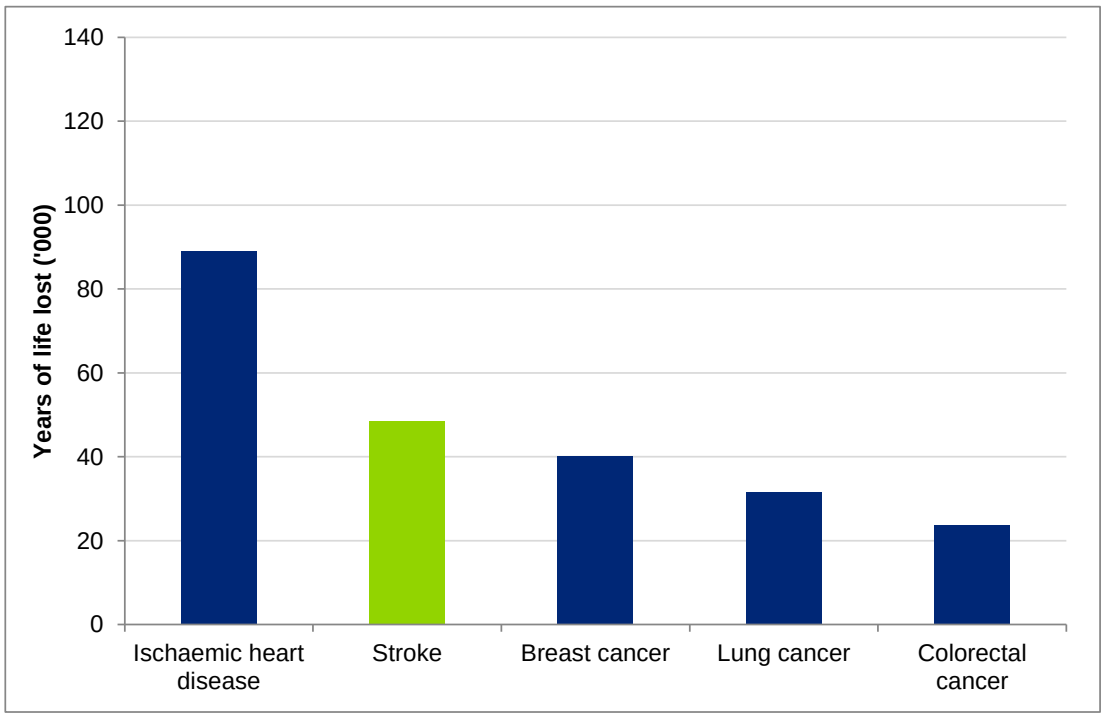
Source AIHW (Begg et al, 2007).

Chart 1.3: Top five most fatal diseases in males, Australia, 2003



Source AIHW (Begg et al, 2007).

Chart 1.4: Top five most fatal diseases in females, Australia, 2003



Source AIHW (Begg et al, 2007).

1.4 Prevention and treatment

Prevention

Given the disease burden of stroke, prevention is an important public health concern. Assessment of risk and appropriate preventative steps should be undertaken as outlined in the 'Guidelines for the management of absolute cardiovascular disease risk' (National Vascular Disease Prevention Alliance, 2012). Modifiable risk factors, such as changes in lifestyle, including diet, physical activity, smoking, obesity and excessive alcohol consumption should be addressed and these interventions should be tailored to the individual. Pharmacotherapy is not routinely recommended except for those high risk categories (as per the guidelines). Treatment can include blood pressure lowering medication, cholesterol medication, anticoagulants and antiplatelet therapy (NSF, 2010)

Early recognition

Various systems have been proposed to increase recognition of stroke by patients, relatives and emergency first responders. A systematic review looked at a number of trials to evaluate how well different physical examination findings are able to predict the presence or absence of stroke. It was found that sudden-onset face weakness, arm drift (when a person is asked to raise both arms, but involuntarily lets one arm drift downward) and abnormal speech are the findings most likely to lead to the correct identification of a case of stroke[2] (Goldstein et al, 2005). While these findings are not perfect for diagnosing stroke, their ability to be evaluated relatively rapidly and easily makes them valuable in the acute setting.

One common framework for the early recognition of stroke is FAST (face, arm, speech, and time), as advocated by the National Stroke Foundation. The use of FAST is not only advocated in Australia but also advocated by the Department of Health in the United Kingdom and the American Stroke Association (Harbison et al, 1999).

Treatment and long term care

As noted by the Clinical Guidelines for Stroke Management (NSF, 2010) "the central aspect of stroke recovery is the provision of a coordinated program by a specialised, multidisciplinary team of health professionals." Intervention may include early rehabilitation, thrombolysis, neurointervention, antithrombotic therapy, acute phase blood pressure lowering therapy, surgery and various targeted forms of management. These interventions will be dependent on the condition of the stroke and patient.

People who have had a stroke should be admitted to a stroke unit, which is a ward or dedicated area in hospital staffed by a team of health professionals including doctors, nurses and therapists with experience in stroke treatment. It has been shown that people admitted to a stroke unit have a higher chance of surviving than those admitted elsewhere in hospital (Stroke Unit Trialists' Collaboration, 2007).

[2] This includes a likelihood ratio of 5.5 when at least one of these phenotypes is present.

When an acute stroke is suspected by history and physical examination, the goal of early assessment is to determine the cause. Treatment varies according to the underlying cause of the stroke, thromboembolic (ischaemic) or haemorrhagic. A non-contrast computed tomography head scan can rapidly identify a haemorrhagic stroke by imaging bleeding in or around the brain. If no bleeding is seen, a presumptive diagnosis of ischaemic stroke is made, which is caused by a thrombus (blood clot) occluding blood flow to an artery supplying the brain. Therapy is aimed at removing the blockage by breaking the clot down (thrombolysis), or by removing it mechanically (thrombectomy). The more rapidly blood flow is restored to the brain, the fewer brain cells die. Other medical therapies are aimed at minimising clot enlargement or preventing new clots from forming. To this end, treatment with aspirin may be given to prevent platelets from clotting.

People with intracerebral haemorrhage require neurosurgical evaluation to detect and treat the cause of the bleeding, although many may not need surgery. Anticoagulants and antithrombotics, key in treating ischaemic stroke, can make bleeding worse and cannot be used in intracerebral haemorrhage. Patients are monitored for changes in the level of consciousness, and their blood pressure, blood sugar, and oxygenation are kept at optimum levels.

Stroke rehabilitation is the process by which patients with disabling strokes undergo treatment to help them return to normal life as much as possible by regaining and relearning the skills of everyday living. It also aims to help the survivor understand and adapt to difficulties, prevent secondary complications and educate carers to play a supporting role. It is a holistic process that should begin on the first day a stroke occurs and should be structured to provide as much practice as possible within the first six months after stroke (NSF, 2010).

A rehabilitation team is usually multidisciplinary as it involves staff with different skills working together to help the patient. These potentially include dieticians, doctors, general ward staff, nurses, occupational therapists, ophthalmologists, orthotists, pathologists, pharmacists, podiatrists, physiotherapists, psychiatrists, psychologists, recreation therapists, therapy assistants, social workers and speech therapists (NSF, 2010). Rehabilitation specific to each patient and condition is required, for example for:

- dysphagia [3];
- weakness;
- loss of sensation;
- visual field loss;
- physical activity – sitting, standing up, standing, walking, upper limb activity;
- activities of daily living – both personal (self-maintenance tasks) and extended (domestic and community tasks);
- communication – aphasia, dyspraxia[4] of speech, dysarthria[5], cognitive communication deficits); and

[3] Difficulty in swallowing

[4] Motor planning disorder, abnormal or difficulty with

[5] Motor speech disorder resulting from neurological injury of the motor component of the motor-speech system

- cognition – attention and concentration, memory, executive functions, limb apraxia[6], agnosia[7], and neglect.

Early and constant intervention is recommended. Patients should be mobilised as early and as frequently as possible. For patients undergoing active rehabilitation, as much physical therapy (physiotherapy and occupation therapy) and therapy for dysphagia or communication difficulties (tailored to each patient as required) should be provided as they can tolerate (NSF, 2010).

[6] Motor planning disorder, inability to execute or carry out

[7] Loss of ability to recognise and identify objects or persons

2 Incidence and prevalence

Prevalence is the 'stock' of a condition in a population in a given period (in this study, people living after a stroke and with its impacts in 2012), while incidence reflects the 'flow' into the population over a period (new cases of stroke in 2012).

This analysis has used a (one year) prevalence approach for estimating the costs of stroke, as the data sources generally lend themselves to this approach. It also avoids uncertainty surrounding estimates of future treatment costs under an incidence approach. However, where costs are reliant on incidence, incident cases have also been utilised.

WHO (2004) concludes from global evidence that the incidence of stroke increases exponentially from 30 years of age, and advanced age is one of the most significant stroke risk factors. In 2004, stroke was the second leading cause of death in the western world, ranking after heart disease and before cancer, and causing 10% of deaths worldwide (WHO, 2004). A person's risk of dying if he or she has a stroke also increases with age. However, stroke can occur at any age, including in childhood.

According to the United States National Institute of Neurological Disorders and Stroke (1999), men are 25% more likely to suffer strokes than women, yet 60% of deaths from stroke occur in women. Since women live longer, they are older on average when they have a stroke and thus die more often than men on average.

More than 1,000 Australians sustain a stroke every week, of whom 40% die within 12 months and 50% of survivors become dependent on carers (NSF, 2012a). Stroke affects many working age Australians, with 20% of strokes occurring in Australians under 60 (AIHW, 2012a). Mortality rates in this group have not declined as strongly as overall rates (AIHW, 2010).

Unlike many other conditions, stroke is more prevalent in urban rather than regional/remote areas and in high rather than low socioeconomic areas (Table 2.1).

Table 2.1: Variance in stroke prevalence by social and geographic factors

Socio-economic status (SES)	% of DALYs	Region	% of DALYs
Low SES areas	4.0%	Remote	2.8%
Medium SES areas	4.6%	Regional	4.2%
High SES areas	4.9%	Urban	4.6%

Source: AIHW (Begg et al, 2007).

2.1 Incidence of stroke in Australia, 2012

The incidence of stroke was calculated by applying the proportions reported by NEMESIS to 2012 Australia demographic data. This assumes there has been no change to the rate of incidence since NEMESIS. NEMESIS defined stroke according to the WHO definition, as 'rapidly, developing clinical signs of focal (or global) disturbance of cerebral function lasting

more than 24 hours (unless interrupted by surgery or death) with no apparent cause other than of vascular origin' (Thrift et al, 2009). Therefore transient ischemic attacks less than 24 hours and silent strokes are not measured in this report. Thrift et al (2012), noted that reduced hospital separations for stroke indicates a potential 2.15% reduction in the incidence rate observed by NEMESIS between the years of 1996-97 and 2005-06. Incidence calculations have been adjusted accordingly. These estimates indicate that 25,831 males and 23,235 females would have had a stroke in 2012. Age gender breakdowns are in Table 2.2.

Table 2.2: Stroke incidence by age and gender, 2012

Age	Male	% of age-gender group	Female	% of age-gender group	Total	% of age group
0-14	11	0.001%	11	0.001%	22	0.001%
15–24	22	0.001%	82	0.01%	104	0.003%
25–34	179	0.01%	158	0.01%	337	0.01%
35–44	267	0.02%	453	0.03%	720	0.02%
45–54	667	0.04%	914	0.06%	1,581	0.05%
55–64	2,897	0.22%	1,472	0.11%	4,369	0.17%
65–74	5,741	0.65%	4,351	0.48%	10,092	0.56%
75–84	9,128	1.96%	6,103	1.09%	15,231	1.48%
>85	6,920	4.47%	9,690	3.41%	16,610	3.79%
Total	**25,831**	**0.23%**	**23,235**	**0.20%**	**49,067**	**0.22%**

Source: NEMESIS (Thrift et al, 2009), Thrift et al, 2012 Deloitte Access Economics calculations.

2.2 Prevalence of stroke in Australia, 2012

The fourth Survey of Disability, Ageing and Carers (SDAC) conducted by the Australian Bureau of Statistics (ABS) released in September 2012 provides detailed information on the self-reported prevalence of a variety of disabilities, including stroke. These data are provided with breakdowns by gender and age (ABS, 2012a). The AIHW also uses the SDAC to quantify the prevalence of stroke in Australia (AIHW, 2012b). While SDAC data may understate the prevalence of silent strokes where people may be unaware of the stroke, in general these are likely to occur after a known stroke so the underestimation is likely to be minor. Another weakness of self-reported data is that some people who have had TIAs may report these as strokes while others may not.

Table 2.3 and Table 2.4 show that 1.77% of the Australian population (420,271 people) were living with stroke, in 2012 – and nearly one in six Australians over 85 years (15.6%). The number of males living with stroke (233,171) was 25% higher than the number of females (187,099). Most people (65%) living with stroke also suffered disability that impeded their ability to carry out activities of daily living unassisted.

Table 2.3: Stroke prevalence rates by age and gender, with and without disability (% of total)

Age group	Female			Male			Total		
	No disability	With disability*	Total	No disability	With disability	Total	No disability	With disability	Total
0-39	0.06	0.12	0.18	0.07	0.13	0.20	0.07	0.12	0.19
40-44	0.06	0.30	0.35	0.21	0.39	0.60	0.13	0.34	0.47
45-49	0.25	0.40	0.65	0.11	0.54	0.65	0.18	0.47	0.65
50-54	0.54	0.89	1.44	0.45	0.97	1.42	0.50	0.93	1.43
55-59	0.49	1.64	2.13	0.93	1.28	2.20	0.71	1.46	2.17
60-64	0.57	2.15	2.71	1.18	2.17	3.35	0.87	2.16	3.03
65-69	0.90	2.11	3.02	2.14	4.32	6.45	1.51	3.20	4.71
70-74	0.96	3.03	3.98	3.86	7.03	10.89	2.36	4.95	7.31
75-79	2.20	4.93	7.12	4.29	8.71	12.99	3.17	6.68	9.84
80-84	3.72	8.02	11.75	6.47	10.00	16.47	4.92	8.88	13.80
85+	6.92	8.11	15.03	8.42	8.25	16.67	7.41	8.15	15.56
Average	**0.53**	**1.06**	**1.59**	**0.71**	**1.23**	**1.94**	**0.62**	**1.15**	**1.77**

Source: Deloitte Access Economics derived from ABS (2012a). Self-reported data. Disability described by restriction in every day activity due to long term stroke effects.

Table 2.4: Stroke prevalence by age and gender, with and without disability, 2012 (cases)

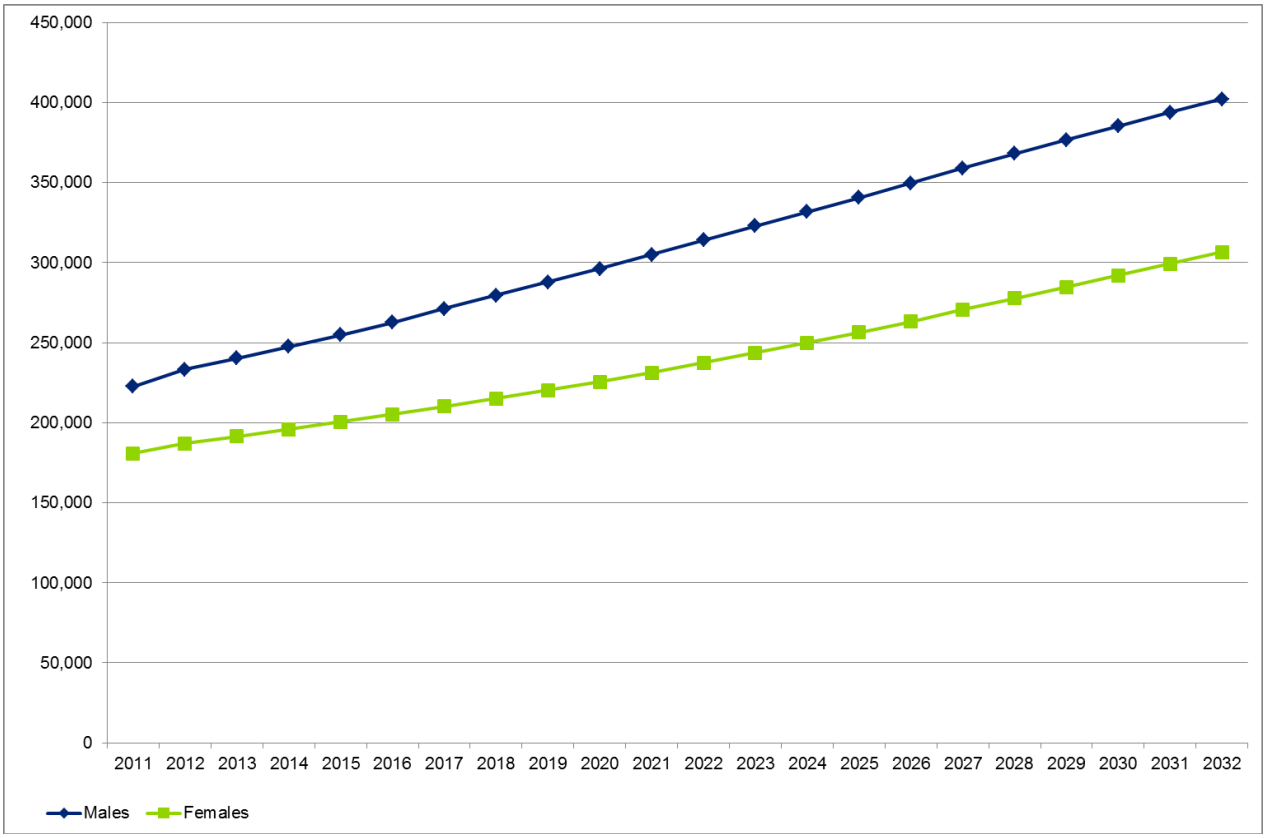
Age	Female			Male			Total		
	No disability	Disability*	Total	No disability	Disability	Total	No disability	Disability	Total
0-39	3,549	7,047	10,596	3,826	6,813	10,639	7,375	13,859	21,235
40-44	486	2,446	2,932	1,687	3,137	4,825	2,174	5,584	7,757
45-49	1,944	3,112	5,056	841	4,141	4,982	2,784	7,254	10,038
50-54	4,156	6,853	11,009	3,377	7,285	10,662	7,534	14,138	21,671
55-59	3,401	11,392	14,793	6,318	8,698	15,016	9,719	20,090	29,809
60-64	3,581	13,517	17,098	7,283	13,397	20,681	10,864	26,915	37,779
65-69	4,669	10,951	15,620	10,918	22,044	32,962	15,587	32,995	48,582
70-74	3,744	11,826	15,570	14,261	25,977	40,238	18,006	37,803	55,808
75-79	6,785	15,209	21,993	11,577	23,509	35,086	18,362	38,718	57,080
80-84	9,435	20,346	29,781	12,676	19,594	32,270	22,111	39,940	62,051
85-89	12,193	14,291	26,484	9,167	8,981	18,148	21,360	23,272	44,631
90+	7,443	8,724	16,167	3,870	3,792	7,662	11,313	12,516	23,829
Total	**61,386**	**125,713**	**187,099**	**85,802**	**147,369**	**233,171**	**147,189**	**273,082**	**420,271**

Source: Deloitte Access Economics derived from ABS (2012a; 2012b). Self-reported data. Disability described by restriction in every day activity due to long term stroke effects.

2.3 Projections of stroke prevalence in Australia

Modelling future prevalence is difficult given the complex interplay between the ageing population, improvements in treatment and changes to the risk factor profile of Australians. On current demographic ageing trends, there will be around 709,000 Australians living with stroke, or 2.4% of the population, by 2032. Chart 2.1 shows estimated trends for stroke. While hospital separations have decreased 16% from 1999-00 to 2009-10, between the 2003 and 2009 SDACs there has been very little change in age-standardised prevalence rates, so a 'no change' assumption was used in the projections (AIHW, 2012b).

Chart 2.1: Projected prevalence of stroke by gender, 2011-2032



2.4 Mortality from stroke in Australia

Relative risk of mortality was derived from AIHW data (Begg et al, 2007). For each age-gender cohort, the percentage of the population who had stroke and died from it was compared to the percentage of the population who did not have stroke but died from other causes. The difference between the two percentages is the relative risk of death from stroke. (It is necessary to only use deaths from stroke, rather than all deaths in the stroke population, as many stroke survivors will eventually die from other causes, particularly in the older cohorts). Noting that the mortality rates from stroke have continued to decrease, these ratios are then applied to the 2010 total stroke mortality estimates provided by the ABS (2012d) and projected for the 2012 population to estimate current deaths. (While the

age and gender distribution of the population changes over time, the relative mortality risks within each cohort are assumed to remain constant over time in the model). On this basis, it is estimated that stroke caused 11,791 deaths in 2012.

Table 2.5: Stroke mortality 2012

Age	Male	Female	Total
0-34	11	9	21
35-39	5	3	7
40-44	11	5	16
45-49	17	13	31
50-54	32	18	50
55-59	57	17	74
60-64	74	45	118
65-69	172	77	249
70-74	397	170	567
75-79	819	516	1,336
80-84	1,322	1,603	2,925
85-89	1,374	2,452	3,826
90+	702	1,870	2,571
Total	**4,992**	**6,799**	**11,791**

Source: AIHW (Begg et al, 2007), Deloitte Access Economics calculations.

3 Financial costs

Conceptual issues relating to the classification of stroke costs include the following:

- Direct and indirect costs: Although literature often distinguishes between direct and indirect costs, the usefulness of this distinction is dubious, as the specific costs included in each category vary between different studies, making comparisons of results somewhat difficult. This report refers to health system expenditures as direct costs and other financial costs as indirect costs.
- Real and transfer costs: Real costs use up real resources, such as capital or labour, or reduce the economy's overall capacity to produce (or consume) goods and services. Transfer payments involve payments from one economic agent to another that do not use up real resources. For example, if a person loses their job, as well as the real production lost there is also less income taxation, where the latter is a transfer from an individual to the government. This important economic distinction is crucial in avoiding double-counting.
- Financial and non-financial costs: Financial costs encompass loss of goods and services that have a price in the market or that can be assigned an approximate price with some certainty. 'Non-financial' costs include the loss of wellbeing of a person. Greater uncertainty tends to surround the valuation of non-financial costs, so results should be presented and interpreted cautiously.

There are five types of costs calculated:

1. Health system expenditure (Section 3.1) comprises the costs of running hospitals, general practitioner (GP) and specialist services reimbursed through Medicare and private funds, the cost of pharmaceuticals funded through the Pharmaceutical Benefits Scheme (PBS) and privately and including over-the-counter medications, allied health services, research and 'other' direct costs (such as health administration).
2. Productivity costs (Section 3.2.1) include the person's productivity losses (temporary absenteeism, long-term employment impacts and unpaid work), premature mortality and the value of informal care.
3. Other financial costs (Section 3.2) include all other government and non-government programs and out-of-pocket expenses (such as formal care, aids, transport and accommodation costs associated with receiving treatment) and the bring-forward of funeral costs.
4. Transfer costs (Section 3.2.4) comprise the deadweight losses (DWLs) associated with government transfers, such as taxation revenue forgone, welfare and disability payments[8].
5. Non-financial costs (Section 4) include the pain, suffering and premature death that result from stroke. Although more difficult to measure, these can be analysed in

[8] Transfer payments represent a shift of resources from one economic entity to another. As the act of taxation and redistribution creates distortions and inefficiencies in the economy, so transfers also involve real net costs to the economy. Welfare and disability payments are the additional payments resulting from stroke.

terms of years of healthy life lost, and in dollar terms (known as the burden of disease).

This report also categorises stroke costs by bearer as well as by type. It is important to understand how costs are shared in order to make informed decisions regarding interventions. From the employer's perspective, depending on the impact of stroke, work loss or absenteeism will lead to costs such as higher wage costs in the short term (i.e. accessing skilled replacement labour or overtime) or alternatively lost production, idle assets and other non-wage costs. Employers might also face costs such as rehiring, retraining and workers' compensation.

While it may be convenient to think of these costs as being purely borne by the employer, in reality they may eventually be passed on to end consumers in the form of higher prices for goods and services. Similarly, for the costs associated with the health system and community services provided to the person, although the government meets this cost, taxpayers (society) are the ultimate source of funds. However, for the purpose of this analysis, a 'who writes the cheque' approach is adopted, falling short of delving into second round or longer term dynamic impacts. Society bears both the resource cost of providing services to people, and also the DWLs (or reduced economic efficiency) associated with the need to raise additional taxation to fund the provision of services and income support.

Typically six groups who bear costs and pay or receive transfer payments are identified:

- people with stroke;
- friends and family (including informal carers);
- employers;
- Australian government;
- state and local governments; and
- the rest of society (non-government, i.e. not-for-profit organisations, workers' compensation groups, private health insurance funds and others).

Classifying the six cost categories and five groups enables a framework for analysis, as shown in Table 3.1.

Table 3.1: Costs associated with stroke by type and bearer – conceptual framework

Conceptual group	Subgroups	Bearers of cost	Comments
Burden of disease	Years of life lost due to disability (YLD) Years of life lost due to premature death (YLL)	Person*	The value of a statistical life year (VSLY) excludes costs borne by the individual that are counted elsewhere, to avoid double counting.
Health system costs	Costs by type of service eg, hospitals, out-of-hospital medical services and pharmaceuticals, allied health, pathology and imaging, etc.	Person*, governments, and society (private health insurers, workers' compensation)	Measured top-down by the AIHW
Productivity costs	Lost productivity from temporary absenteeism (time off work)	Person, employer and government#	Absenteeism is that in excess of average absenteeism
	Employment participation	Person and government#	Includes premature retirement
	Premature death	Person and government#	Loss of productive capacity i.e. the stream of future earnings
	Additional search and hiring replacement	Employer	Incurred when people prematurely leave jobs
	Lost unpaid work of person	Person	Includes housework, yardwork, childcare and volunteer work
	Lost informal carer productivity	Friends and family, and government#	Measured as the opportunity costs of paid work by carers
Other financial costs	Cost of care, aids, equipment, modifications, etc	Person, government and society	Includes aids, equipment and home modifications, alternative and herbal medications, transport costs, private domestic assistance, and miscellaneous out-of-pocket costs not included in other cost categories.
	Funeral costs brought forward	Friends and family	
Transfer costs	DWL	Society	Relate to transfers from taxation, welfare etc

* Friends/family may also bear loss of wellbeing, health costs and lower living standards as a result of the individual's stroke; however, care is needed to assess the extent to which these are measurable, additional (to avoid double counting) and not follow-on impacts. For example, a spouse may pay a medical bill and children may share in lower household income if the person's work hours are reduced – but as this is simply redistribution within family income it is not measured here.

Where earnings are lost, so is taxation revenue and frequently also there are other transfers, such as workers' compensation or welfare payments for disability/sickness/caring etc, so federal and state/territory governments share the burden.

There are essentially two ways of estimating each element of cost for each group:

- top-down: data are available for the total costs in a category (e.g. health system); or

- bottom-up: data may provide estimates of the number of cases in the category ('n') and the average cost for that category; the product is the total cost (e.g. the wage rate for lost earnings multiplied by the reduction in the number of people employed).

It is generally more desirable to use top-down national datasets in order to derive national cost estimates to ensure that the whole is not greater or less than the sum of the parts. On the other hand, it is often difficult to obtain top-down estimates. In this report the top-down approach is applicable to health system and burden of disease costs and the bottom-up approach applies in most other cases.

- Data on health system costs and burden of disease are derived from the AIHW, which in turn are based on other data sources, such as the Australian Hospital Statistics and Bettering the Evaluation and Care of Health (BEACH) data for GP costs.
- Data on other financial costs are drawn from a variety of sources, for example the ABS SDAC 2009.

3.1 Health system expenditure

3.1.1 Methodology

Estimates for direct health system costs are derived in Australia by the AIHW from an extensive process developed in collaboration with the National Centre for Health Program Evaluation for the Disease Costs and Impact Study (DCIS). The approach measures health services utilisation and expenditure (private and public) for specific diseases and disease groups in Australia. The DCIS methodology has been gradually refined over the 1990s to now estimate a range of direct health costs from hospital morbidity data, case mix data, BEACH data, the National Health Survey (NHS) and other sources. AIHW (2012b) provides a summary of the main results of estimates of health expenditures by disease and injury for the year 2009-10. The advantage of a top-down methodology is that cost estimates across diseases will be consistent, enhancing comparisons and ensuring that the sum of expenditure on particular conditions does not exceed total health expenditure in Australia.

The AIHW data used here, obtained through a special data request, include hospital expenditures (including admitted and non-admitted patients), out-of-hospital expenditure (including GP services and other medical specialists, imaging and pathology), pharmaceutical costs (prescription and over-the-counter) and other costs (including other health professionals and research) in 2008-09 (AIHW, 2009).

The proportions of health costs borne by each party are based on 2008-09 AIHW data on payers for health system costs by sector (hospital, out of hospital, pharmaceutical and other costs). These data were inflated to current 2012 prices by using health inflation indices (AIHW, 2012c).

3.1.2 Cost calculations

AIHW (2009a) allocated health expenditure on stroke per head of population, by age and gender (Table 3.2), was calculated by dividing the AIHW's total health expenditure by the prevalence of stroke in 2008-09. This expenditure per person is updated for health inflation.

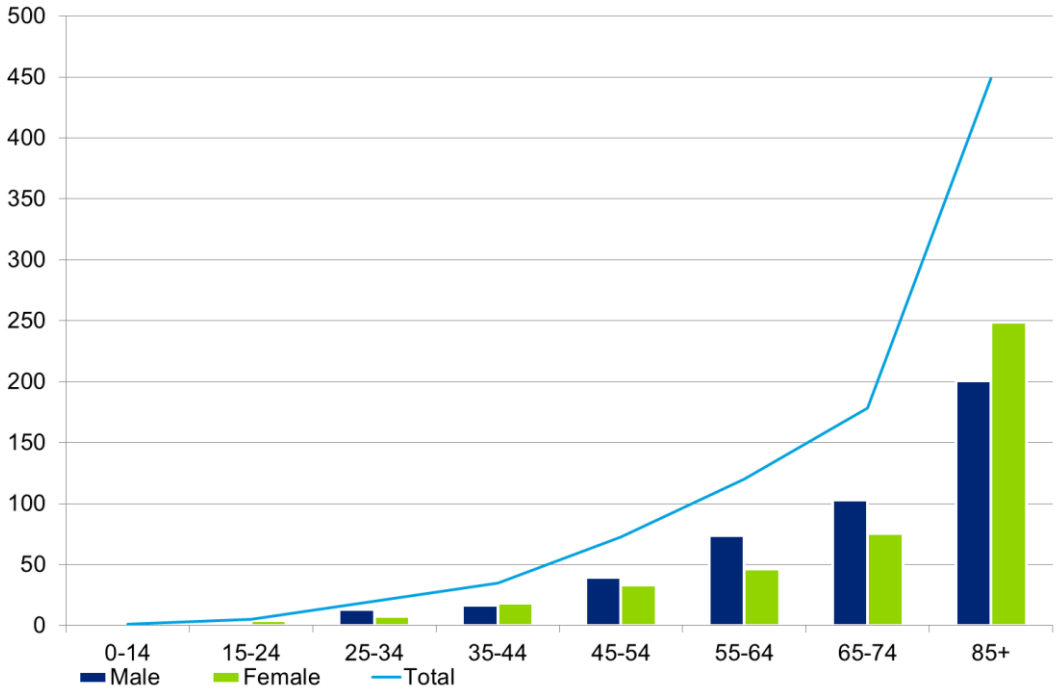
Table 3.2: Allocated stroke expenditure per person by age and sex, 2012 ($'000)

	0-4	5-14	15-24	25-34	35-44	45-54	55-64	65-74	75-84	85+
Males	2.97	7.32	0.48	2.35	14.15	33.88	63.43	88.42	116.32	55.89
Females	0.66	3.27	2.11	3.67	15.70	28.30	39.67	64.77	116.42	97.10

Note: Prices inflated to 2012 dollars from 2008-09 dollars.
Source: AIHW (2009a).

The AIHW cost data in Table 3.2 are then multiplied by the number of people in each age and gender cohort to ascertain total expenditure on stroke. However, the AIHW includes only 87.5% of total recurrent health expenditure in their estimates of expenditure by disease and injury, referred to as 'allocated' health expenditure. The 'unallocated' remainder (12.5%) includes capital expenditures, expenditure on community health, public health programs, health administration and health aids and appliances. Thus as a final step, allocated health expenditure is factored up by (1/0.875)-1 or 14.3% to obtain **total stroke health system expenditure of $881 million in 2012** (Chart 3.1, Table 3.3).

Chart 3.1: Total stroke health expenditure by age cohort, $ million, 2008-09 (2012$)



Source: AIHW (2009; 2012c), ABS (2012b) and Deloitte Access Economics calculations.

The AIHW (2012c) reports that total health expenditure paid by the Australian government is 42.7% of the total. State, territory and local governments contribute 26.4%, and individuals (with family and friends) finance 18.3%. Thus, health system costs of stroke for Australians are largely borne by the Australian government ($376 million) and state, territory and local governments ($233 million). Individuals contribute $161 million, while others in society fund the remaining $111 million.

Table 3.3: Stroke health system expenditure by bearer, 2012

Health expenditure	$ million	% of total
Individuals	161	18.3
Federal government	376	42.7
State/territory governments	233	26.4
Others in society	111	12.6
Total	**881**	**100.0%**

Source: AIHW (2009; 2012c), ABS (2012b) and Deloitte Access Economics calculations.

3.2 Other financial costs

As well as direct costs to the health system from stroke, there are a range of indirect costs such as productivity losses for people who have a stroke who were working, and the cost of providing care for people living with stroke.

Productivity losses occur when a person does not work due to ill-health. The productivity loss is the value of the lost production including any premium that has to be paid to a replacement worker (eg, overtime), as well staff turnover costs and retraining in the event that worker is unable to work for an extended period. Different elements of these costs are borne by:

- the employer – sick leave, the overtime premium for the replacement worker, staff turnover costs and employer 'excess' contributions to compensation payouts if the stroke was work-related;
- the worker – reduced income after tax, which may be partially offset by disability or compensation payments;
- government – reduced taxation receipts and higher welfare payments (e.g. Disability Support Pension, Sickness Allowance); and
- society – e.g. compensation payments.

Other financial costs include items such as:

- **carer costs** – people who are unwell may require others to care for their needs and this care often does not enter into health system expenditure – for example, an informal (unpaid) family carer assisting with personal care or taking someone to appointments, or a formal sector (paid) carer coming in to perform household tasks;
- **aids and home modifications** not included in health system expenditure that the person may need to purchase as a result of the stroke, as well as **funeral costs** brought forward associated with premature mortality; and
- **DWLs** – the redistribution of public sector resources to care for the sick person incurs deadweight costs on society, such as the need to raise additional tax revenues (see Figure 3.1). The revenue itself is a transfer payment, not a real economic cost, but for every dollar of tax raised, about 28.75 cents is absorbed in the distortions induced and the administration of the tax system. Tax revenue is also required to finance welfare and disability payments in a budget-neutral setting (since long term fiscal deficits for consumption are unsustainable).

3.2.1 Productivity costs

Productivity losses are the cost of production that is lost when people with stroke are unable to work because of the condition. They may work less than they otherwise would – either being employed less, being absent more often or being less productive while at work (presenteeism), or they may die prematurely. Data for productivity costs were obtained from numerous sources, with attribution across short term and long term impacts of stroke.

Short term impacts of stroke were measured using a friction methodology and largely comprise absenteeism costs. The friction methodology measures the cost from the employer's perspective to sustain production until an employee who has a stroke returns to work or is replaced (e.g. sick leave and overtime premiums for a temporary replacement worker). Short term absenteeism was determined using data on acute hospitalisation following stroke drawn from the AIHW national hospital morbidity database (AIHW, 2012c) and average length of stay estimates for CVD (AIHW, 2011), as well as estimates by Dewey and colleagues (2001) of the additional time to attend GP and specialist visits for stroke post-hospital care.

As is appropriate in developed countries, a human capital approach was adopted to measure long term productivity losses. The human capital approach, opposed to the friction method, measures the cost to society of a contraction in the production possibility frontier due to lower labour inputs overall. Key parameter inputs (the change in employment participation and productivity or presenteeism following a stroke), were determined through a review of available literature (especially Goetzel et al 2004; Hannerz et al, 2011).

3.2.1.1 Employment participation

If employment rates are lower for people with stroke after accounting for other factors such as age and gender, this loss in productivity represents a real cost to the economy. The employment rate is calculated by dividing the number of employed people by the total number of people in each age-gender group. This calculation can be made for people with stroke and then compared with the employment rates for people without stroke in corresponding age-gender groups. The difference (or excess) between the two groups can then be attributed to stroke and its risk factors and impacts.

Data from Hannerz and colleagues (2011) indicated that 62.1% of working age people recovering from stroke were gainfully employed, compared to 79.1% of the working age population in Australia without stroke (ABS, 2012c) – a 17% difference. Data on employment rates and average weekly earnings (AWE) for each respective age gender group were combined to calculate the lost earnings due to reduced employment.

The cost of lost earnings due to reduced employment from stroke was estimated as $975 million in 2012 for people of working age.

This result is consistent with the epidemiology of stroke – in that it can be a debilitating condition significantly reducing a person's ability to participate in employment.

3.2.1.2 Absenteeism from paid and unpaid work

For people with stroke who are employed, the condition can adversely affect work performance through absence from work. Such absenteeism is measured by looking at the number of work days missed by people with stroke over a 12 month period.

According to Dewey and colleagues (2001) and AIHW datasets (2011; 2012c), people recovering from stroke took an average of 26 more days away from work per year compared to their counterparts without stroke. The same number of days is estimated to be lost, for those who do not work, from their household productivity, which is valued at 30% of the average wage rate.

Based on these parameters and AWE for each age-gender group, the cost of absenteeism and lost home production due to stroke was estimated as $1.14 billion in 2012 for people of a working age. This includes around $1.05 billion due to absenteeism for people in paid work and around $0.09 billion in lost household productivity for those in unpaid work.

3.2.1.3 Presenteeism

Stroke can also affect a person's ability to function effectively while at work, for the same reasons as it contributes to absenteeism and lower employment participation. Presenteeism can be estimated by multiplying the number of days worked with stroke by the percentage reduction in effectiveness on days worked with stroke.

A meta-analysis by Goetzel et al (2004) of presenteeism studies in the United States found that workers with heart disease averaged 13.5% lower productivity than their counterparts. Using this reduction in productivity while at work and the AWE for each age-gender group, the lost work effectiveness was calculated.

The cost of 'presenteeism' (lower productivity while at work) due to stroke was estimated as $0.7 billion in 2012 for people of working age.

3.2.1.4 Premature death

From the calculations in Section 2.4, there were an estimated 11,791 deaths due to stroke in 2012 (4,992 males and 6,799 females). Based on the age-gender distribution of these deaths, and incorporating employment rates and estimates of average lifetime earnings for different age-gender groups, the present value of lost earnings due to premature mortality among those who would otherwise have been employed can be estimated.

The cost of lost productivity from premature death due to stroke was estimated as $0.2 billion in 2012 for people of all ages.

The predominant prevalence of stroke deaths in older age groups, where employment rates and potential loss of lifetime earnings is low, explains the lower cost of this element.

Premature death also leads to additional search and hiring costs for replacement workers. These are estimated as the number of people with stroke (by age and gender) who die prematurely, multiplied by the chance of being employed (if they did not die), multiplied by the search and hiring cost brought forward three years. The search and hiring cost is

estimated as 26 weeks[9] at AWE and the three year bring forward reflects average staff turnover rates in Australia.

In 2012, additional search and hiring costs are estimated at $0.43 million for people with stroke of working age.

3.2.1.5 Lost taxation revenue from lower productivity

Reduced earnings due to reduced workforce participation, absenteeism and premature death also have an effect on taxation revenue collected by the government. As well as forgone income (personal) taxation, there will also be a fall in indirect (consumption) tax, as those with lower incomes spend less on the consumption of goods and services.

There are two sources of lost tax revenue that result from the lower earnings – the personal income tax forgone and the indirect (consumption) tax forgone. The latter is lost because, as income falls, so does consumption of goods and services. The average personal income tax rate used is 21.8% and the average indirect taxation rate used is 11.1%, based on parameters for 2012 from the Deloitte Access Economics macroeconomic model.

Around $1 billion in potential tax revenue is estimated to be lost in 2012, due to the reduced productivity of people with stroke.

Lost taxation revenue is considered a transfer payment, rather than an economic cost per se. However, raising additional taxation revenue to replace these losses does impose real efficiency costs on the Australian economy, known as deadweight losses (DWLs). Administration of the taxation system costs around 1.25% of revenue raised (derived from total amounts spent and revenue raised in 2000-01, relative to Australian Government department running costs). Even larger DWLs arise from the distortionary impact of taxes on workers' work and consumption choices. These distortionary impacts are estimated to be 27.5% of each tax dollar collected (Lattimore, 1997 and used in Productivity Commission, 2003:6.15-6.16, with rationale). Altogether the DWL is 28.75% of the value of the taxation forgone.

Around $262 million in DWL was incurred in 2012 from the additional taxation required to replace that forgone due to lost productivity of people with stroke (Table 3.4).

[9] Literature estimates of search and hiring costs range from 26 to 104 weeks' salary, covering recruitment, training and lose business costs. See for example:

http://www.safeworkaustralia.gov.au/sites/SWA/about/Publications/Documents/660/Cost%20of%20Work-related%20injury%20and%20disease.pdf and
http://www.dol.govt.nz/publications/nohsac/techreport4/025_content.asp

Table 3.4: Lost earnings and taxation due to stroke, 2012

Component	$ million
Potential earnings lost ($million)	2,987
Average personal income tax rate*	21.80%
Potential personal income tax lost	604
Average indirect tax rate*	11.11%
Average indirect tax lost	308
Total potential tax revenue lost	911
Deadweight loss from additional taxation	**262**

Note: absenteeism from unpaid work does not reduce tax revenue.
Source: * Deloitte Access Economics macroeconomic model (2012).

Welfare payments made to people who are no longer working must, in a budget-neutral setting, also be funded by additional taxation. The DWLs associated with welfare transfers are calculated in Section 3.2.3, where the nature of DWLs is explained in more detail.

3.2.2 Carer costs

Carers are people who provide informal care to others in need of assistance or support. Most informal carers are family or friends of the person receiving care. Carers may take time off work to accompany people with stroke to medical appointments, stay with them in hospital, or care for them at home. Carers may also take time off work to undertake many of the unpaid tasks that the person with stroke would do if they did not have stroke and were able to do these tasks.

Informal care is distinguished from services provided by people employed in the health and community sectors (formal care) because the care is generally provided free of charge to the recipient and is not regulated by the government.

While informal care is provided free of charge, it is not free in an economic sense, as time spent caring is time that cannot be directed to other activities such as paid work, unpaid work (such as housework or yard work) or leisure. As such, informal care is a use of economic resources. Carers may also experience health and quality of life impacts from caring, although in this study the measurement of carer costs is limited to productivity losses.

3.2.2.1 Methodology

There are three potential methodologies that can be used to place a dollar value on the informal care provided.

- Opportunity cost is the value of lost wages forgone by the carer.
- Replacement valuation is the cost of buying a similar amount of services from the formal care sector.
- Self-valuation is what carers themselves feel they should be paid.

Deloitte Access Economics has adopted the opportunity cost method in this report as it provides the most accurate estimate of carer costs and sufficient demographic data on providers of care for people with stroke are available.

3.2.2.2 Informal and community care costs

Informal care costs are the value of the care provided by informal friends or family carers. This report analyses the available epidemiological data (from Australia and overseas) together with ABS SDAC data (ABS, 2009), to gain estimates of the total number of hours of care provided to people with stroke, and the average unit cost of that care.

SDAC data for the year 2009 identified around 26,367 carers who cared for people with stroke as their main condition. The SDAC reports that 68% of carers spent 40 hours or more per week caring for people with stroke. Assuming this cohort spent an average of 50 hours a week, the weighted average for all carers would be 41 hours per week.

The cost of lost productivity is measured in the model by what the carers could have earned had they been in the workforce. This is determined by the average wage for someone of the same age and gender who is still in the workforce. As half the carers are over 55, and two thirds of them are female, the average hourly rate is $13. However, most of this group would probably not be in the workforce even if they did not have to care for a stroke survivor. (The weighted average of employment in matching age gender groups is 31%). Thus, the average cost of lost productivity is $8,425 per carer.

In 2012 the total additional cost of care for Australians with stroke is around $222 million.

3.2.3 Aids and modifications, funeral costs

Aids and modifications consist of out-of-pocket costs borne by the individual, and include aids, equipment and home modifications, alternative and herbal medications, transport costs, private domestic assistance, and miscellaneous out-of-pocket costs (Dewey et al, 2001). In 2012 dollars, these amount to $922 per person living with stroke.

The cost of aids and modifications associated with stroke was estimated as $388 million in 2012.

The 'additional' cost of funerals borne by family and friends of people with stroke is based on the additional likelihood of premature death associated with stroke in the year 2012 (Section 2.4). In NPV terms, the cost of a funeral expected in the future is less than that of a funeral in the current year. So, while everyone must die and incur funeral expenses eventually, there is a "bring forward" cost from premature funerals. If someone who is 90 dies from a stroke, when they would only have been expected to live for another year or two anyway, these bring forward costs may be relatively small. Conversely, for a young person, the NPV of a funeral expected many decades hence approaches zero. Thus, if their death is resultant from a stroke, the bring forward cost of the funeral is close to the current cost.

The Bureau of Transport and Road Economics (2000) calculated a weighted average cost of a funeral across all states and territories, to estimate an Australian total average cost of $3,200 per person for 1996, or $4,819 per person who died in 2012. The bring forward cost is calculated using a discount rate of 3% for each year of life lost using standard life expectancies, assuming constant real funeral costs.

The bring forward of funeral costs associated with premature death for people with stroke is estimated at around $10.7 million in 2012.

3.2.4 Transfer costs

3.2.4.1 Welfare and income support payments

Transfer payments represent a shift of resources from one economic entity to another. As the act of taxation and redistribution creates distortions and inefficiencies in the economy, so transfers also involve real net costs to the economy.

Centrelink data (special data request) shows that there were 20,234 people with "acquired brain impairment" receiving Disability Support Pensions. Whilst "acquired brain impairment" may include other impairments apart from stroke it was provided as the closest indication for those with stroke. Similarly for Sickness and Newstart Allowance, results used were recipients of the allowances with a "Medical Condition of Brain Injury". Of those, 135 were on Sickness Allowance and 182 on Newstart Allowance.

Using these figures shows that the (weighted) average payment for Disability Support Pension (DSP), Newstart Allowance and Sickness Allowance was $649.90 per fortnight (Table 3.5). Applying this payment to those with stroke indicated $342 million was spent supporting them. However, as some of these people would have been on welfare even if they did not have a stroke, this figure needs to be reduced by the reliance rate of the average population in comparison to stroke. For every four people with stroke on DSP, statistically, around three of them (73%) would have been on DSP anyway. The reliance rate of the stroke population on Newstart is no greater than the general population. For Sickness Allowance, 90% would have been on it anyway. Thus, $92 million (27%) of DSP and $0.2 million (10%) of Sickness Allowance paid to stroke survivors can be attributable to their stroke.

The Department of Human Services was unable to supply an estimate of the number of people receiving Carer Payment (for full time care) and Carer Allowance (a supplement for carers with other income sources) to care for stroke survivors. However, Access Economics (2005) estimated an average hourly rate for carers (for all conditions). Applying this to estimated hours of caring for stroke yields carer transfers of $94 million.

Adding carer and caree transfers together totals $186 million.

Table 3.5: Welfare payments to people with stroke, 2012

	People	Payment for singles no children ($ per fortnight)	Total payments ($m)	Due to stroke ($m)
Disability Support Pension	20,234	650.19	342	92
Newstart Allowance	135	724.03	3.4	0
Sickness Allowance	182	506.30	1.8	0.2
Total	**20,551**	**649.90**	**347.3**	**92.2**

Source: Centrelink special data request, ABS 2012d and Deloitte Access Economics calculations.

3.2.4.2 Deadweight losses

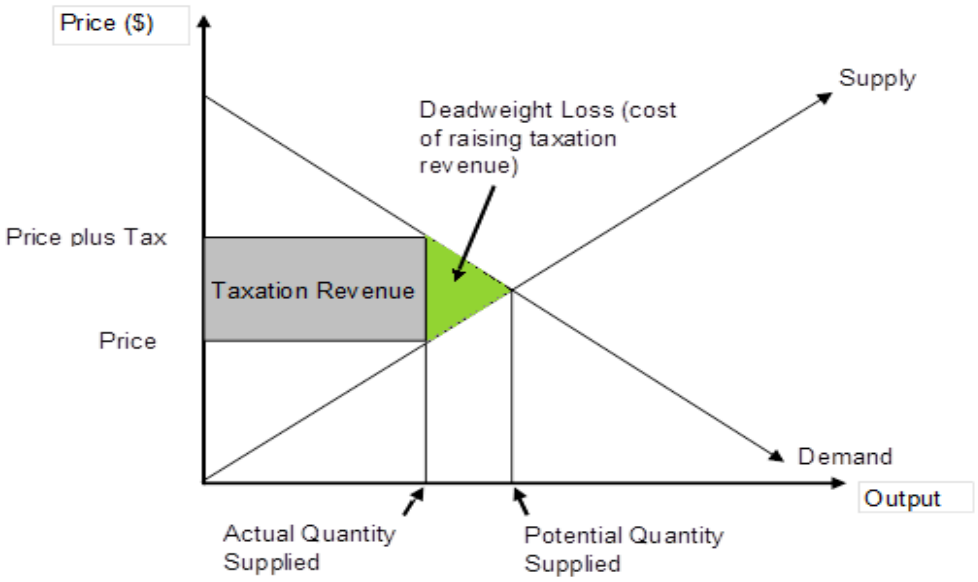
The welfare payments calculated in the section immediately above are, like taxation revenue losses, not themselves economic costs but rather a financial transfer from taxpayers to the welfare recipients. The real resource cost of these transfer payments is only the associated DWL. DWLs refer to the costs of administering welfare pensions and raising additional taxation revenues.

Although invalid and sickness benefits and forgone taxation are transfers, not real costs (so should not be included in the estimation of total costs), it is still worthwhile estimating them as that helps us understand how the total costs of stroke are shared between the taxpayer, the individual and other financiers.

Transfer payments (Government payments/services and taxes) are not a net cost to society as they represent a shift of consumption power from one group of individuals to another. If the act of taxation did not create distortions and inefficiencies in the economy, then transfers could be made without a net cost to society. However, through these distortions, taxation does impose a DWL on the economy.

DWL is the loss of consumer and producer surplus, as a result of the imposition of a distortion to the equilibrium (society preferred) level of output and prices. Taxes alter the price and quantity of goods sold compared to what they would be if the market were not distorted, and thus lead to some diminution in the value of trade between buyers and sellers that would otherwise be enjoyed (Figure 3.1).

Figure 3.1: DWL of taxation



The rate of DWL used in this report is 28.75% overall as per Section 3.2.1.5. The total extra tax dollars required to be collected include:

- the $911 million of taxation revenue forgone as a result of lost productivity from stroke and its impacts – resulting in $262 million in DWL;
- the $608 million of Government-funded health system costs – resulting in $175 million of DWL; and
- the $186 million of additional induced social welfare payments (to stroke survivors and their carers) – resulting in $53 million of DWL.

Thus the DWL for people with stroke in 2012 is estimated at around $491 million.

3.2.5 Summary of non-health financial costs

In total, the non-health related financial costs of stroke are estimated to be $4.28 billion in 2012.

Table 3.6: Summary of other financial costs of stroke, 2012

	$ million
Productivity costs	**2,987**
Employment impacts	975
Absenteeism	1,138
Presenteeism	665
Premature death	208
Search and hiring costs	0.4
Carer costs	**222**
Aids and modifications	**388**
Funeral costs	**11**
DWL	**491**
Total other financial costs	**4,098**

4 Burden of disease costs

People who experience stroke may lose health-related quality of life (recall Section1.3). This section estimates the value of this lost quality of life among Australians living with stroke in 2012.

4.1 Methodology

4.1.1 Disability adjusted life years

The methodology is based on that used to estimate burden of disease. This was developed by a consortium led by the WHO, as a comprehensive measure of mortality and disability from diseases, injuries and risk factors for populations around the world (Murray and Lopez 1996). It uses a non-financial approach, where pain, suffering and premature mortality are measured in terms of disability adjusted life years (DALYs).

The DALY is a measurement unit that quantifies the impacts of morbidity and premature mortality associated with various diseases and injuries (Murray and Acharya 1997). The total burden of disease associated with a condition is calculated from estimates of years of healthy life lost due to disability (YLD) and years of life lost due to premature death (YLL):

$$DALY = YLL + YLD$$

The DALY framework allows comparisons of the overall mortality and disability burden associated with different diseases in a given population.

- YLL represents the difference in life expectancy for a person with a particular condition compared to the general population.
- YLD is estimated by multiplying the average duration of the condition (to remission or death) by a measure of severity of the disease, a 'disability weight'. Disability weights are measured on a scale of zero to one, where a zero represents a year of perfect health and a one represents death. A disability weight of, for example, 0.395 for people who survive a heart attack, is interpreted as a 39.5% loss in the quality of life relative to perfect health following the heart attack (Mathers et al, 1999).

4.1.2 Disability weights

One of the main costs of stroke is the loss of wellbeing and quality of life that it entails, estimated by ascribing disability weights by age and gender from Mathers et al (1999). (The most recent Burden of Disease report (Begg et al, 2007) does not contain a list of disability weights used, but states that they had not changed since Mathers et al (1999).) Disability weights vary depending on the severity of disability. Disability weights also vary with age, reflecting how the significance of impairment varied with changing life circumstances. Weights by gender and age group are provided in Table 4.1.

Table 4.1: Disability weights by age and gender

Age group	Male	Female
15-24	0.360	0.360
25-34	0.360	0.360
35-44	0.360	0.360
45-54	0.360	0.360
55-64	0.360	0.360
65-74	0.366	0.373
75+	0.481	0.455

Source: Mathers et al 1999.

4.1.3 Value of a statistical life year

The burden of disease as measured in DALYs can be converted into a dollar figure using an estimate of the value of a 'statistical' life (VSL). The VSL is an estimate of the value society places on an anonymous life. Since Schelling's (1968) discussion of the economics of life saving, the economic literature has focused on willingness to pay (WTP) – or, conversely, willingness to accept (WTA) – measures of mortality and morbidity, in order to develop estimates of the VSL.

Estimates may be derived from observing people's choices in situations where they rank or trade off various states of wellbeing (loss or gain) either against each other or for dollar amounts eg, stated choice models of people's WTP for interventions that enhance health or WTA poorer health outcomes or the risk of such states. Alternatively, risk studies use evidence of market trade-offs between risk and money, including numerous labour market and other studies (such as installing smoke detectors, wearing seatbelts or bike helmets and so on).

Weaknesses in the WTP approach, as with human capital approaches to valuing life and wellbeing, are that there can be substantial variation between individuals. Extraneous influences in labour markets such as imperfect information, income/wealth or power asymmetries can cause difficulty in correctly perceiving the risk or in negotiating an acceptably higher wage in wage-risk trade off studies, for example.

As DALYs are enumerated in years of life rather than in whole lives it is necessary to calculate the **Value of a 'Statistical' Life Year (VSLY)** based on the VSL. The Office of Best Practice Regulation (OBPR) (2008) provides a recommended value for the VSLY of $151,000[10] in 2007 dollars. The value for the VSLY used in this report has been adjusted for inflation, to $172,955 in 2012 dollars.

[10] http://www.finance.gov.au/obpr/cost-benefit-analysis.html

Table 4.2: DALYs by gender and YLD/YLL

	Males	Females	Total
YLD	115,453	97,251	212,704
YLL	32,295	40,158	72,454
DALYS	147,749	137,409	**285,158**

Stroke is estimated to have caused 285,158 DALYs in 2012. This equates to a cost of $49.3 billion in 2012.

5 Cost effective interventions

The burden of stroke can be lowered through various interventions. The National Stroke Foundation has proposed a number of interventions to government. Using the model, we are able to estimate the potential savings generated from the efficacy of the interventions.

The treatment of benefits only considers the potential financial savings, that is, it does not consider the burden of disease on the individual. As health system expenditure provided by the AIHW (2009a) uses a unit cost approach, all interventions have an incidence based approach for health system expenditure and prevalence for the continued condition. As such, benefits comprise reductions in health system costs, productivity costs, carer costs, deadweight losses and other financial costs. The total financial costs per stroke is therefore $27,709 per person in 2012. This figure is used to value each stroke averted under primary interventions.

This figure is also used to measure benefits of secondary and tertiary interventions that reduce disability (but not deaths) from stroke. As the figure of $27,709 is an average, the fact that it includes 35% of people who have stroke but do not have a disability may tend towards under-estimation of the benefits, but the fact that it includes the costs of premature death may tend towards over-estimation of the benefits of reducing disability. Given the two sources of potential bias work in opposite directions, it is assumed that the benefit of preventing a stroke from causing disability (secondary prevention) or successfully treating the disability (tertiary prevention) are also worth $27,709 per successful intervention.

In each of the interventions Deloitte Access Economics considered both the required operating and capital costs and based the calculations on the effectiveness of the intervention once fully implemented (as some interventions could take a few years to properly implement). All costs were adjusted to 2012 dollars. The assumptions made by the National Stroke Foundation in each business case are used in our costings (e.g. support from stakeholders, take-up rates of services).

In all cases, costs would be borne by governments, while benefits would largely accrue to patients. However, the benefit-cost ratio is from a whole of society perspective (as governments are ultimately funded by taxpayers to provide benefits to all of society). Following Access Economics (2008), in each case, as the modelled intervention leads to further action), half the gains are assumed to be attributed to the intervention and half to the follow-up action (hypertension treatments, newly introduced best practice secondary treatment and increased rehabilitation, respectively).

5.1 Raising individual awareness of disease risk

Know Your Numbers (KYN) is an evidence-based intervention that has proven successful in enabling Australians at risk of stroke and other CVD to better identify, understand, manage and control their risks. The National Stroke Foundation has run KYN (in localised areas) since 2007 (NSF, 2012b).

AIHW (2009b) data shows that current Australian Government funded health checks are not identifying most people who are at risk, since less than a quarter of Australians aged over 75 years, and only 6% of those aged 45-49, are accessing regular health checks. Participation at KYN pressure stations for 2007-2011 have demonstrated that of the 104,437 people checked, 48% did not know their blood pressure numbers and 28% of those were recommended to visit their General Practitioner for follow up due to high blood pressure. Yet, early detection of high risk individuals is a necessary (if not sufficient) condition for the success of stroke reduction.

The business case developed by the Foundation investigated the permanent placement and operation of blood pressure stations, with a target audience of people over 50 years of age and a secondary audience of those aged 25 and over. The stations would be offered in pharmacies and available to community and workplace providers all year round for the conduct of pressure checks by qualified personnel. The stations would be supported through social marketing strategies, state-wide advertising, website promotion and provided with the standard KYN resource kit (with additional resources as required).

KYN can also help address other issues relating to high blood pressure including heart attack, heart failure or kidney disease. The use of blood pressuring lowering drugs has been proven to prevent coronary heart disease (CHD). Law et al (2009), a meta-analysis of randomised trials of blood pressure lowering drugs recording CHD events and stroke (from Medline over the period 1966-2007), noted all classes of blood pressure lowering drugs have a similar effect in reducing chronic heart disease events, with an extra protective effect of beta blockers given shortly after a myocardial infarction. The 22% reduction (excluding the larger reduction due to effect of beta blockers after myocardial infraction) was the same or similar regardless of pre-treatment blood pressure and the presence or absence of existing cardiovascular disease. This benefit has been applied to a reduction of heart attacks (acute myocardial infarction) and associated chest pain (unstable angina) based on previous work by Access Economics (2009) and adjusting for changes in hospital separations, inflation and population growth.

KYN also provides type 2 diabetes risk assessment checks through the AUSDRISK tool. The tool has been proven to provide a valid and reliable method to estimate the risk of developing type 2 diabetes for asymptomatic individuals who are likely to have undiagnosed diabetes (Chen et al, 2010). There are no results available, however, that identify how many people modify their behaviour, preventing or delaying type 2 diabetes manifesting as a result of the tool, and as such no cost benefit estimates can be applied.

Fully funded, this model of the KYN program has the potential to check 570,000 people per annum, at a cost to the government of $15 million over three years. If this occurred, 542 strokes, 274 heart attacks and 187 cases of angina would be averted in 2012. As there are two steps to preventing incidents here: firstly identifying hypertension through KYN, and secondly having the hypertension successfully treated, Deloitte Access Economics has conservatively allocated 50% of the benefits to each step. Thus the potential savings attributable to KYN are $27.1 million per year, half of which can be directly attributed to the intervention, giving a BCR of 2.7 to 1.[11]

[11] 50% of total savings is calculated for the BCR assuming additional costs are required to actually treat the cause of blood pressure.

5.2 Monitoring and improving hospital care

The National Stroke Foundation advocates for a multifaceted approach to improve the delivery of evidence-based care. This approach includes integrated data collection processes and a comprehensive quality improvement program ("StrokeLink") for stroke. Collection of data that monitors the quality of care provided and identifies poor outcomes is a fundamental component of quality improvement activities. Current complementary data collection processes for stroke in Australia includes the Australian Stroke Clinical Registry (AuSCR) and the National Stroke Audit. Integrated data collection provides a mechanism whereby a small number of data items are collected on critical processes of care for all patients (via AuSCR) to ensure variations in care are captured, which is then supplemented by a periodic, larger data set on a cohort of patients (via the National Stroke Audit) to provide greater insight into complex care processes, such as those provided by a multidisciplinary stroke team and to explain factors contributing to variation in care. The current proposal includes activity that further facilitates integration of AUSCR and the National Stroke Audit.

In addition to integrated data collection processes, a quality improvement program for stroke care in Australia (StrokeLink) will ensure data is used to drive greater adherence to recommendations in the clinical guidelines for the treatment of stroke, thereby improving the outcomes of those affected by stroke in Australia. StrokeLink is a comprehensive, multifaceted quality improvement program designed to assist hospitals to obtain evidence-based best practice care as outlined in the Clinical Guidelines for Stroke management. StrokeLink offers a range of interventions including outreach visits by trained staff using interactive educational formats and local consensus processes. A key component of the program is the identification of local barriers to implementation and the development of an agreed action plan to overcome these barriers (NSF, 2012b). The program is underpinned by the rapid quality improvement framework 'plan-do-study-act' (PDSA), to test agreed improvement strategies. Ongoing activities such as follow up site visits, telephone and email support act as reminders and allow sharing of successful strategies between hospitals and clinicians facing similar issues.

Overall this comprehensive program of data collection and StrokeLink is integral to enable the health system to identify gaps and solutions via established, robust and collaborative methodology demonstrated to improve stroke care and patient outcomes.

Using similar methodology to that used in StrokeLink, the National Stroke Foundation advises the Quality in Acute Stroke Care (QASC) interventions provides a reasonable proxy of benefit for the overall program noting QASC was undertaken in a strict research trial.[12] QASC is a multidisciplinary intervention targeting evidence-based management of fever, hyperglycaemia, and swallowing dysfunction, as evaluated by Middleton et al (2011). Eligible people in the QASC study were those who presented to nominated acute stroke units (n=19) within 48 hours after having a stroke (n=1,696). Treatment was found to be effective with a total reduction in dependency of 15.7% (intervention) compared to sites

[12] This may be conservative, as the Foundation (2012b) notes that StokeLink has the potential to improve care over a broader range of interventions than those covered by QASC.

being provided with information on clinical guidelines only (control).[13] The 90-day mortality, however, did not differ between the intervention and the control.

In the Foundation's StrokeLink business case, total annual costs would be $3.35 million per year, including training, materials and program team salaries. Costs do not include ongoing hospital staff time, as the Foundation advises that StrokeLink would become part of current practice. However, while this is a "steady state" analysis (that is, after the costs of transitioning to the program have been incurred) there will be face-to-face StrokeLink training for participating hospitals, of two four hour sessions a year. It is expected that 150 hospitals will participate in StrokeLink and 8-12 people will be present at any one training session. Using hospital wage data (AIHW 2012e) an additional $0.93 million can be attributed to the hospitals time spent being involved in the program. As the main aim of the intervention is to enable earlier response to threatening conditions rather than increasing the amount of treatment, material costs are considered negligible. Conversely a more rapid response would also decrease ongoing costs from increased complications without the intervention.

The Stroke Audit (NSF, 2011) notes that 60% of stroke discharges (equivalent to 21,180 in 2012), have mild to severe disabilities (mRS>2). If funded to cover the 35,300 stroke admissions in hospitals (AIHW 2012b), an expected absolute reduction of 2,047 cases of stroke-induced disability would be averted. Based on QASC outcomes, StrokeLink is expected to reduce this level of disability by at least 5.8% (the lower bound found by the QASC study as the actual program may not be as effective as the controlled trial), which is modelled here as equivalent in cost terms to a 5.8% reduction in total stroke cases (2,047 = 35,300*0.058). As QASC only impacted on 'average' outcomes (neither death nor complete lack of disability) the benefit per stroke prevented under StrokeLink is assumed to be the same as the average cost of stroke ($27,709). Half the benefits of StrokeLink are attributed to the initiative being successful in successfully implementing best practice secondary interventions, and half to those interventions per se. Thus, had StrokeLink been fully implemented in 2012, $56.7 million would have been saved (2,047 cases of disability averted, with benefits of $27,709 per case). Again, half of these benefits can be directly attributed to the intervention, giving it a BCR of 6.6 to 1.

5.3 Comprehensive coordinated follow up of stroke survivors and carers

The impact of a stroke on stroke survivors and carers is significant:

- Stroke survivors are more likely to have profound limitations relating to self care, movement and communication than other people with disability (Sturm et al, 2004).
- Health related quality of life (HRQoL) for the majority of stroke survivors up to two years after their stroke has been rated as very poor (Hackett et al, 2005).
- Depression is seen in approximately a third of survivors (NSF, 2008).

Despite the fact there are a number of evidence based programs in place to improve life after stroke, and stroke survivors describe these services as being important to their

[13] Reductions in dependency were measured in patients with Modified Rankin Scales of 2 to 5. Below 2, patients do not have significant disabilities, and above 5 means the patient has died.

recovery, many stroke survivors report that access to services in the community to support their ongoing recovery is problematic.

Consultation with survivors and carers undertaken by the NSF, and audit of patient case notes, confirms many survivors are not referred to, or accessing services - proven to reduce the burden of stroke and facilitate optimal recovery. There is little coordination of care post discharge with many stroke survivors and carers left to negotiate a complex community service sector with little or no assistance.

As noted by the NSF (2011):

- 50% of stroke patients are discharged without a discharge care plan;
- 67% of hospitals did not report having any protocols for reviewing patients post discharge;
- Around 33% of hospitals did not provide any discharge care contact.

Currently there are no national, or state based programs for routinely following up stroke survivors.

As 88% of stroke patients are admitted by the larger hospitals across Australia (NSF 2011), a focus on improving these services would have the greatest impact.

The implications of this are not only confined to the immediate treatment of stroke but also post inpatient rehabilitation. As noted by the National Stroke Audit Rehabilitation Services (NSF, 2012a), 33% of patients discharged after inpatient rehabilitation receive no referral for further rehabilitation in the community.

To address this, StrokeConnect, at a cost of approximately $10.5 million over three years, would provide a comprehensive follow up and navigation service, ensuring early intervention and linking survivors and carers to services. StrokeConnect would provide:

- establishment of a central referral process for every stroke survivor discharged home;
- provision of phone follow-up to determine ongoing needs in the community; and
- navigation (linking) of stroke survivors to services that survivors report they are currently unable to access.

However, costs related to an increased uptake in services because of StrokeConnect have not been estimated due to the disparate requirements by each person living with stroke impacts post stroke. The services they may need to access could include community based rehabilitation, exercise programs, peer support programs, counselling, home and community care programs and community based aged care programs (respite, meals on wheels and care provided by the General Practitioner). Or the expected uptake in Medicare items to support enhanced primary care include referral for a limited number of allied health interventions to provide top up therapy, mental health care packages, and the care planning by the GP.

The format of StrokeConnect is based on Ellis et al (2010), which estimated that there would be 11 fewer dependent patients per 100 cases of people with a mild to moderate

stroke that results in a score of 15 to 19 on the Barthel Activities of Daily Living Index[14]. Of the current 35,300 stroke cases in acute hospitals, around a third are estimated to be in this category (NSF, 2012a).

This means over 1,294 cases could be reduced by StrokeConnect. As they occur after a stroke, in hospital health system costs have been excluded from the benefit calculation.[15] Half the benefits of the intervention are attributed to patients being assigned to appropriate service through StrokeConnect, and half the benefits to those services per se. StrokeConnect could thus save $16.6 million in financial costs from stroke, with a BCR of 4.7 to 1.

5.4 Summary

All interventions assessed would provide potential savings to the Australian economy. As each intervention was assessed in the same model, relative effectiveness can be compared across interventions.

However, benefits across all three programs are not cumulative. If KYN was successfully implemented, there would be fewer stroke cases to treat and hence less impact of StrokeLink to improve care. In turn, if StrokeLink was successfully implemented, there would be fewer patients needing StrokeConnect support.

Table 5.1: Benefit and cost of interventions

Intervention	Cases reduced	Benefit (2012$m)	Cost (2012$m)	Benefit Cost Ratio
Know Your Numbers	542 stroke, 460 CHD	13.6	5.0	2.7
StrokeLink	2,047	28.4	4.3	6.6
StrokeConnect	1,294	16.6	3.5	4.7

[14] Severe dependence is defined as a score of less than 15. A score of 20 means the patient is independent. As per the StrokeLink analysis, the benefit of averting the average stroke outcome (disability) is assumed to be the same *ex ante*, as averting the total stroke outcome (death, mild to severe disability, no disability)

[15] Benefit per person is $25,640

6 Conclusions and comparisons

In 2012, there are over 420,000 Australians estimated to be living with the effects of stroke. Two thirds of these people have a disability that impedes their ability to carry out activities of daily living unassisted. There are about 25% more males living with stroke (233,171) than females (187,099).

Table 6.1: Stroke prevalence 2012 by demography (with/without disability)

Age	Female	Male	No disability	Disability	Total
0-39	10,596	10,639	7,375	13,857	21,236
40-44	2,932	4,825	2,174	5,584	7,757
45-49	5,056	4,982	2,784	7,254	10,038
50-54	11,009	10,662	7,534	14,138	21,671
55-59	14,793	15,016	9,719	20,090	29,809
60-64	17,098	20,681	10,864	26,915	37,779
65-69	15,620	32,962	15,587	32,995	48,582
70-74	15,570	40,238	18,006	37,803	55,808
75-79	21,993	35,086	18,362	38,718	57,080
80-84	29,781	32,270	22,111	39,940	62,051
85-89	26,484	18,148	21,360	23,272	44,631
90+	16,167	7,662	11,313	12,516	23,829
Total	**187,099**	**233,171**	**147,189**	**273,082**	**420,271**

Source: Deloitte Access Economics derived from ABS (2012a; 2012b).

The total financial costs of stroke in Australia were estimated to be $5 billion in 2012. The largest cost component was productivity costs ($3 billion). Health costs also present a significant cost at $881 million. Carer costs were estimated as $222 million. Because taxes both reduce income and increase the price of goods and services, the deadweight loss (DWL) of the taxation needed to pay for health services, welfare and carer support for people with stroke is also significant, at $491 million.

Largely reflecting productivity costs, individuals bear the greatest financial burden of stroke ($2.2 billion in 2012). The Federal Government bore $1.5 billion of the costs, or $3,507 per person, while State Governments bore $233 million, families and friends bore $67 million, and employers bore $407 million. As the DWL is incurred by the whole population, together with health costs borne in the private sector the cost of stroke to the 'rest of society' was $602 million in 2012.

However, the biggest impact of stroke is not the financial costs it causes, but the pain and suffering it inflicts. Using the market-based price of risk methodology required by the Commonwealth Department of Finance and Deregulation (VSLY / DALY), the average person with stroke would require over $172,000 – annually – to restore them to a pre-stroke level of wellbeing. The total Burden of Disease cost in 2012 was $49.3 billion. (By

way of comparison, this is not dissimilar to the $41 billion estimated by Access Economics (2010) for anxiety and depression.)

Table 6.2: Costs of stroke in Australia, 2012 ($m)

	Individuals	Family/ Friends	Federal Govt	State Govt	Employers	Society/ Other	Total
Health system costs	161	1	376	233	0	111	881
Productivity costs	1,742	0	838	0	407	0	2,987
Carer costs	0	149	73	0	0	0	222
Other costs	388	11					398
DWL	0	0	0	0	0	491	491
Transfers	-92	-94	186	0	0	0	0
Total financial cost	**2,198**	**67**	**1,474**	**233**	**407**	**602**	**4,979**
Burden of disease	49,319	0	0	0	0	0	49,319
Total cost	**51,517**	**67**	**1,474**	**233**	**407**	**602**	**54,299**

Source: Deloitte Access Economics calculations.

Table 6.3: Costs of stroke per person, prevalence calculations, 2012 ($)

	Individuals	Family/ Friends	Federal Govt	State Govt	Employers	Society / Other	Total
Health system costs	382	2	895	554	0	264	2,097
Productivity costs	4,144	0	1,995	0	968	0	7,107
Carer costs	0	355	174	0	0	0	529
Other costs	922	26	0	0	0	0	948
DWL	0	0	0	0	0	1,167	1,167
Transfers	-219	-223	443	0	0	0	0
Total financial cost	**5,229**	**158**	**3,507**	**554**	**968**	**1,432**	**11,847**
Burden of disease	117,352	0	0	0	0	0	117,352
Total cost	**122,581**	**158**	**3,507**	**554**	**968**	**1,432**	**129,199**

Source: Deloitte Access Economics calculations.

Chart 6.1 : Financial costs of stroke by type, 2012, $m

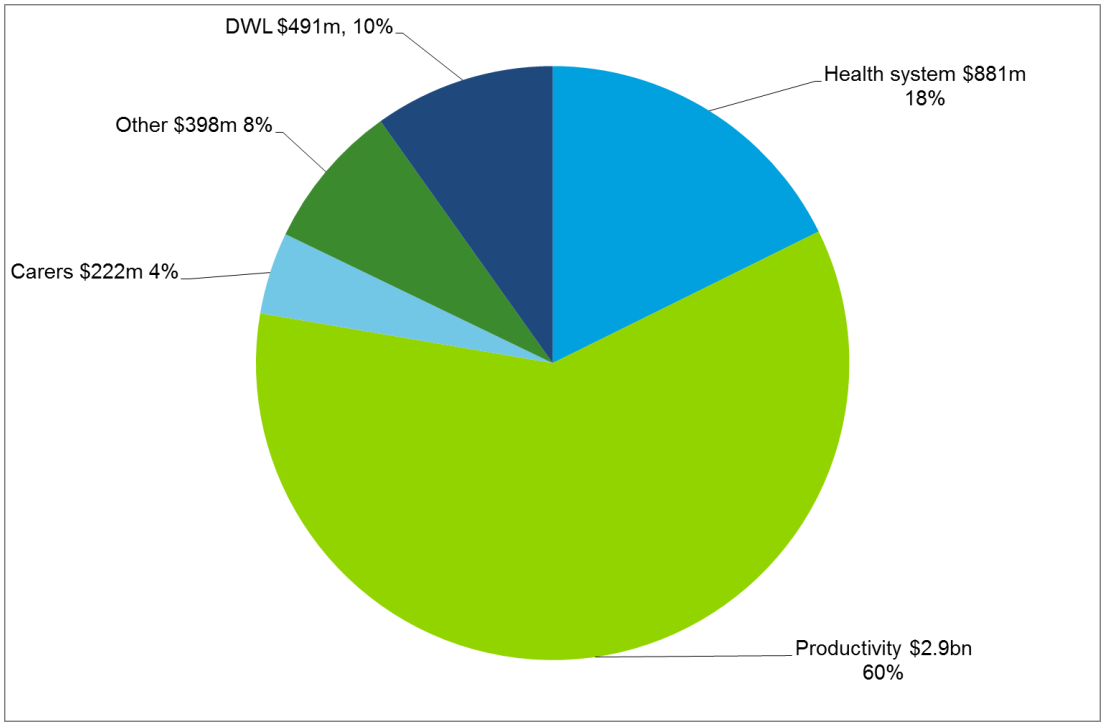
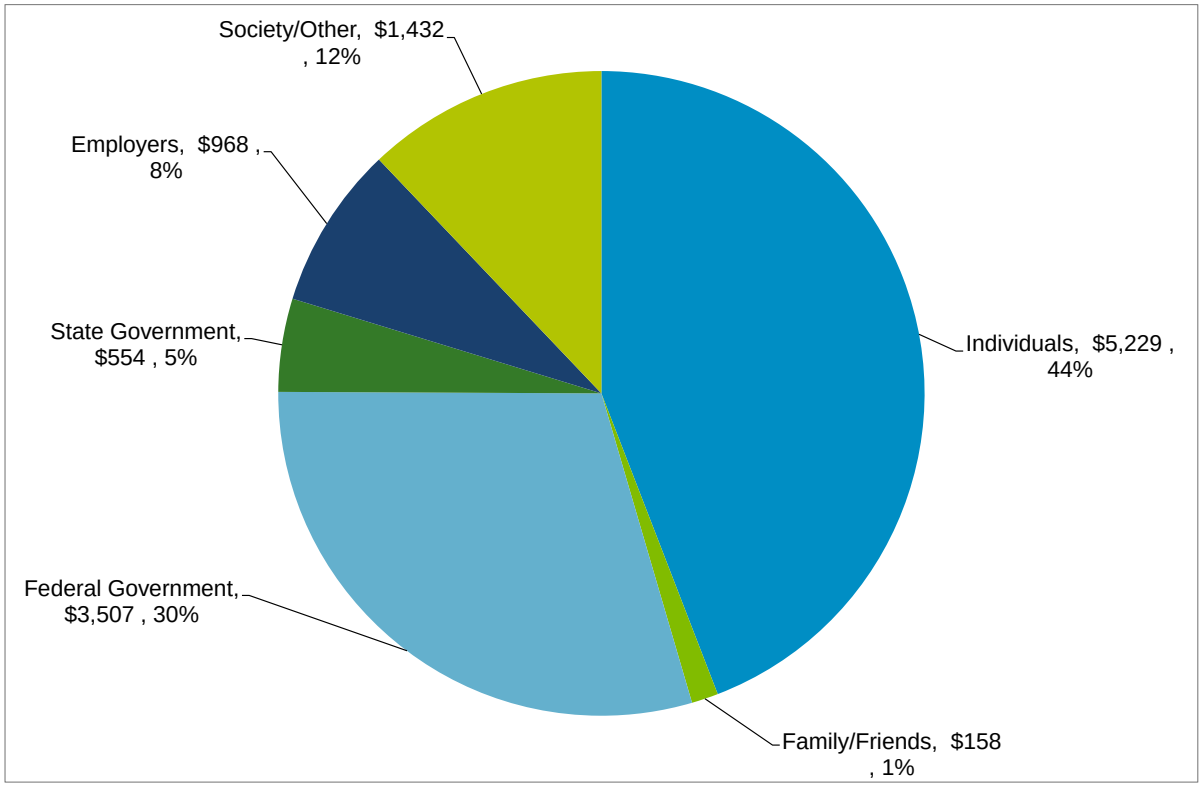


Chart 6.2: Financial costs of stroke, per person, by bearer, 2012

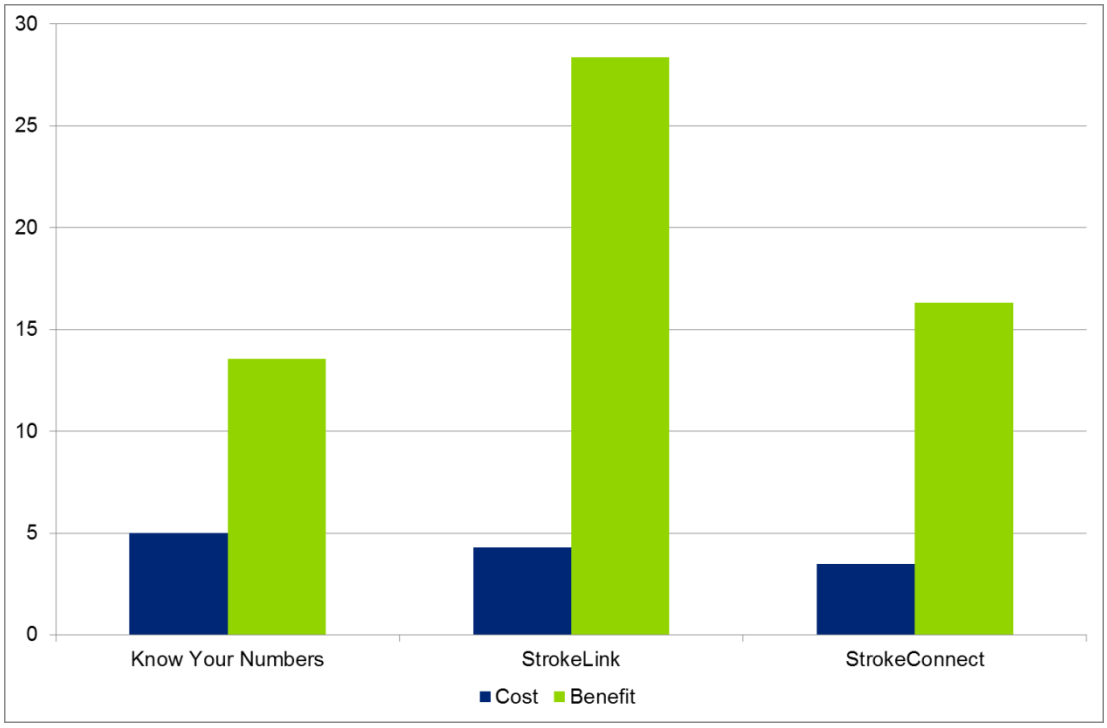


Given the substantial financial and wellbeing costs of stroke, it is important to identify cost-effective means to prevent stroke or ameliorate its disabling consequences. While those best placed people to prevent stroke are those at risk themselves, the Know Your Numbers program demonstrated that very few at risk people are aware they have high blood pressure. For an estimated cost of $5 million per annum, this program has the capacity to inform 570,000 Australians per year of their blood pressure; if those at risk acted on this information once aware and successfully reduced their blood pressure to normal levels, over 500 strokes and over 400 cases of cardiovascular heart disease could be averted each year, potentially saving some $13.6 million in financial costs. Moreover, adopting best practice acute care and rehabilitation could avert thousands of cases of stroke-induced disability. For a cost of $4.3 million per annum, the StrokeLink program could prevent over 2,047 cases of stroke induced disability annually, potentially saving $28 million in financial costs. For a cost of $3.5 million, effective support under the StrokeConnect program could enable over 1,294 stroke survivors to regain functional independence each year, for a potential saving of $16.3 million.

Table 6.4: Benefit and cost of interventions

Intervention	Cases reduced	Benefit (2012$)	Cost (2012$)	Benefit Cost Ratio
Know Your Numbers	542 stroke, 460 CHD	13.6	5.0	2.7
StrokeLink	2,047	28.4	4.3	6.6
StrokeConnect	1,294	16.6	3.5	4.7

Chart 6.3: Benefit and costs of interventions, 2012, $m



Appendix A: References

Access Economics 2008, *Returns to NHMRC funded R&D*, Report for the National Health and Medical Research Council.

Access Economic 2009, *The economic costs of heart attack and chest pain (Acute Coronary Syndrome),* commissioned by Eli Lilly.

Access Economics 2010, *Positive Family Functioning*, Report for the Department of Families, Housing, Community Services and Indigenous Affairs.

(ABS) Australian Bureau of Statistics 2012a, 4430.0.30.002 - Microdata: Disability, Ageing and Carers, Australia.

(ABS) Australian Bureau of Statistics 2012b, 3101.0 Australian Demographic Statistics, Australia.

(ABS) Australian Bureau of Statistics 2012c, 6105.0 Australian Labour Market Statistics, Australia.

(ABS) Australian Bureau of Statistics 2012d, 1301.0 Year book Australia, 2012, Australia.

(ABS) Australian Bureau of Statistics 2012e, 3303.0 Causes of Death; Australia 2010, Australia.

American Heart Association 2007, *Stroke Risk Factors*, http://www.heart.org/idc/groups/stroke-public/@wcm/@hcm/documents/downloadable/ucm_309713.pdf, accessed 23 July 2012.

(AIHW) Australian Institute of Health and Welfare 2009a, "AIHW Disease expenditure database", Special data request.

(AIHW) Australian Institute of Health and Welfare 2009b, Prevention of cardiovascular disease, diabetes and chronic kidney disease: targeting risk factors. Cat. No. PHE 118. Canberra: AIHW.

(AIHW) Australian Institute of Health and Welfare 2010, Cardiovascular disease mortality: trends at different ages. Cardiovascular series no.31. Cat. No.47. Canberra:AIHW. http://www.aihw.gov.au/publication-detail/?id=6442468344&tab=2

(AIHW) Australian Institute of Health and Welfare 2011, Cardiovascular disease: Australian facts 2011, Cardiovascular disease series. Cat. no. CVD 53. Canberra: AIHW.

(AIHW) Australian Institute of Health and Welfare 2012a, Stroke, http://www.aihw.gov.au/stroke/, accessed 4 June 2012.

(AIHW) Australian Institute of Health and Welfare 2012b, Australia's health 2012. Australia's health series no.13. Cat. no. AUS 156. Canberra: AIHW.

(AIHW) Australian Institute of Health and Welfare 2012c, Health expenditure Australia 2010–11. Health and welfare expenditure series no. 47. Cat. no. HWE 56. Canberra: AIHW.

(AIHW) Australian Institute of Health and Welfare 2012d, National Hospital Morbidity Database 2008-09 to 2009-10, http://www.aihw.gov.au/hospitals-data-cube/?id=10737419463, accessed 20-October-2012.

(AIHW) Australian Institute of Health and Welfare 2012e, Australian hospital statistics 2010-11. Health Services services no. 43. Cat. No. HSE 117. Canberra: AIHW.

Baigent C, Blackwell L, Emberson J, Holland LE, Reith C, Bhala N, Peto R, Barnes EH, Keech A, Simes J, Collins R 2010, "Efficacy and safety of more intensive lowering of LDL cholesterol: a meta-analysis of data from 170 000 participants in 26 randomised trials" *Lancet* 376(9753):1670–1681.

Begg S, Vos T, Barker B, Stevenson C, Stanley L & Lopez A 2007, The burden of disease and injury in Australia 2003. PHE 82. Canberra: AIHW.

Brugts J, Yetgin T, Hoeks SE, Gotto AM, Shepherd J, Westendorp RGJ, de Craen AJM, Knopp RH, Nakamura H, Ridker P, van Domburg R, Deckers JW 2009, "The benefits of statins in people without established cardiovascular disease but with cardiovascular risk factors: meta-analysis of randomised controlled trials" *BMJ* 338:b2376.

Cantu C, Arauz A, Murillo-Bonilla LM, López M, Barinagarrementeria F 2003, "Stroke associated with sympathomimetics contained in over-the-counter cough and cold drugs". *Stroke* 34 (7): 1667–72.

Chen L, Magliano D, Balkau B, Colagiuri S, Zimmet P, Tonkin A, Mitchell P, Phillips P & Shaw J 2010, "AUSDRISK: an Australian Type 2 Diabetes Risk Assessment Tool based on demographic, lifestyle and simple anthropometric measures", *The Medical Journal of Australia*, 192(4):197-202.

Coffey C. Edward, Cummings Jeffrey L, Starkstein Sergio, Robinson Robert 2000, *Stroke - the American Psychiatric Press Textbook of Geriatric Neuropsychiatry* (Second ed.). Washington DC: American Psychiatric Press. pp. 601–617.

Collins R, Peto R, MacMahon S et al. 1990, "Blood pressure, stroke, and coronary heart disease. Part 2, Short-term reductions in blood pressure: overview of randomised drug trials in their epidemiological context". *Lancet* 335 (8693): 827–38.

Demarin V, Lisak M, Morovic S, Cengic T 2010, "Low high-density lipoprotein cholesterol as the possible risk factor for stroke". *Acta Clinical Croatia*, 49(4):429-39.

Demarin V, Lisak M, Morovic S 2011, "Mediterranean diet in healthy lifestyle and prevention of stroke", *Acta Clinical Croatia*, 50(1):67-77.

Dewey HM, Thrift AG, Cimalopoulos C, et al. 2001, “Cost of Stroke in Australia From a Societal Perspective: Results From the North East Melbourne Stroke Incidence Study (NEMESIS)”, *Stroke*, 32:2409-2416.

Dormandy JA, Charbonnel B, Eckland DJ et al. 2005 "Secondary prevention of macrovascular events in patients with type 2 diabetes in the PROactive Study (PROspective pioglitAzone Clinical Trial In macroVascular Events): a randomised controlled trial". *Lancet* 366 (9493): 1279–89.

Ellis G, Mant J, Langhorn P, Dennis M & Winner S 2010, Stroke liaison workers for stroke patients and carers: an individual patient data meta-analysis (Review), The Cochrane Library 2010, 5. Art. No.: CD005066. DOI:10.1002/14651858.CD005066.pub2.

Ezekowitz JA, Straus SE, Majumdar SR, McAlister FA 2003, "Stroke: strategies for primary prevention". *American Family Physician* 68 (12): 2379–86.

Goetzel R, Long SR, Ozminkowski RJ et al. 2004, “Health, Absence, Disability, and Presenteeism Cost Estimates of Certain Physical and Mental Health Conditions Affecting U.S. Employers”, *Journal of Occupational & Environmental Medicine*, 46(4):398-412.

Goldstein LB, Simel DL 2005, "Is this patient having a stroke?", *JAMA* 293 (19): 2391–402.

Gorelick PB 1987, "Alcohol and stroke". *Stroke* 18 (1): 268–71.

Gueyffier F, Boissel JP, Boutitie F et al. 1997, "Effect of antihypertensive treatment in patients having already suffered from stroke. Gathering the evidence, The INDANA (INdividual Data ANalysis of Antihypertensive intervention trials) Project Collaborators". *Stroke* 28 (12): 2557–62.

Hackett ML, Yapa C, Parag V, Anderson CS 2005, “Frequency of depression after stroke: a systematic review of observational studies”, *Stroke* 36(6):1330-40.

Hannerz H, Pedersen BH, Poulsen OM, et al. 2011, “A nationwide prospective cohort study on return to gainful occupation after stroke in Denmark 1996–2006”, *BMJ Open*, 1:e000180.

Hankey GJ et al. 2002, “Long-term disability after first-ever stroke and related prognostic factors in the Perth Community Stroke Study, 1989–1990”. *Stroke* 33:1034–40.

Harbison J, Massey A, Barnett L, Hodge D, Ford GA 1999, "Rapid ambulance protocol for acute stroke", *Lancet* 353 (9168): 1935.

Katzenellenbogen J, Begg S, Somerford P, Anderson C, Semmens J, Codde J & Vos T 2010, “Disability burden due to stroke in Western Australia: new insights from linked data sources” , *Journal of Stroke* (5):269-277.

Kim J, Gall S, Dewey H, MacDonnell R, Sturm J, Thrift A 2011 “Sufferers of stroke who smoke at baseline are at greater risk of death or non-fatal vascular events” *Asia Pacific Stroke Conference* Colombo Sri Lanka p66. www.theapso.com/images/114/apsc2011.pdf

Lattimore R 1997, “Research and Development Fiscal Incentives in Australia: Impacts and Policy Lessons, OECD Conference on Policy Evaluation in Innovation”, 26-27 June, Paris, 81:574-7.

Lange B, Flynn S & Rizzo A 2009, "Initial usability assessment of off-the-shelf video game consoles for clinical game-based motor rehabilitation". *Physical Therapy Reviews* 14 (5): 355–362.

Law M, Morris J & Wald N 2009, “Use of blood pressure lowering drugs in the prevention of cardiovascular disease: meta-analysis of 147 randomised trials in the context of expectations from prospective epidemiological studies” *BMJ* 338:b1665.

Leary MC, Saver JL 2003 "Annual incidence of first silent stroke in the United States: a preliminary estimate". *Cerebrovascular Disorders* 16 (3): 280–5.

Mathers C, Vos T, Stevenson C 1999, *The burden of disease and injury in Australia — summary report,* Australian Institute of Health and Welfare, Canberra: AIHW.

Middleton S, McElduff P, Ward J, Grimshaw JM, Dale S, D’Este C, Drury P, Griffiths R, Cheung NW, Quinn C, Evans M, Cadilhac D, Levi C, on behalf of the QASC Trialists Group 2011, “Implementation of evidence-based treatment protocols to manage fever, hyperglycaemia, and swallowing dysfunction in acute stroke (QASC): a cluster randomised controlled trial“, *Lancet* DOI:10.1016/S0140-6736(11)61485-2.

Miwa K, Hoshi T, Hougaku H et al. 2010, "Silent cerebral infarction is associated with incident stroke and TIA independent of carotid intima-media thickness". *Intern. Med.* 49 (9): 817–22.

National Institute of Neurological Disorders and Stroke (NINDS) 1999, "Stroke: Hope Through Research". National Institutes of Health. http://www.ninds.nih.gov/disorders/stroke/detail_stroke.htm.

National Institute of Neurological Disorders and Stroke (NINDS) 2012. http://www.ninds.nih.gov/disorders/stroke/preventing_stroke.htm, accessed 23 July 2012.

National Prescribing Practice Review 44: Antiplatelets and anticoagulants in stroke prevention 2009, http://www.nps.org.au/health_professionals/publications/prescribing_practice_review/current/nps_prescribing_practice_review_44, accessed 23 July 2012.

NSF (National Stroke Foundation) 2008, Walk in our shoes, Melbourne, Australia.

NSF (National Stroke Foundation) 2010, Clinical Guidelines for Stroke Management 2010, Melbourne, Australia. http://www.nhmrc.gov.au/_files_nhmrc/publications/attachments/cp126.pdf

NSF (National Stroke Foundation) 2011, National Stroke Audit Acute Services – Organisational Survey Report 2011, Melbourne, Australia.

NSF (National Stroke Foundation) 2012a, National Stroke Audit – Rehabilitation Services Report 2012, Melbourne, Australia.

NSF (National Stroke Foundation) 2012b, National Action Plan for Stroke 2012, Melbourne, Australia.

National Vascular Disease Prevention Alliance, 2012 Guidelines for the management of absolute cardiovascular disease risk. http://strokefoundation.com.au/site/media/AbsoluteCVD_GL_webready.pdf

Productivity Commission (2003) 'Evaluation of the Pharmaceutical Industry Investment Program' Research Report, AusInfo, Canberra.

Office of Best Practice and Regulation 2008, Best Practice Regulation Guidance Note: Value of statistical life, http://www.finance.gov.au/obpr/docs/ValuingStatisticalLife.pdf, accessed 29 January 2013.

O'Regan C, Wu P, Arora P, Perri D, Mills EJ 2008 "Statin therapy in stroke prevention: a meta-analysis involving 121,000 patients". *Am. J. Med.* 121 (1): 24–33.

Senes S 2006, *How we manage stroke in Australia*. Cardiovascular Disease Series Number 24, Australian Institute of Health and Welfare, Canberra, Cat no CVD 31.

Spence JD; Lees, K.; Spence, J. D. 2006 "Nutrition and stroke prevention". *Stroke* 37 (9): 2430–5.

Stroke Unit Tralists' Collaboration 2007 "Organised inpatient (stroke unit) care for stroke" *Cochrane Database Syst Rev* (4):CD000197. http://www.ncbi.nlm.nih.gov/pubmed/17943737

Sturm J, Donnan G, Dewey H, Macdonell R, Gilligan A & Thrift A 2004, "Determinants of hándicap after stroke: the North East Melbourne Stroke Incidence Study (NEMESIS)" *Stroke,* 35(3):715-720.

Taylor F, Ward K, Moore THM, Burke M, Davey Smith G, Casas JP, Ebrahim S 2011 "Statins for the primary prevention of cardiovascular disease" *Cochrane Review*, reprinted in *The Cochrane Library* 2012:5, John Wiley and Sons.

Thomas B, ed. (1988) Manual of Dietetic Practice, Blackwell Scientific Publications, Oxford.

Thomson R 2009 "Evidence based implementation of complex interventions". *British Medical Journal*, 339: b3124.

Thrift A, Dewey H, Sturm J, Srikanth V, Gilligan A, Gall S, Macdonell R, McNeil J & Donnan G 2009, "Incidence of Stroke Subtypes in the North East Melbourne Stroke Incidence Study (NEMESIS): Differences between Men and Women". Neuroepidemiology 32:11–18.

Thrift A, Tong B, Senes S, Waters A-M, Lalor E 2012, "No Evidence for an Epidemic of Stroke with the Ageing of the population" Neuroepidemiology 2012;38:268–273.

Westover AN, McBride S, Haley RW 2007, "Stroke in young adults who abuse amphetamines or cocaine: a population-based study of hospitalized patients". *Archives of General Psychiatry* 64 (4): 495–502.

Whisnant JP 1996, "Effectiveness versus efficacy of treatment of hypertension for stroke prevention". *Neurology* 46 (2): 301–7.

World Health Organization 2004, *The World health report 2004*. Geneva:. http://www.who.int/entity/whr/2004/en/report04_en.pdf, accessed 23 July 2012.

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