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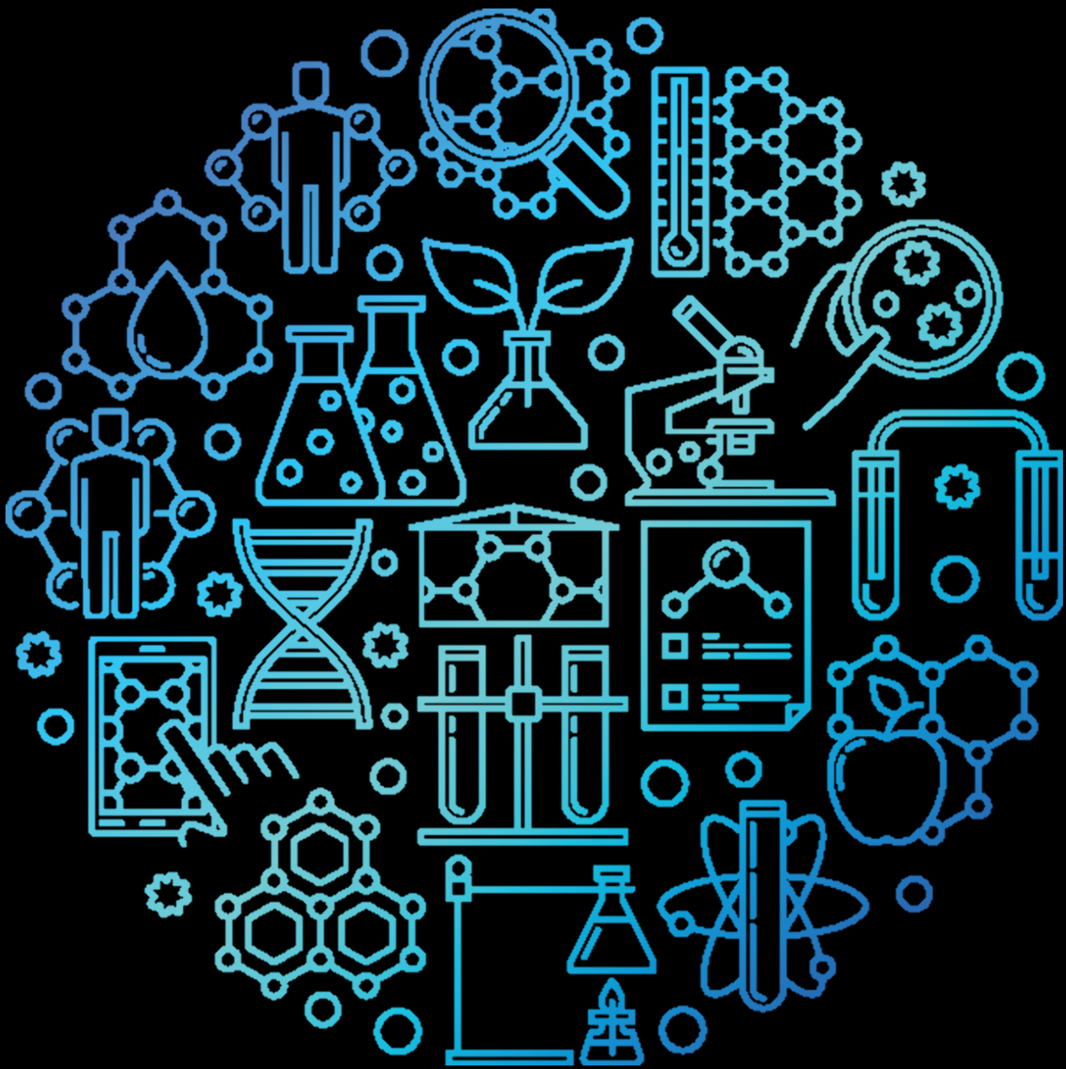

The economic impact of stroke in Australia, 2020

Stroke Foundation

November 2020

Deloitte Access Economics

Foreword

Stroke can be prevented, it can be treated and it can be beaten. The economic impact of stroke in Australia, 2020 (the Report) demonstrates the significant value and opportunity to invest in improved stroke treatments and care.

As the Report demonstrates, it is estimated the economic impact of stroke is a shocking $6.2 billion in direct financial costs and a further $26.0 billion in lost wellbeing and premature mortality in this financial year alone.

Stroke has long been recognised as being among Australia's most costly disease groups.[1]

In measuring the financial impact of stroke we must remember that behind these figures are real people. Our families, friends, colleagues, or even ourselves.

In 2020 it is estimated there will be 27,428 strokes experienced by Australians, and there are 445,087 survivors of stroke living in our community.[2]

As demonstrated in the Report, the impact of stroke extends well beyond the immediacy of the stroke and the individual impacted. Stroke instantly changes the life of the sufferer and their loved ones. Advancements in emergency stroke treatments mean more Australians are surviving stroke than ever before, however its impact can be felt for decades. This is particularly evident as we see the prevalence of stroke increasing among younger Australians.

Stroke is a leading cause of disability in Australia.[3] The impact of stroke on survivors and carers (most likely a family member) can be significant, ranging from profound limitations relating to self-care, movement and communication to difficulty with balance, ongoing fatigue and loss of concentration. Depression and anxiety are also common after stroke.

When Stroke Foundation commissioned a similar report in 2013, the economic impact of stroke was then estimated at $5 billion per year.[4] Today, it has increased markedly.

By 2050, without action, the number of strokes occurring in this country could increase to 50,600 and in that scenario, an estimated 819,900 Australians would be living with the impact of this debilitating disease. The consequential financial implications would be significant, but they are avoidable.

In addition to demonstrating the current economic impact of stroke, the Report shows the value of investing in stroke prevention, treatment and care. By reducing uncontrolled high blood pressure among Australians, developing stroke equipped ambulances, ensuring equity of access to comprehensive stroke centres and increasing stroke unit care we can improve outcomes from stroke and reduce its burden. Finally, by reducing the risk of further stroke through improved secondary prevention we can help more Australians live well after stroke and avoid hospital readmissions.

We know what good stroke treatment and care looks like. Stroke Foundation annual stroke audits identify the hospitals and teams that are setting benchmarks in treatment access, quality of care provided and improved outcomes for survivors of stroke. Each benchmark referenced in the Report could mean thousands of Australians avoiding stroke annually, surviving and living well after stroke, resulting in total estimated savings of $2.6 billion in economic and wellbeing costs over a 5 year period.

The 2050 scenario could be avoided if we act now to implement the interventions that we know could change the state of stroke in Australia for generations to come.

No report commissioned in 2020, can avoid noting the impact of the coronavirus (COVID-19) pandemic in Australia and across the world. While the data contained in this report has been delivered independent of the pandemic, COVID-19 will undoubtedly affect its results as emerging evidence demonstrate both unintended consequences and direct consequences of COVID-19 on stroke.

Australians are not visiting their general practitioner to have risk assessments or manage chronic conditions, calls to triple zero (000) have decreased meaning further delays in stroke treatments, our lifestyles are more sedentary. In addition, those who have experienced a stroke during this period are not being connected to rehabilitation or provided with the secondary prevention information they need to recover well. Continuity of care has been a major challenge and its impact will be felt as the country emerges from various restrictions and adapts to living in COVID-19 world. There is also some evidence from the United States and Europe suggesting COVID-19 may lead to an increase in stroke among younger people.[5]

The National Strategic Action Plan for Heart Disease and Stroke (The Action Plan) provides a roadmap of evidence based interventions, many of which have been modelled in this report. The Action Plan was developed by Stroke Foundation in partnership with the National Heart Foundation and funded by the Australian Government. We look forward to working in partnership with governments to implement the Action Plan and change the course of stroke in Australia.

We have an opportunity to act, to reduce the burden of stroke. It is in an investment we can and must make for the health and wellbeing of future generations.

Sharon McGowan
Chief Executive Officer
Stroke Foundation

Acknowledgements

Deloitte Access Economics acknowledges and thanks Stroke Foundation for commissioning the report. We would like to recognise the time and important contributions from the many clinicians and stroke experts who have contributed to the report.

Special thanks to Stroke Foundation Non-Executive Director representing interests of Clinicians and Chair of Clinical Council Professor Bruce Campbell MBBS (Hons), BMedSc, PhD, FRACP, FAHMS; Non-Executive Director representing interests of Research and Chair of Research Advisory Committee Professor Amanda Thrift, BSc (Hons), PhD, PGDipBiostat; Research Advisory Member Dr Nadine Andrew, and Associate Professor Seana Gall, BSc(Hons), PhD, Chair of the Health Promotion Advisory Subcommittee.

We would also like to thank the many people who volunteered to have their stories included in this report, to demonstrate the real impact of stroke on everyday Australians.

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Stroke FOUNDATION

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Acronym	Full description
ABS	Australian Bureau of Statistics
AIHW	Australian Institute of Health and Welfare
AR-DRGs	Australian Refined Diagnosis Related Groups
ARR	Absolute risk reduction
AWE	Average weekly earnings
BEACH	Bettering the Evaluation and Care of Health
BMI	Body mass index
DALY	Disability adjusted life years
DWL	Deadweight loss
F.A.S.T.	Face, Arm, Speech, and Time
GBD	The Global Burden of Disease Study
GP	General practitioner
HR	Hazard ratio
IHPA	Independent Hospital Pricing Authority
MBS	Medicare Benefits Schedule
mRS	Modified Rankin scale
NDIS	National Disability Insurance Scheme
NHS	Australian National Health Survey
NPV	Net present value
PAF	Population attributable fraction
PBS	Pharmaceutical Benefits Scheme
RFDS	Royal Flying Doctors Service
RR	Relative risk
SDAC	Survey of Disability, Ageing and Carers
The Clinical Guidelines	The Australian Clinical Guidelines for Stroke Management
VSLY	Value of a statistical life year
YLD	Years of life lost due to disability
YLL	Years of life lost due to premature death

Key insights

In 2020…

There were
445,087
Australians living with stroke

One stroke occurs every
19 minutes

8,703
people died from stroke

An estimated
27,428
Australians will experience stroke for the first time in their lives

Although there is a greater risk of stroke if you are older, almost
24%
of first-ever strokes happen in people **54 years and younger**

The impacts of stroke are far reaching

- Almost **70,000** people were hospitalised, costing the health system **$714 million**
- The productivity losses due to stroke total **$1.4 billion for those aged 54 years** and younger, compared to **$1.5 billion for 55 years and over**
- Informal carers provided **39.7 million** hours of care to survivors of stroke
- Survivors of stroke lose an average of **3.8 full time weeks** of work each year due to stroke
- **37% of people** living with the effects of stroke require support with everyday activities of living

Stroke costs…

Individuals and their families
$1.93 billion

Society and community
$1.02 billion

Employers
$427 million

Governments
$2.83 billion

The most devastating cost is borne by survivors of stroke

$26 billion
in lost wellbeing due to long term disability and premature death

Stroke can be prevented, and it can be treated.
Achieving realistic benchmarks can improve wellbeing and avoid economic costs with savings estimated to be …

$1.2 billion
by improving access and timeliness to treatment

$1.3 billion
by reducing uncontrolled hypertension in Australia

$45 million
by increasing anti-hypertensives prescription on discharge from hospital to prevent recurrent stroke

Executive summary

An estimated 27,428 Australians experienced stroke for the first time in their lives in 2020, and there were an estimated 445,087 survivors of stroke living in the community.[i] The economic cost of stroke exceeded $6.2 billion, with a further $26.0 billion in lost wellbeing - due to short and long-term disability, and premature death.

Stroke occurs when blood cannot travel to the brain, a result of a blocked or burst artery. Limited blood to the brain causes brain cells to die due to a lack of oxygen and nutrients.

"Stroke attacks the brain – the human control centre – changing lives in an instant…stroke can happen to anyone of any age" – Stroke Foundation

Stroke - and broader cardiovascular disease - is well recognised as one of the costliest disease groups in Australia.[6] Stroke is a complex medical condition, it can impact mobility, vision, communication, cognitive (thinking) ability, personality and behaviours. Stroke is one of this nation's biggest killers and is a leading cause disability.[7]

Advancements in stroke treatment have resulted in death from stroke declining in recent decades (deaths per 100,000 people almost halved between 2000 and 2013).[8] However, as this report demonstrates stroke remains a significant burden on our economy, health system and community.

This report quantifies the economic and wellbeing impact of stroke on the health system, aged care and disability services, the economy and our community. It also highlights potential cost savings that can be realised by reaching achievable benchmarks including access to timely stroke treatment and prevention. Most importantly, this report captures the real impact of stroke on individuals due to short and long-term disability and premature death.

In 2020, it was estimated that 445,087 Australians had experienced a stroke some time in their lives, of which 56% were male.

One stroke every

minutes

incidence rates have been **increasing over time** for aged **35-54**

The incidence of stroke has been declining in Australia. However, it must be noted there has been an increase in Australians having strokes at younger ages, particularly among those aged 35 to 54 years. In 2020, 6,535 (24% of total) strokes occurred in people aged 54 years and younger. This is equivalent to approximately 18 strokes a day and if trends continue, this is set to increase.[9]

The epidemiology of stroke also varies by geography. Regional and rural Australians are identified as 17% more likely to experience a stroke.[10] According to the National Stroke Audit Report, regional health services and their patients were also identified as having limited access to well established standard stroke treatments[11] resulting in poorer health outcomes from stroke.

[i] The economic impact of stroke in Australia, 2020 report was done independent of the coronavirus (COVID-19) pandemic. It is important to note the pandemic may have an impact on the data included in this report. Emerging evidence indicates chronic disease, including stroke, diagnosis and management may be impacted by the pandemic. There have also been reported delays in people accessing emergency stroke treatment and links between COVID-19 and stroke in younger people from the United States of America.

Key methodological revisions between reports

In Deloitte Access Economics' 2013 report, *The economic impact of stroke in Australia*, incidence of stroke was calculated by applying the rates reported by Thrift et al (2009) to 2012 Australian demographic data, after adjusting for the annual decline in stroke hospitalisations in the ten years between 1996-97 and 2005-06. The rates derived in the 2013 report were also used to estimate stroke prevalence and incidence in Stroke Foundation's 2017 report, *No postcode untouched: Stroke in Australia 2017,* by multiplying these rates by demographic data. Similarly, the prevalence and mortality rates from the 2013 report were also used to inform estimates of stroke deaths and the number of Australians living with stroke in 2017.

Stroke incidence and mortality have continued to decline since 2013, and there is emerging evidence that the number of Australians living with stroke may be declining. In this report, current estimates of incidence were calculated using a population-based study undertaken in Adelaide, South Australia. As the latest available incidence data were reported for 2010, the rates were further adjusted to reflect the continued decline in stroke incidence observed between 2000 and 2010 in Western Australia, specific to each age and gender group. These estimated rates were then applied to 2020 Australian demographic data. At the same time, the mortality and prevalence estimates in this report also reflect the latest and best available data sources on stroke from Australia.

These methodological revisions mean estimated stroke incidence, mortality and prevalence are lower compared to 2017. However, it is important to note the true incidence, prevalence and mortality from stroke may differ to those figures estimated here. Recent advances in data linkage capability in Australia may make it possible to estimate these data with greater certainty in the future.

These factors all have quantifiable economic and wellbeing consequences.

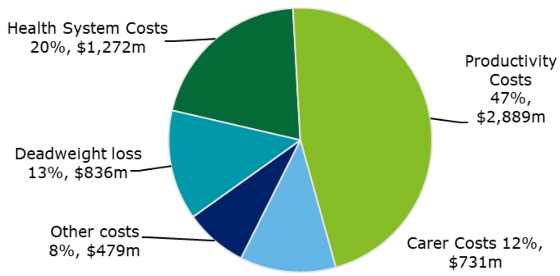
"We have made enormous gains in treating stroke in the past two decades, however this disease continues to place a heavy burden on Australia. The challenge is to ensure all Australians can access life-changing treatment when they need it. At the moment they are not." - Stroke Foundation Clinical Council Chair Professor Bruce Campbell.

Stroke can have devastating effects on individuals including physical and cognitive impairment, disability and sometimes death. In 2020, there was an estimated 8,703 deaths due to stroke. Mortality exponentially increases with age. Further, a third of stroke events resulted in a disability which impeded the survivor of stroke's ability to carry out activities of daily living unassisted.

*In 2020, the estimated economic cost of stroke was **$6.2 billion,** with a further **$26.0 billion** in lost wellbeing due to long term disability and premature death.*

The cost of stroke is not only felt by individuals but by their families and carers, government and society as a whole. The total economic cost of stroke in Australia was estimated to be $6.2 billion in 2020 (see Chart i). Productivity losses were the largest ($2.9 billion) resulting largely from premature mortality, time off from work and lower employment (compared with general community, see section 4.1) as a result of stroke.

Chart i: Economic cost of stroke in Australia, 2020

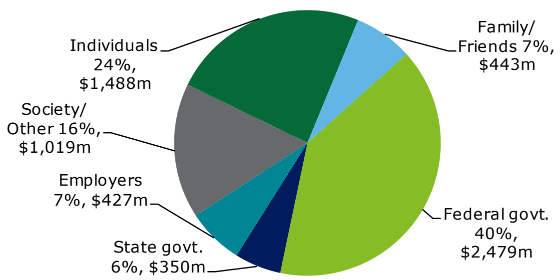


Source: Deloitte Access Economics.

However, the biggest impact of stroke is not the economic costs it causes, but the loss of healthy life. Of the total burden of stroke, loss of healthy life and wellbeing accounted for the majority at $26.0 billion. Meanwhile, should higher incidence rates among those aged 35-55 continue as they have done historically, the lifetime burden of this disease is expected to increase.

The Federal Government bore the greatest financial and economic burden at $2.5 billion (see Chart ii). This is due to lost productivity, with survivors of stroke affected by reduced employment, absenteeism and presenteeism, but also the services funded by the Federal Government, including health system costs, the National Disability Insurance Scheme and aged care services. State governments bore $350.2 million, mostly due to health care needs of people experiencing a stroke. Individuals and the broader Australian community bore most of the burden of stroke.

Chart ii: Economic costs due to stroke by cost payer category, 2020



Source: Deloitte Access Economics

If prevalence and incidence rates of stroke from 2020 were to continue, it is estimated there will be 819,900 Australians who have experienced a stroke some time in their lives by 2050.[12] This is an increase of 45.7% from 2020. Economic and wellbeing costs of stroke may also increase accordingly.

However, as this report demonstrates, there is significant value in investing to prevent stroke and improve access to timely treatment.

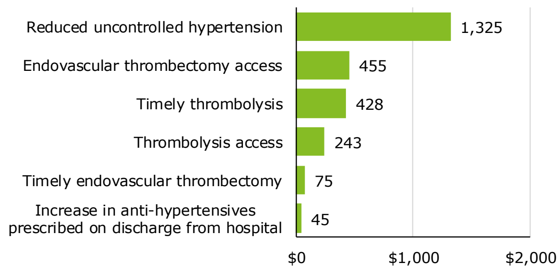
More than 80% of strokes in Australia are preventable by managing modifiable risk factors such as hypertension, overweight and obesity.[13]

Improvements in stroke prevention and treatment were modelled based on an assumed shift from current treatment to the national benchmarks provided by Stroke Foundation. Stroke Foundation consulted the latest in evidence and experienced clinicians in ensuring these measures were achievable and had significant potential to improve stroke outcomes. The benefits of reaching the proposed national benchmark in 2020 were captured through savings to wellbeing, productivity, the health system and to other financial costs.

Meeting these benchmarks in 2020 has the potential to save $179.0 million over five years and improve wellbeing and reduce mortality from stroke to the value of $2.4 billion.

Each benchmark considered has the potential to improve health outcomes for thousands of Australians annually. If these benchmarks were met in 2020, the expected benefits over the next 5 years from improved wellbeing and reduced mortality were estimated at $2.4 billion (in net present value, or NPV terms); further, there are also notable economic and financial savings of $179.0 million over five years in NPV terms (see Chart iii). These benefits would accrue to government as well as society, in addition to Australians directly impacted by stroke.

Chart iii: Estimated cost savings by benchmark ($ millions)



Source: Deloitte Access Economics

Note: Increase in antihypertensives prescribed on discharge from hospital is a secondary prevention measure to prevent recurrent stroke. The modelling estimates potential benefits that accrue over a 5-year period for changes in the benchmarks in 2020.

Advances in stroke treatment have resulted in significant declines in mortality, and better control of risk factors has resulted in reduced incidence of stroke. However, as quantified in this report, stroke continues to place a significant economic and wellbeing burden on our health, aged care and disability systems, the economy and the community. It does not have to be this way. This report demonstrates, there are potentially billions of dollars and many years of healthy life to be gained annually by investing in evidence based actions to reach achievable benchmarks in stroke prevention and equitable access to timely treatment.

Deloitte Access Economics

Bill and Denise Vernon

"When I suffered my stroke, I was living in a remote part of Western Australia. When I got to my local hospital, they didn't think I was going to make it through the night. It wasn't until the next morning that I was transported to Bunbury, and then onto Perth. After they assessed me, I was told I would never walk or talk again. But I was determined to recover. We moved to Perth, so I could get the rehabilitation I needed. I know I will never be able to go back to work, and I still have problems with my memory and finding words. But today, after a lot of hard work, and with the support of my family, I am able to walk."

– Bill Vernon, Survivor of stroke.

1 Introduction

This chapter outlines how stroke is defined, the types of strokes that people have, the risk factors that may lead to stroke and the available treatment pathways of stroke. There is also a discussion on how stroke care is evolving and the likely treatment pathways into the future.

1.1 Defining stroke

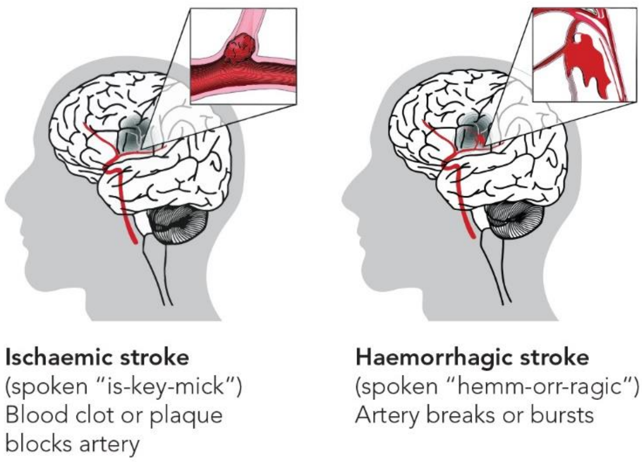
Stroke attacks the brain - the human control centre - changing lives in an instant.

The brain is fed by blood carrying oxygen and nutrients through blood vessels called arteries. A stroke happens when blood cannot get to your brain, because of a blocked or burst artery. As a result, your brain cells die due to a lack of oxygen and nutrients.

When blood supply to the brain is blocked brain cells begin to die at a rate of 1.9 million a minute.[14]

Every stroke is different depending on where in the brain it strikes and how severe it is. What is common, is the devastation it can cause the survivor, their carer and family.

Figure 1.1 There are two types of stroke



Source: Used with permission from the Stroke Foundation

Impaired functions may include:

- Movement and sensations
- Speech and language
- Eating and swallowing
- Vision
- Cognitive ability
- Perception and orientation to surroundings
- Self-care ability
- Bowel and bladder control
- Emotional control
- Sexual ability.

1.1.2 Risk factors for stroke

Some risk factors associated with stroke are modifiable, and others are not. The Australian Burden of Disease identified ten modifiable risk factors and the burden of stroke that can be attributed to them.[15] However, the prevalence of risk factors by age and gender may result in certain population groups being at higher risk of stroke. In this report, the prevalence of six of those risk factors were estimated across the population: these were determined as priority action areas in order to significantly impact health outcomes from stroke. These six risk factors were:

- High blood pressure
- High cholesterol
- Overweight and obesity
- Physical inactivity
- Smoking
- Atrial fibrillation.

Each of these risk factors was derived based on National Health Survey (NHS) data.[16] The following definitions have been used:

- Daily smoking corresponds to self-report data on people who smoke daily.
- Physical inactivity includes people who reported **no physical activity** (either exercise or work related) in the past week.
- High blood pressure includes people with a systolic blood pressure measurement was greater than 140/90 mmHg. Does not include people who had high blood pressure but were managing their condition using blood pressure medications.
- High cholesterol includes people who had total cholesterol exceeding 5.5 mmol/L. Does not include people who had high blood pressure but were managing their condition using blood pressure medications.
- Overweight and obesity includes all people with a body mass index score >25 (a score between 25-30 is considered overweight while a score >30 is considered obese).

The prevalence of atrial fibrillation has also been estimated within the Australian adult population.[17]

In general, the likelihood of a person having any of the selected risk factors increases with age. However, there are also gender differences. Physical inactivity and high blood cholesterol were found to be more prevalent among women, while the remaining four were more prevalent among men.

High blood pressure is the most important risk factor, responsible for almost four times the burden compared to either physical inactivity or smoking (unadjusted for comorbidity across risk factors). Overweight and obesity is the second most burdensome risk factor (21% of the total burden of stroke, unadjusted for comorbidity across risk factors). The Global Burden of Disease study estimated that risk factors account for approximately 83% of the total burden of stroke in Australia.[18]

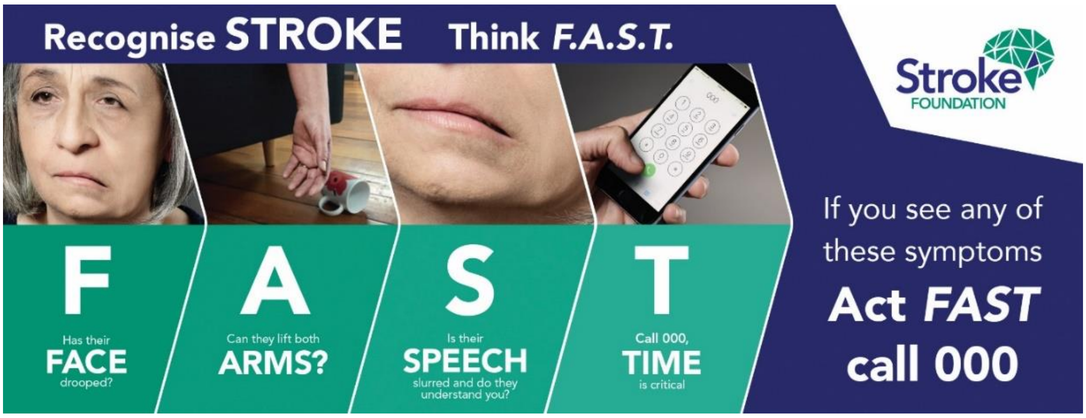
1.2 Stroke treatment

1.2.1 Early recognition, treatment and long-term care

Prevention starts with knowing your risk. One in two Australians have at least one risk factor associated with stroke. Modifiable risk factors, such as those mentioned in Section 1.1.2, can be addressed with interventions tailored to the individual. However, were stroke to occur, one common framework for early recognition, as advocated by the Stroke Foundation, is F.A.S.T. (Face, Arm, Speech, and Time).[19]

Around 80 percent of strokes will exhibit one or more of the F.A.S.T.[20] signs of stroke symptoms. Stroke Foundation dedicates significant efforts and resources to raise awareness of the F.A.S.T. signs among the community.

Figure 1.2 Symptoms of stroke



Source: Used with permission from the Stroke Foundation

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, ischaemic or haemorrhagic. Typically, a non-contrast computed tomography (CT) brain scan is used to determine whether an individual has experienced a haemorrhagic stroke based on identifying bleeding in or around the brain. If bleeding is detected, a neurosurgical evaluation is required to detect and treat the cause of the bleeding. The individual is then monitored for changes in the level of consciousness, and whether their blood pressure, blood sugar, and oxygenation are kept at optimum levels.

If no bleeding is identified, the individual is assumed to have had an ischaemic stroke. Resulting in the use of thrombolysis to break the clot down in order to remove the blockage. If this is not possible, the clot can also be mechanically removed using thrombectomy. Both methods are effective in enabling blood flow to be restored to the brain. The sooner blood flow is restored to the brain the better the outcome for the patient.[21]

Following a stroke, rehabilitation enables survivors to reach and maintain their optimal physical, sensory, intellectual, psychological and social functional wellbeing. Providing survivors of stroke with the ability to regain independence through self-determination.[22]

1.2.2 Future of stroke healthcare

Mortality rates following a stroke are improving and can be attributed to significant advancements in emergency stroke treatment. This follows the Clinical Guidelines for Stroke Management (the Guidelines) evolving into the world's first living guidelines and means that as new evidence becomes available the Guidelines are updated to assist with clinical practice and policy development.[23]

Regional health services and their patients are being left behind as treatments advance.[24] This is because regional patients have limited access to well established stroke treatments, while major city hospitals continue to innovate benefiting their patients. However, this could change with technology enabling experienced clinical and allied health practitioners to engage with patients in the regions. For example, Australia has led the way in:

- Proving the benefits and safety of endovascular thrombectomy (clot retrieval).
- Utilisation of telehealth and clinical pathways for emergency stroke treatment in limited regional areas of Australia.
- Bringing emergency stroke diagnosis and treatment technologies to patients via the Mobile Stroke Unit or Stroke Ambulance.
- Adopting a living evidence approach to translate the latest in stroke research into practice. This method has been utilised for the development of clinical guidelines for COVID-19 management.

Innovations have been focused on emergency treatment and primarily in our metropolitan areas. There is an opportunity to expand lessons from these innovations, boosting the capacity of our health professionals, to benefit more Australians, and at different stages of the stroke journey.

1.3 Purpose and scope of this report

Stroke Foundation engaged Deloitte Access Economics to provide an updated estimate on the social and economic impact of stroke in 2020. This report draws on the latest evidence both within Australia and internationally to highlight the significant cost associated with stroke. It is anticipated that this this report will support informed policy development in relation to stroke healthcare in Australia.

The costs of stroke in Australia were estimated for the 2019-20 financial year using a prevalence approach. A prevalence approach measures the number of people with stroke at a point in time, and estimates the costs incurred due to stroke for a given year. Table 1.1 provides the conceptual framework for costs associated with stroke by type and cost bearer.

The broad types of costs associated with stroke includes:

- **financial costs to the Australian health system**, which include 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), allied health services and other health system expenditures.
- **productivity costs**, which include reduced workforce participation, reduced productivity at work, loss of future earnings due to premature mortality, and the value of informal care (lost income of carers of survivors of stroke).
- **other costs**, including all other government and non-government programs and out-of-pocket expenses (such as formal aged and disability care; aids, equipment and home modifications; and deadweight losses from raising additional tax revenue).
- **transfer costs**, which comprise the deadweight losses, or reduced economic efficiency, associated with the need to levy taxes to fund the provision of government services.
- **wellbeing costs** that are non-financial in nature, capturing the costs associated with reduced quality of life among survivors of stroke and premature death for those who die from stroke. These costs are measured using a burden of disease methodology, based on the years of healthy life lost due to morbidity and mortality.

Table 1.1: Conceptual framework for costs associated with stroke by type and bearer

Cost component	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)	Individuals	The value of a statistical life year (VSLY) excludes costs borne by the individual that are counted elsewhere, to avoid double counting (i.e. it is a net VSLY)
Health system	• Hospital inpatient and outpatient • Imaging and pathology • Pharmaceuticals • General practitioners, specialists and allied health • Complementary and alternative medicine • Rehabilitation	Individuals, Federal government, State and Territory government, health insurance providers, other parts of society (e.g. workers' compensation)	Measured bottom-up using data from Australian Institute of Health and Welfare (AIHW), Independent Hospital Pricing Authority (IHPA), NHS, PBS, Medicare Benefits Schedule (MBS) and other literature

Cost component	Subgroups	Bearers of cost	Comments
Productivity	• Reduced employment participation • Temporary absenteeism • Presenteeism • Premature death • Increased need for informal care	Individuals, Federal government, State and Territory government, other parts of society (e.g. employers)	• Includes premature retirement • Absenteeism is that in excess of average absenteeism • Reduced productivity while at work • Loss of productive capacity i.e. the stream of future earnings • Measured as the opportunity costs of paid work by informal carers
Other financial	• Aids, equipment and home modifications • Aged care • National Disability Insurance Scheme • Deadweight losses	Individuals, Federal government, State and Territory government, health insurance providers, other parts of society	• Includes mobility and hearing aids, and structural changes to the home • Includes the Commonwealth Home Support Programme and Home Care Packages • Cost of disability support for those aged <65 • Efficiency losses that arise due to the increased taxation to provide support payments, health services and replace lost employment taxes

Importantly, while "2020" has been used to describe the year in which estimates have been provided, some conceptual timing differences should be noted.

First, **costs have been estimated for the 2019-20 financial year, occurring between 1 July 2019 and 30 June 2020**. Where costs were available for previous financial years, they have been updated using appropriate inflators (e.g. a health inflation index) and also demographic changes since the earlier year.

Second, it is worth highlighting prevalence has been estimated for 2020 by multiplying estimated population demographics (based on Deloitte Access Economics' demographics model, DAE-DEM) at 30 June 2020 by the prevalence rates described in section 2.1. This means that prevalence is current as at the end of each financial year.

Finally, incidence in 2020 has been estimated by multiplying population estimates at 30 June 2020 by incidence rates described in section 2.2. Incidence rates are typically measured as a rate per some number of person years (e.g. incidence per 1,000 person years). Estimating the rates in 2020 in this way means there may be some cases that are excluded from the analysis: for example, if a person alive at 30 June 2019 has a stroke and then dies during the year from a cause other than stroke, they may not be counted. As the differences will be small, these cases have not been modelled in this report.

1.3.1 Key methodological revisions between reports

In Deloitte Access Economics' 2013 report, *The economic impact of stroke in Australia*, incidence of stroke was calculated by applying the rates reported by Thrift et al (2009) to 2012 Australian demographic data. At the time, the incidence rates were conservatively adjusted to reflect the annual decline in stroke hospitalisations noted by Thrift et al (2012) in the ten years between 1996-97 and 2005-06. The rates derived in the 2013 report were also used to estimate stroke prevalence and incidence in Stroke Foundation's 2017 report, *No postcode untouched: Stroke in Australia 2017*, which provided estimates of stroke incidence nationally and for each Federal electoral division in Australia. Similarly, the prevalence and mortality rates from the 2013 report were also used to inform estimates of stroke deaths and the number of Australians living with stroke in 2017.

Stroke incidence and mortality have continued to decline since 2013, and there is emerging evidence that the number of Australians living with stroke may be declining based on self-reported data published in the Australian Bureau of Statistics' *Survey of Disability, Ageing and Carers*. In this report, current estimates of incidence were calculated using a population-based study undertaken by Leyden et al (2010) in Adelaide, South Australia. As the latest available incidence data were reported for 2010, the rates were further adjusted to reflect the continued decline in stroke incidence using trend data reported by Sarink et al (2018), who provided trends specific to each age and gender in Western Australia. The estimated rates were then applied to 2020 Australian demographic data. At the same time, the mortality and prevalence estimates in this report also reflect the latest and best available data sources on stroke from Australia, coupled with Deloitte Access Economics' demographic projections.

The estimated stroke incidence, mortality and prevalence have declined since 2017 due to these methodological revisions. However, it is important to note the true incidence, prevalence and mortality from stroke may differ to the figures estimated here. Recent advances in data linkage capability in Australia may make it possible to estimate these data with greater certainty in the future.

In addition to the epidemiological source changes, there have also been a number of other updates to methodology and data sources between the two reports. For example, it was possible to estimate the aged care and disability supports due to stroke in this report. Similarly, other data revisions have included updates to health expenditure data (e.g. in particular, more comprehensive pharmaceutical data were available for this report), productivity impacts and loss of wellbeing estimates.

1.3.2 Structure of this report

This report is structured in the following way:

- **Chapter 2 Prevalence, incidence and mortality:** Describes the key data sources and calculations used to estimate the epidemiology of stroke, and presents estimates by age, gender and disability status.
- **Chapter 3 Health system costs:** Details the estimate of the health system costs incurred due to stroke, including inpatient and outpatient hospital costs; imaging and pathology; pharmaceuticals; general practitioners, specialists and allied health; and rehabilitation.
- **Chapter 4 Productivity** losses**:** Describes the differences in employment between the general population and survivors of stroke and presents the economic costs that emerge as a consequence, including reduced employment, absenteeism, presenteeism, premature mortality and informal care.
- **Chapter 5 Other costs** Provides estimates of other financial costs that arise due to stroke, including aids, equipment and home modifications; aged care; the National Disability Insurance Scheme; and deadweight losses.
- **Chapter 6 Loss of wellbeing:** Presents the non-financial costs of reduced quality of life associated with the morbidity and mortality of stroke.
- **Chapter 7 Improvements to stroke care:** Explores the benefits if stroke care were to improve such that a range of benchmarks are met, from improved access to thrombolysis and endovascular thrombectomy to better management of hypertension in the community (including post-stroke).

Shannon Nelson

"Recovering from a stroke is extremely difficult. It impacts your physical and metal health, but also your independence, family life and financial livelihood. Even after intense rehab, I still struggle with aphasia and verbal dyspraxia - the ability to coordinate the movement of the muscles used during speech. But I've learnt it's important to pursue things that make you happy. I was determined to go back to work and create new memories with my family."

– Shannon Nelson, Survivor of stroke.

2 Prevalence, incidence and mortality

This chapter outlines the approach taken to estimate the prevalence, incidence and mortality of stroke in Australia during 2020. Australian data has been relied upon and is supplemented by targeted literature reviews of international literature. Where possible, emphasis has been given to recent publications as there is evidence to suggest incidence and mortality has been declining over time across all ages.

Key findings

- In 2020, there were an estimated 445,000 survivors of stroke compared to 420,000 survivors of stroke in 2012.
- There were 27,400 Australians who experienced stroke for the first time in their lives in 2020. Rates of first-ever stroke have declined over time particularly in people aged 65 years or older.
- There is evidence that stroke incidence is rising in people aged 35-54 years old, which if unaddressed may lead to greater costs due to stroke in the future.
- There were an estimated 8,700 deaths due to stroke in 2020. Mortality from stroke has declined over time, though this trend has steadied over the last 5 years.
- By 2050, there will be an estimated 819,900 survivors of stroke: incident cases are expected to increase to 50,600 and there will be an estimated 19,800 deaths.[ii]

2.1 Prevalence

Prevalence refers to the number of people who are living with the effects of stroke, herein referred to as "survivors of stroke", at any given time.

It was estimated that **there were an estimated 445,000 survivors of stroke in 2020.** Over half (56%) were male and the prevalence rate increases with age (Table 2.1 and Chart 2.1). Based on projected demographic changes, **there will be 819,900 survivors of stroke in 2050.** Chart 2.1 provides a visual summary of the estimated prevalence rates and the number of survivors of stroke in Australia in 2020. Table A.2 provides detailed prevalence rates by age, gender.

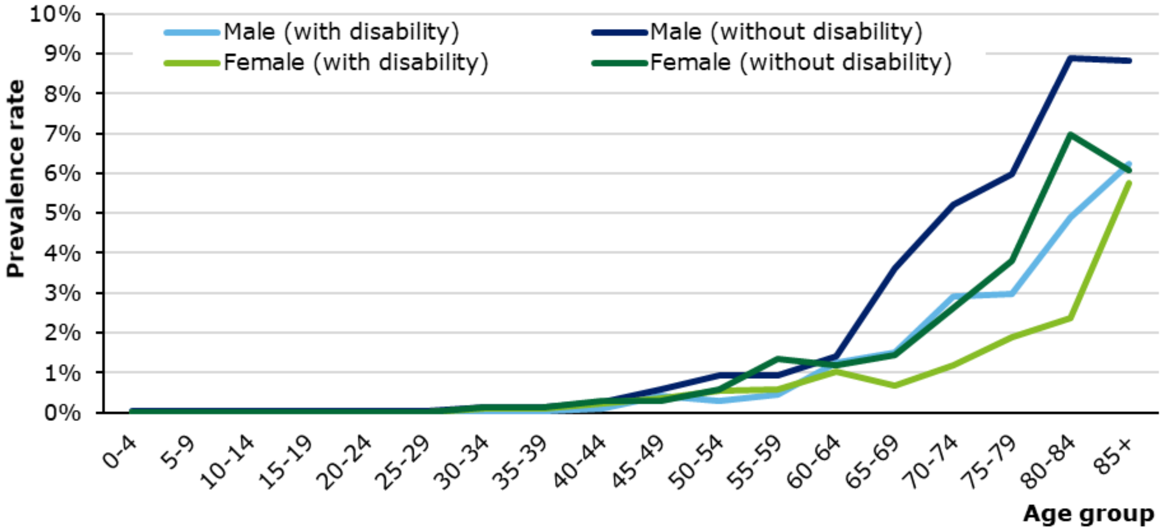
In reviewing these data, it is important to note stroke affects sections of the Australian population differently. In 2018, the AIHW reported Aboriginal and Torres Strait Islander people were more than 1.7 times more likely to be hospitalised for stroke. [25]

Correlated with these findings are the prevalence rates of health risk factors in the Aboriginal and Torres Strait Islander population. Recognised disadvantage sees Aboriginal and Torres Strait Islander people have high rates of obesity, smoking and physical inactivity compared to non-Aboriginal and Torres Strait Islander people.[26] These are all known risk factors of stroke considered in this report. Aboriginal and Torres Strait Islander people also have dietary risks and higher levels of alcohol consumption (both stroke risk factors not included within this report) placing them at greater risk of stroke.

Similarly, people living in remote areas are at a disadvantage with regard to stroke, with 1.4 times higher likelihood of being hospitalised due to stroke. Compared to major cities, outer regional and remote areas have higher rates of high blood pressure, daily smoking, insufficient physical activity, obesity and alcohol consumption.[27]

[ii] These estimates assume that there are no further improvements to stroke prevention or treatment in Australia.

Chart 2.1: Prevalence rates of stroke with and without disability, by age and gender



Source: Australian Bureau of Statistics (2019), Deloitte Access Economics calculations. Note: Disability is defined as a restriction in everyday activities due to the long-term effects of stroke.

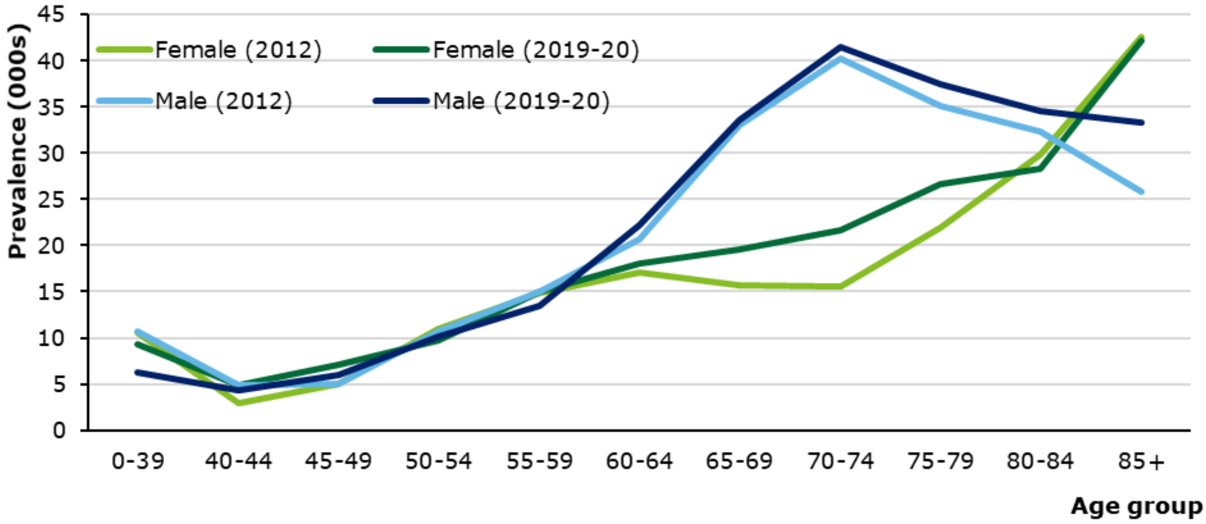
Table 2.1: Stroke prevalence by age and gender, 2020

	000's of people			Prevalence rate	
Age group	**Male**	**Female**	**Total**	**Male**	**Female**
0-19	1.9	0.7	2.5	0.06%	0.02%
20-44	8.7	13.5	22.1	0.08%	0.13%
45-54	16.1	16.7	32.9	0.08%	0.13%
55-59	13.5	15.0	28.5	0.16%	0.33%
60-64	22.2	18.1	40.2	0.16%	0.33%
65-69	33.6	19.6	53.3	0.53%	0.60%
70-74	41.4	21.6	63.0	0.72%	0.83%
75-79	37.5	26.6	64.1	1.34%	1.21%
80-84	34.5	28.3	62.8	1.78%	1.90%
85+	33.3	42.2	75.6	3.21%	2.48%
Total	**242.7**	**202.4**	**445.1**		

Source: Australian Bureau of Statistics (2019), Deloitte Access Economics calculations. Note: Disability is defined as a restriction in everyday activities due to the long-term effects of stroke.

Prevalence of stroke has remained relatively stable despite Australia's overall population and ageing demographic increasing. For example, 1.77% of the Australian population were living with the effects of stroke in 2012 (or 420,000).[28] This has decreased slightly to 1.73% of the Australian population in 2020. Overall, the epidemiological profile of people living with stroke has remained stable, with men aged 70-74 and women aged 85+ the worst affected age groups. Chart 2.2 provides a visual comparison of prevalence by age and gender in 2020 compared to 2012.

Chart 2.2: Prevalence of stroke by age and gender, 2012 and 2020



Source: Deloitte Access Economics (2013), Australian Bureau of Statistics (2019), Deloitte Access Economics calculations.

The prevalence estimates were based on the 2009, 2012, 2015 and 2018 Survey of Disability, Ageing and Carers (SDAC) conducted by the Australian Bureau of Statistics (ABS).[29] [30] [31] [32] The SDAC provides detailed information on the self-reported prevalence of a variety of disabilities by age and gender, including stroke.[33] For example, 1.5% of the Australian population or 386,900 persons were self-reported survivors of stroke in 2018. To account for variation between surveys and small number counts for young survivors of stroke, pooled rates were estimated using the four surveys combined. Pooled rates were calculated by summing the total survivors of stroke across the four surveys and dividing by the sum of the overall population across the four surveys (calculated separately for each age and gender group).

The SDAC is nationally representative and includes people residing in institutional care facilities, including aged care facilities as well as hospitals and other care facilities. Due to the self-reported nature of the data, the SDAC may underestimate the prevalence of stroke where people have experienced a silent stroke. Similarly, some people who have had a transient ischaemic attack may report these as strokes while others may not. Despite these limitations, it remains the most comprehensive and up-to-date source of information in Australia.

To derive the final prevalence estimates for 2020, the rates from the SDAC were multiplied by the Australian population by age and gender using estimates available from Deloitte Access Economics' Demographic projection model, DAE-DEM. In 2020, the population estimates are comparable with the Australian Bureau of Statistics' Estimated Resident Population series. Further details about DAE-DEM are provided in Appendix A. These population estimates were also used as the basis for incidence and mortality in 2020, and also for projecting the number of Australians living with stroke, incidence of stroke and mortality from stroke into the future. Projections were made on the basis that the rates by five-year age and gender group remain constant into the future, so the increasing prevalence reflects trends in the changing demographics of the Australian population for the same groups.

2.2 Incidence

Incidence refers to the number of people who experience a stroke for the first time, within a given time period. This analysis estimates the incidence of first-ever stroke in Australia during 2020.

The annual trends from Table 2.3 were used to adjust the 2010 incidence rates from Leyden et al to 2020 rates. [34] The 2020 rates are provided in Table 2.2. Overall, **there were an estimated 27,428 incident cases (events) of stroke in 2020** with almost 56% of incident cases of stroke occurring in men. Based on projected demographic changes, **there will be 50,582 incident**

cases of stroke in 2050. The age and gender breakdown of incidence of stroke is provided in Table 2.2.

Though stroke incidence has not been disaggregated for the Aboriginal and Torres Strait Islander population, it is understood that Aboriginal and Torres Strait Islander people are at a much greater risk of stroke. For example, Dos Santos et al found age-standardised incidence to be three times higher in the Aboriginal and Torres Strait Islander population compared to non-Aboriginal and Torres Strait Islander people.[35] Similar results were reported by Katzenellenbogen et al where the Aboriginal and Torres Strait Islander to non-Aboriginal and Torres Strait Islander age-standardised stroke incidence rate ratio was 2.6 for males and 3.0 in females.[36]

Table 2.2: Incidence rates and total cases of stroke by age and gender, 2020

Age group	Male incidence rate (per 100,000 people)	Female incidence rate (per 100,000 people)	Male population	Female population	Males (cases)	Females (cases)	Total
0-19	4.0	2.0	3,234,560	3,060,546	129	61	191
20-24	11.0	9.0	905,033	856,684	100	77	177
25-34	32.5	33.3	1,921,506	1,932,885	625	643	1,268
35-44	44.2	38.1	1,711,664	1,739,181	756	662	1,419
45-54	130.3	86.0	1,584,557	1,646,615	2,065	1,415	3,481
55-64	205.0	86.5	1,447,482	1,517,151	2,967	1,313	4,280
65-74	201.3	183.0	1,144,751	1,201,351	2,304	2,199	4,502
75-84	600.1	413.6	580,071	660,947	3,481	2,734	6,215
85+	1,480.3	933.2	197,796	318,016	2,928	2,968	5,896
Total			**12,727,418**	**12,933,378**	**15,355**	**12,073**	**27,428**

Source: Deloitte Access Economics calculations based on Leyden et al (2013), Anderlini et al (2020), Sarink et al (2018).

The most current population-based study, with enough detail for the economic modelling and robust case ascertainment, was conducted in Adelaide in 2010.[37] Leyden et al assessed cases of stroke through screening of emergency department presentations, hospital admissions and through weekly contact with nursing homes.[38] The stroke outpatient clinic in the region was monitored as well as neurology outpatient clinics. Leyden et al determined the incidence of stroke in a population of 148,000 people in the Western Suburbs of Adelaide.[39] **Given the strengths of the Leyden et al's case ascertainment, it was selected as the basis of incidence more broadly in Australia**.[iii iv]

Anderlini et al undertook analysis of persons hospitalised for stroke in Queensland.[40] These results were used to estimate stroke incidence for people aged <25.[41] Incidence of stroke hospitalisation for people aged <20 was 2 per 100,000 people for women and 4 per 100,000 people for men. These rates are consistent with international literature on childhood stroke.[42] For the 20-29 age

[iii] The incidence rates were consistent with the only other population-based study Newbury et al (2017). This paper followed the methodology of the Adelaide Incidence Study and applied this to a rural population. Incidence rates were lower than the Adelaide Incidence Study, though this was likely due to a slightly younger population (7.4% of people aged over 75 compared to 9.9% in the Adelaide Incidence Study).

[iv] Compared to hospitalisation data, incidence rates per 100,000 people are broadly consistent. Notably, the incidence rates are similar to hospitalisation rates for younger adults, whereas hospitalisation rates in people aged 55 years or older are significantly higher than the incidence rates. For example, there were 7 hospitalisations per 100,000 people aged <25 which compares to incidence rates of 4 (males) and 2 (females) per 100,000 people. There were 2,677 stroke hospitalisations per 100,000 people aged 85+ compared to incidence rates of 1,480 (males) and 933 (females) per 100,000 people.

group, incidence rose to 9 for women and 11 for men. Several other sources were considered in the analysis. The sources are described in Table A.3.

Leyden et al provides data for the 2010 calendar year. [43] Given that there have been reported declines in stroke incidence over time, a targeted literature review was undertaken to determine whether there were any identifiable trends in incidence data since 2010.

Sarink et al provided the most informative estimate of trend in incidence. [44] Sarink et al provides data over the longest period by relevant age and gender groups. Incidence was reported on the basis that a person was not hospitalised for stroke in the 10 years prior to the relevant date of admission in order to account for recurrent stroke. The trend described in Table 2.3 was then multiplied by the incidence rates reported by Leyden et al, adjusting incidence rates for 2020 by the likely continued downward trend in incidence since 2010.

It is noted that incidence was found to be increasing in people aged 35-54. This is reflective of international trends, and it may partly be explained by increased sedentary lifestyle among these ages.[45] It is possible part of this increase may be attributed to increased detection in younger ages through improvements to diagnostic criteria and imaging over time. Insufficient trend data for those aged 0-35, meant no trend was applied to incidence to these age groups.

Table 2.3: Average annual trend in incidence rates by age and gender, 1995 to 2010

Age group	Male	Female
0-34	0.00%	0.00%
35-54	1.31%	2.86%
55-59	-1.39%	-2.22%
60-64	-1.39%	-2.22%
65-69	-3.37%	-3.35%
70+	-3.32%	-3.32%

Source: Adapted from Sarink et al (2018).

2.3 Mortality

It was estimated there were 8,703 deaths in 2020 due to stroke. Table 2.4 provides the breakdown of mortality in 2020. Based on demographic projections, **deaths due to stroke will increase to 19,800 by 2050.**

The AIHW found that Aboriginal and Torres Strait Islander people have a 1.3 times greater risk of dying from stroke compared to non-Aboriginal and Torres Strait Islander people.[46] The same elevated risk applies for people in the lowest socioeconomic areas.[47]

Table 2.4: Deaths due to stroke, 2020

Age group	Male	Female	Total
0-19	10	6	16
20-44	57	34	91
45-54	103	93	196
55-59	125	89	215
60-64	115	82	197
65-69	311	231	542
70-74	258	188	446
75-79	690	716	1,406
80-84	450	518	968
85+	1,508	3,118	4,626
Total	**3,627**	**5,077**	**8,703**

Source: AIHW (2020), Deloitte Access Economics calculations.

Mortality due to stroke was based on analysis of the National Hospital Mortality Database. The National Hospital Mortality Database uses cause of death data to estimate the number of deaths due to stroke. For the purposes of this analysis, mortality from stroke has been based on deaths where stroke is the principal underlying cause.[v, 48] Stroke deaths by age and gender were used to calculate mortality rates due to stroke for the year 2018. These mortality rates are presented in Table 2.5.

Table 2.5: Mortality rates due to stroke by age and gender, 2018

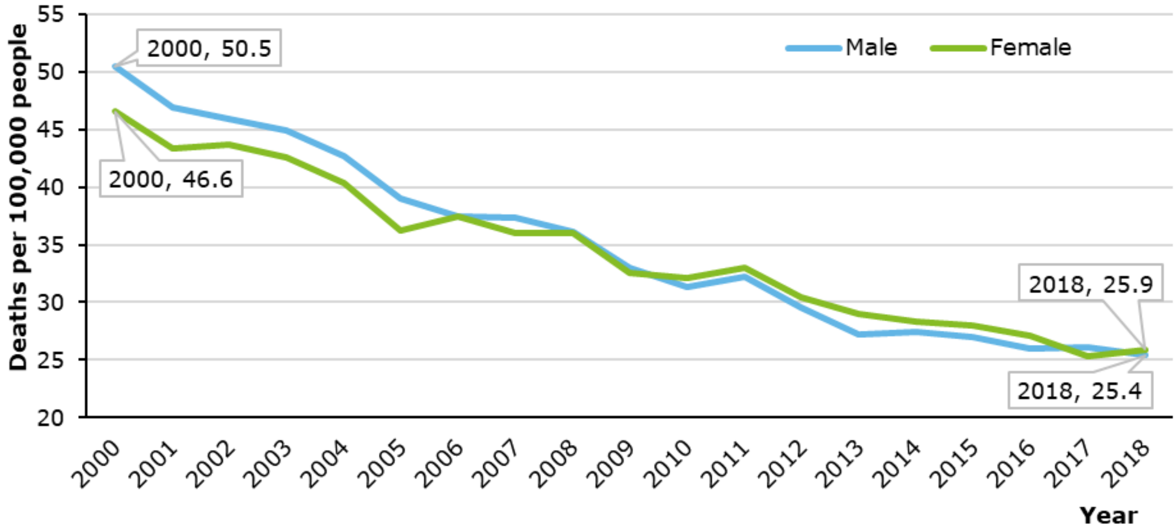
Age group	Male	Female
<35	0.0003%	0.0002%
35-44	0.0028%	0.0016%
45-54	0.0065%	0.0056%
55-64	0.0166%	0.0113%
65-74	0.0497%	0.0349%
75-84	0.1965%	0.1867%
85+	0.7623%	0.9805%

Source: AIHW (2020), Deloitte Access Economics calculations.

Mortality due to stroke has declined since 2000. Chart 2.3 highlights that deaths per 100,000 people almost halved between 2000 and 2018. However, it is noted that there has been little decrease in mortality due to stroke from 2013 onwards. Given that the trend in mortality appears to be levelling out, no trend was applied to the mortality rates provided in Table 2.5.

[v] It is noted that ABS cause of death data identified more than 16,158 deaths where stroke was one of multiple causes of death in 2018. This suggests that there are a significant number of deaths which may be partly attributable to stroke which are not included within this analysis.

Chart 2.3: Trend in deaths due to stroke per 100,000 people, 2000-2018



Source: AIHW (2020)

2.4 Prevalence of stroke risk factors

Certain population groups may be at a higher risk of stroke given the presence of certain stroke risk factors. The Australian Burden of Disease identified ten modifiable risk factors and the burden of stroke which can be attributed to them.[49] Briefly, these were:

- High blood pressure
- High cholesterol
- Alcohol use
- Dietary risks
- High blood plasma glucose
- Impaired kidney function
- Overweight and obesity
- Physical inactivity
- Tobacco use
- Air pollution

Data for five of these risk factors – high blood pressure, high cholesterol, overweight and obesity, physical inactivity[vi] and smoking – are reported in Table 2.6. Atrial fibrillation was also considered as a modifiable risk factor in the analysis.

Risk factors selected for analysis were determined as priority actions in order to significantly impact health outcomes from stroke. The definitions of these risk factors are presented in section 1.1.2.

Overweight and obesity was the most prevalent risk factor with almost 13.8 million Australians aged 15 and over, followed by high blood pressure (4.7 million Australians aged 15 and over) and no physical activity (3.1 million Australians aged 15 and over).[50]

[vi] In this report, physical inactivity has been estimated based on data corresponding to people who report **no physical activity** in the past week, as reported in the National Health Survey.

Table 2.6: Estimated prevalence of selected risk factors by age and gender, '000s of people or % of population, 2020

Age group	High blood pressure	Atrial fibrillation	High blood cholesterol	Physically inactive~	Smoking	Overweight and obesity
Male						
15-19	34.0	0.0	0.0	53.4	81.8	325.5
20-44	640.3	0.0	162.4	391.4	897.0	3,156.6
45-74	1,522.3	92.4	844.4	701.9	618.4	3,477.3
75+	359.0	115.8	218.1	236.5	53.4	573.8
Total male	**2,555.7**	**208.2**	**1,225.0**	**1,383.2**	**1,650.6**	**7,533.3**
Female						
15-19	11.4	0.0	4.9	82.8	43.3	215.2
20-44	404.6	0.0	120.6	471.0	527.5	2,366.8
45-74	1,315.5	60.4	849.2	795.6	532.1	2,980.4
75+	440.9	115.8	272.3	395.3	37.4	679.3
Total female	**2,172.4**	**176.2**	**1,247.0**	**1,744.7**	**1,140.3**	**6,241.8**
All persons	**4,728.1**	**384.4**	**2,472.0**	**3,127.9**	**2,790.8**	**13,775.0**
Percent of population aged 15 and over	23%	2%	12%	15%	13%	66%
Proportion of total burden^	41%	-*	15%	10%	11%	21%

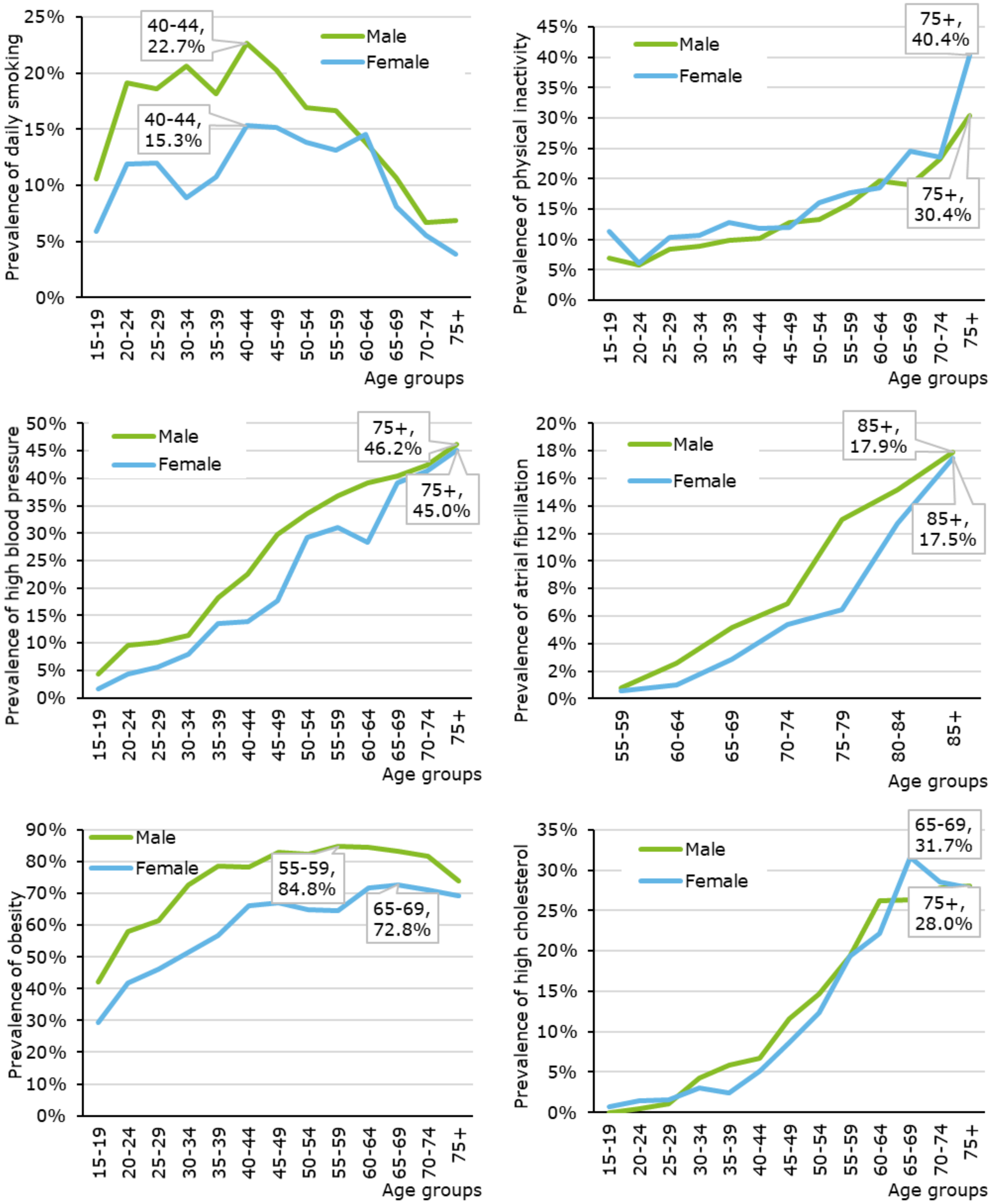
Source: AIHW (2018), Ball et al (2015), Deloitte Access Economics calculations. *The proportion of stroke burden for atrial fibrillation was not measured by the AIHW. ^ Each risk factor has been reported independent of other risk factors, so the sum of the burden of stroke due to each individual risk factor sums to more than 100%: these data have not been adjusted for comorbidities across stroke risk factors, although when adjusted for comorbidity, risk factors account for approximately 83% of the total burden of stroke. ~ physical inactivity is based on people who reported no physical activity within the past week.

The proportion of people with each of the selected risk factors by age and gender is shown in Chart 2.4. The likelihood of a person having any of the selected risk factors increases with age, while men are more likely to have each risk factor (except for physical inactivity and blood cholesterol).

Also included in Table 2.6, is the proportion of the total stroke burden attributable to each risk factor. The percentages shown were derived from the Australian Burden of Disease Study.[51] Notably the percentages are not mutually exclusive, meaning that there is significant overlap between risk factors.[vii] The proportions remain informative when used in comparison. High blood pressure is the most important risk factor, responsible for almost four times the burden compared to either physical inactivity or smoking. Overweight and obesity was the second most important risk factor (21% of the total burden of stroke, unadjusted for comorbidity across risk factors). The Global Burden of Disease study estimated that risk factors account for approximately 83% of the total burden of stroke of Australia.[52]

[vii] The sum of the burden of stroke due to each individual risk factor reported in the Australian Burden of Disease Study sums to 151.5%: these data have not been adjusted for comorbidities across stroke risk factors, although when adjusted for comorbidity, risk factors account for approximately 83% of the total burden of stroke.

Chart 2.4: Prevalence of selected risk factors nationally, 2017-18



Source: ABS (2018).

3 Health system costs

Chronic conditions increase health care costs not only for the individual but also for the public and private health system. People with conditions such as stroke must navigate the health care system to coordinate disease management.

The Australian Institute of Health and Welfare (AIHW) is the principal source used to estimate health expenditure at the national, state and territory levels. In addition to publishing the annual expenditure series,[53] the AIHW periodically conducts additional studies into the nature of health expenditure. This includes analysis on diseases or conditions being managed, stratified by a range of demographic characteristics.

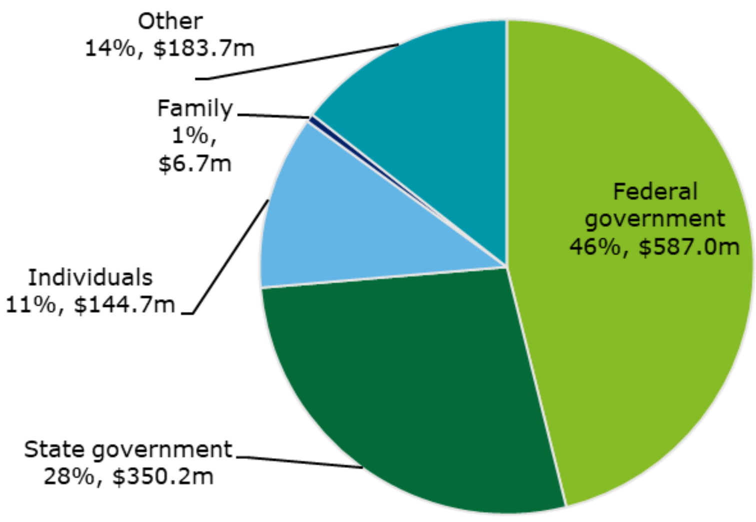
In 2019, the AIHW calculated the total cost of stroke for 2015-16 by age and gender.[54] In this report, methods for estimation were updated and expanded. This includes the methodology for estimating admitted patient costs and the principal diagnoses recorded for each episode of admitted patient care. The latest estimates by the AIHW were also expanded to include emergency departments and outpatient clinics. The AIHW informs inpatient, outpatient, medical imaging and pathology expenditure within this chapter.

Other expenditure items within this chapter include ambulance transfers, pharmaceuticals, general practitioners and specialists, as well as allied health costs. These cost items were estimated using a combination of national datasets as well as local and international literature.

In 2020, the total cost due to the direct care for stroke patients was estimated to be $806.0 million. Meanwhile, an additional $466.3 million in health costs brought the total **health system costs attributable to stroke to an estimated $1.3 billion in 2020.**

Figure 3.1 provides a summary on the breakdown of expenditure and the bearer. Health system costs in 2020 were primarily borne by the Federal Government ($587.0 million), which was followed by State and Territory Governments ($350.2 million), individuals and their families ($151.4 million) and other payers ($183.7 million).

Figure 3.1: Expenditure by payer type, 2020 ($, millions)



Source: Deloitte Access Economics calculations.

Note: Components may not sum to totals due to rounding.

3.1 Inpatient, outpatient and ambulance transfers

In 2020, total estimated inpatient, outpatient and ambulance transfer expenditure was $806 million. This includes patients who were:

- Admitted into public, private, and psychiatric hospitals
- Visited public emergency departments
- Visited public outpatient clinics
- Transferred by ambulance.

3.1.1 Inpatient costs

Hospitalisation rates where stroke was identified as the primary diagnosis in 2020 were determined using rates calculated by the AIHW.[55] For the 2017-18 period, the AIHW analysed the National Hospital Mortality Dataset to identify the principal and additional diagnosis of each patient. Applying these rates to demographic trends observed in 2020, there were an estimated 69,983 inpatients admissions nationally for stroke.

Table 3.2: Stroke hospitalisations per 100,000 hospitalisations (principal diagnosis), by age and sex

	Hospitalisations per 100,000 persons			Number		
Age group	Male	Female	Persons	Male	Female	Persons
<25	7	7	7	290	274	564
25–34	29	22	26	557	425	1,001
35–44	62	62	62	1,061	1,078	2,139
45–54	189	135	161	2,994	2,222	5,200
55–64	436	242	337	6,309	3,670	9,987
65–74	922	568	742	10,550	6,821	17,400
75–84	1,902	1,343	1,603	11,029	8,873	19,886
85+	2,882	2,553	2,677	5,699	8,117	13,805
Total	**-**	**-**	**-**	**38,488**	**31,480**	**69,983**

Source: Deloitte Access Economics calculations based on AIHW (2020) data.

In 2020, total inpatient expenditure was estimated to be $714.5 million. This was estimated by applying the weighted average cost per separation for stroke specific Australian Refined Diagnosis Related Groups (AR-DRGs)[viii] to estimated inpatient admissions in 2020.[56] After applying health inflation, the weighted average cost per separation came to $10,209.

3.1.2 Outpatient costs

Outpatient expenditure is incurred when a patient is not formally admitted into hospital. However, receives specialist medical care, diagnostic or other procedures, allied health care and/or specialist nursing care in an outpatient setting. Following adjustments for demographic trends, **outpatient costs were estimated to have been $47.8 million in 2020.** This is based on expenditure published in the AIHW and is on average $1,622 for males and $1,825 for females.[57]

3.1.3 Ambulance

Ambulance transfers account for 74% of all stroke patient hospital arrivals.[58] In 2020, this was the equivalent of 51,787 individuals arriving by ambulance. To calculate the cost of these patient transfers, noting that each state and territory has a different pricing arrangement, a weighted average cost per ambulance transfer was calculated. This cost came to $843 per ambulance transfer. When multiplied by the total number of patients transferred, total **expenditure in 2020 was estimated to be $43.6 million**.

[viii] B70A – Major Complexity, B70B – Intermediate Complexity, B70C – Minor Complexity, B70D – Transferred <5 days

3.2 Medical imaging and pathology

There is currently no national data source in Australia that includes diagnostic information for medical services outside of hospitals. The AIHW have estimated these costs for stroke patients in the Australian Burden of Disease Study,[59] using the Bettering the Evaluation and Care of Health (BEACH) survey.[60] After adjusting these data for demographic trends, **expenditure was estimated to be $18.8 million in 2020**. This is on average $33 for males and $54 for females.

3.3 Pharmaceuticals

The Australian Clinical Guidelines for Stroke Management (the Clinical Guidelines) provides clinicians with a general guide on the appropriate treatment and prevention of stroke.[61] This includes general information on the prescribing of medications for blood pressure lowering therapy, antiplatelet therapy, anticoagulant therapy and cholesterol lowering therapy. However, as many of these medications are not stroke specific, data from the NHS was used to inform the percentage of survivors of stroke who were taking these medications long-term.[62] These percentages were applied to prevalence estimates in order to determine the total number of individuals taking each medication type (see Table 3.3).

Table 3.3: Survivors of stroke taking medication by type, 2020

Medication group	Proportion taking medication	Individuals taking medication
Antiplatelet and anticoagulants	49%	217,822
High cholesterol	53%	237,653
Blood pressure	35%	155,812

Source: Deloitte Access Economics calculations based on National Health Survey (2018) data.

The PBS publishes annual Date of Supply data.[63] These data were used to inform the annual cost per script for each of the medications specified within the Clinical Guidelines. However, where the Clinical Guidelines identify under each of the medication types multiple medications that may be prescribed, a weighted average cost was calculated (see Table 3.4). These costs were then applied to the estimated number of individuals taking each of the medication types seen in Table 3.4.

Table 3.4: Total scripts and expenditure by medication type, 2020

Medication group	Scripts	Annual cost per individual ($)	Total ($ millions)
Antiplatelet and anticoagulants	2,674,949	584	127.1
High cholesterol	2,891,442	226	53.8
Blood pressure	1,932,982	178	27.8
Total			**208.7**

Source: Deloitte Access Economics calculations based on National Health Survey (2018) data.

Note: Components may not sum to totals due to rounding.

In 2020, expenditure was estimated to be $208.7 million. This is after adjusting Date of Supply data, published by the PBS, for the percentage of the population receiving medications for stroke prevention.[64]

3.4 General practitioners (GPs) and specialists

Many survivors of stroke are living with functional limitations that require ongoing GP and specialist consultations. To estimate this ongoing economic impact, GP and specialist patient encounters were calculated using the NHS by looking at the mean number of visits among those who identified stroke as their main condition relative to the general population.[65] These estimates were adjusted for demographic information such as age and gender.

When multiplied by the prevalence of stroke, the estimated number of GP and specialist encounters is equivalent to 907,978 (or 721,042 and 186,937) during 2020. The most recent unit costs were taken from the MBS,[66] with costs for GPs and specialists based on the average item reimbursement. **In 2020, this is equivalent to $37.13 and $140.23, meaning that the total expenditure over this period was estimated to be $53.0 million.**

According to the NHS, survivors of stroke visited a GP an additional 1.62 times over a period of twelve months.[67] This estimate is consistent with findings reported by Harrison et al, which identified patients with chronic conditions consulted a GP an additional 1.06 times over a period of twelve months.[68] This figure was identified after reviewing GP-patient encounter details for 43,501 patients across Australia between 2012 and 2016. Although not directly comparable, these data indicate that, relative to those with chronic conditions, survivors of stroke on average require an additional 0.6 GP visits per annum.

Similarly, survivors of stroke consulted a specialist practitioner an additional 0.42 times over a period of twelve months according to the NHS.[69] This estimate is conservative when compared to analysis undertaken by Obembe et al, [70] which identified that survivors of stroke visited a specialist practitioner an additional 2.0 times over a twelve month period in Canada.[71] Whilst this is a useful comparison, the NHS was selected as it is both more recent and based on Australian survey responses.

3.5 Other allied health professionals

In 2020, it was estimated survivors of stroke received 850 thousand hours of private home-based rehabilitation delivered by allied health professionals. This estimate was calculated by multiplying the number of individuals estimated to be receiving private home-based rehabilitation and annual therapy time. Meanwhile, the most recent unit costs were taken from the MBS in which allied health services for chronic disease management[ix] were $64.20 for twenty minutes or $192.60 for each hour. [72] Similarly, the average item reimbursement for acupuncture of $46.38 was also taken from the MBS and applied to 6,105 survivors of stroke who were estimated to have utilised acupuncture therapy on 8.8 occasions over a twelve month period. [73] **Total expenditure by survivors of stroke on other allied health professionals was conservatively estimated to be $185.7 million in 2020**. Since this an estimate of allied health services delivered in the community, it will be likely be conservative when compared to total allied health costs (i.e. this estimate excludes rehabilitation that may be provided in inpatient or outpatient settings).

The private use of allied health services among survivors of stroke was assumed to occur during community rehabilitation. Following a stroke, rehabilitation is recommended to maximise functional outcomes and community participation after stroke. Typically, rehabilitation is more commonly provided in community settings for survivors of stroke with mild to moderate initial impairment (modified Rankin Scale 2-3).[x, 74] Home-based rehabilitation and alternative therapies have been selected to avoid double-counting with services offered as part of outpatient services in section 3.1.

Grimley et al identified that patients receiving home-based rehabilitation over a period of six months received six hours of therapy time.[75] This figure was doubled to account for a therapy time over a twelve month period and is comparable with analysis undertaken by Obembe et al.[76] However, not all survivors of stroke receive home-based rehabilitation. In 2018, the National Stroke Audit Rehabilitation Services Report identified 66% of individuals were referred for further rehabilitation following discharge of which 27% then received home-based rehabilitation.[77] When applied to prevalence, an estimated 79,285 survivors of stroke received home-based rehabilitation.

[ix] Inclusive of speech therapy, physiotherapy, occupational therapy, nutritionist, and nurse care

[x] Measuring the degree of disability or dependence in the daily activities of people who have had a stroke: categorised as dependent (score ≥ 2) or independent (score < 2).

Meanwhile, Shah et al identified that among survivors of stroke 46% reported using Complementary and Alternative Medicine (CAM).[78] Acupuncture was identified as the only CAM therapy used more frequently by survivors of stroke than the rest of the population – the equivalent of 3%. This differential was used to determine the number of survivors of stroke who indicated that they use CAM and multiplied by the mean number of visitations documented in Steel et al.[79] Therefore, 6,105 survivors of stroke were estimated to have utilised acupuncture therapy on 8.8 occasions over a twelve month period.

Warren Wheatley

"I was at home getting ready for work when I had my stroke. Luckily my son Aaron found me and dialled triple zero (000). The Stroke Ambulance (Mobile Stroke Unit) arrived at my home and pulled into the driveway. The paramedics got me out of the house and into the ambulance as quick as they could. They scanned my brain and saw that I had suffered a severe stroke on the right side of my brain, which was causing my slurred speech and leg weakness. They gave me an injection of a clot-busting drug right there in the ambulance, and I was taken to hospital. Because I was able to be treated so quickly in the Stroke Ambulance, I was back at work after two months. Now I'm back doing the things I love, riding my bike, coaching sport and walking the dog."

– Warren Wheatley, Survivor of stroke.

4 Productivity losses

Stroke can have a substantial impact on an individual's ability to engage and attend work. The main impacts on work include a reduced chance of employment, early retirement or exiting the workforce due to premature mortality.

As such, stroke may impose a range of productivity costs which affect not only individuals but also their employers and government. These costs are real costs to the economy. For example, if worker productivity is lower for people with a condition caused by stroke, a firm's output may be reduced, resulting in a cost to the firm and to government (through reduced taxes).

A human capital approach was adopted to estimate productivity losses. This involves the calculation of the difference in employment or production of survivors of stroke compared to that of the general population, multiplied by average weekly earnings (AWE). Productivity losses from premature mortality are estimated in terms of the net present value (NPV) of future income streams lost.

The five potential productivity losses are:

- Reduced employment - classified as early retirement or workforce withdrawal.
- Absenteeism - where a worker may be unwell more often than average and taking time off work, while remaining in the workforce.
- Presenteeism - where a worker produces less output while at work.
- Premature mortality - where for a person who dies early due to stroke would no longer receive future income streams (in discounted NPV terms).
- Informal care – where support is provided by typically a spouse, friend or another member of the family

Overall, the total cost of productivity losses for stroke were estimated to be $3.6 billion in 2020, or $8,133 per survivor of stroke. The largest component of productivity losses was reduced employment ($1,769 million) followed by informal care ($731 million). Table 4.1 summarises the total costs of productivity losses attributed to stroke in 2020.

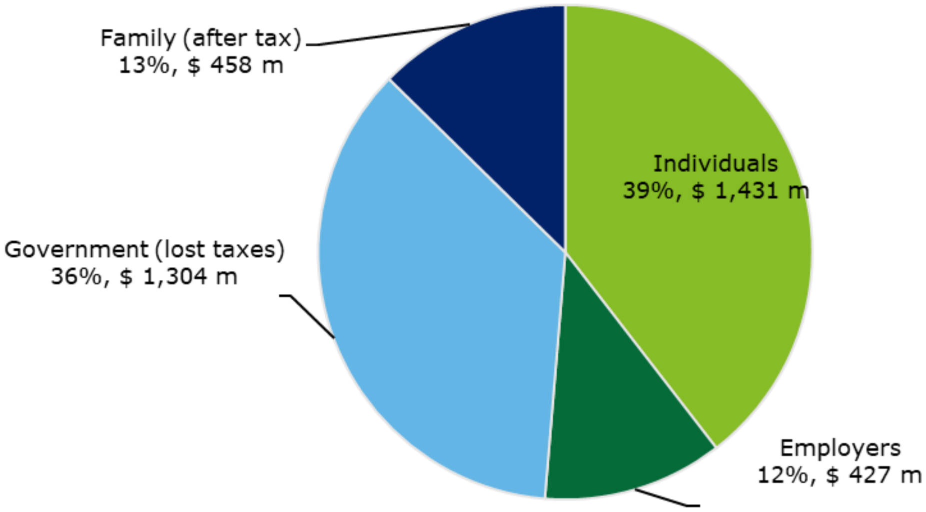
Table 4.1: Summary of productivity costs due to stroke in 2020

Age group	Male	Female	Total	Cost
	$Millions			$Per person
Reduced employment	1,072	698	1,769	3,975
Premature mortality	318	147	465	1,045
Absenteeism	288	198	486	1,092
Presenteeism	102	66	169	379
Informal care	399	332	731	1,643
Total	**2,179**	**1,441**	**3,620**	**8,133**

Source: Deloitte Access Economics calculations.

Chart 4.1 summarises the productivity costs due to stroke by payer in 2020. Around 40% of the costs were borne by individuals ($1.4 billion). Federal Government bore 36% of the costs of stroke ($1.3 billion) while 13% of the burden was borne families ($457.7 million) and 12% by employers ($426.7 million).

Chart 4.1: Summary of productivity costs due to stroke by payer, 2020



Source: Deloitte Access Economics calculations.

4.1 Reduced employment

Stroke is likely to have long-term impacts on a person's ability to perform daily tasks. The extent to which the person is affected depends on the severity of the stroke. These limitations may also result in a person being unable to continue their employment or may prevent the person from finding new employment. To attribute any reduction in the likelihood of employment to stroke, the employment rates of people with stroke can be compared to the employment rates of the general population, adjusted for age and gender.

The total cost of reduced employment due to stroke was estimated to be $1.8 billion in 2020. The breakdown of these productivity losses is provided in Table 4.2.

Table 4.2: Productivity loss due to reduced employment in survivors of stroke by age and gender, 2020

Age group	Male	Female	Total	Cost
		$Millions		$Per person
15-44	145.7	159.6	305.3	13,431
45-54	292.6	210.4	503.0	15,307
55-59	223.3	160.8	384.2	13,497
60-64	243.7	129.8	373.5	9,286
65-69	89.7	28.0	117.7	2,210
70-74	76.1	8.7	84.8	1,345
Total	**1,071.1**	**697.4**	**1,768.5**	**7,352**

Source: Westerlind et al (2017) and Deloitte Access Economics calculations.

The reduced employment estimate was determined with regard to literature and consideration of the SDAC dataset. Westerlind et al was the preferred source as the authors observed return to work rates over the longest period of time (a total of six years, though survivors of stroke only returned within the first 3 years post stroke). Based on this study it was estimated that 74.7% of survivors of stoke can return to work. It is noted that the Australian study by Hackett et al found a similar return to work rate within one year. This suggests that the actual return to work rate may be higher if Australian survivors of stroke continue to return to work post one year. A summary of the sources considered is provided in Table B.1.

The return to work rate was applied to ABS employment data (adjusted for age and gender) to calculate the number of survivors of stroke who remain out of the workforce after stroke.[80] It is noted that this assumes that more people return to work than the results found by the SDAC in . This is particularly evident when considering women aged 35-44.

4.2 Absenteeism

Survivors of stroke may take more days off work due to their condition. Absenteeism was measured by estimating the incremental change in workdays missed by survivors of stroke relative to the rest of the population.

The **total cost of absenteeism was estimated to be $485.9 million in 2020.** The breakdown of costs by age and gender are provided in Table 4.3.

Table 4.3: Cost of absenteeism for stroke, 2020

Age group	Male	Female	Total	Cost
		$Millions		$Per person
15-44	39.1	45.1	84.2	3,705
45-54	75.8	58.6	134.5	4,092
55-59	58.0	45.1	103.1	3,622
60-64	66.7	37.7	104.4	2,596
65-69	26.2	8.7	34.8	654
70-74	22.2	2.7	24.9	395
Total	**288.0**	**197.9**	**485.9**	**2,020**

Source: Deloitte Access Economics calculations.

To estimate the average absenteeism of survivors of stroke in 2020, a combination of the results from Vuong et al[81] and Hackett et al[82] and Kotseva et al[83] were used. The summary of these studies is provided in Table B.2. People who had a first ever stroke in 2020 (approximately 7% of all survivors of stroke) were assumed to be absent from work for 49 days before returning. The remaining 93% of survivors of stroke who did not have an incident stroke in 2020 were assumed to be absent from work an additional 14 days compared to the general population. The average stroke survivor in Australia in 2020 was absent from work for 16.0 additional days of work compared to the general population.[xi]

It is noted that absenteeism costs are only incurred by employed survivors of stroke. Thus the 19 days of absenteeism were applied to age and gender adjusted employment rates and adjusted for the reduced likelihood of employment (discussed in Section 4.1). The costs due to absenteeism were estimated by applying the proportion of days missed in the year to average annual earnings (adjusted for age and gender).

4.3 Presenteeism

Survivors of stroke may be less productive while at work compared to their colleagues. Presenteeism captures this loss in productivity due to stroke by multiplying the estimated loss of productive time by average earnings.

[xi] 7%*49+93%*13.5 = 16.0 days off work.

In 2020, the total cost of presenteeism was estimated to be $168.5 million among survivors of stroke. The breakdown of costs by age and gender are provided in Table 4.4.

Table 4.4: Cost of presenteeism for stroke, 2020

Age group	Male	Female	Total	Cost
	$Millions			$Per person
15-44	13.9	15.2	29.1	1,280
45-54	27.9	20.0	47.9	1,458
55-59	21.3	15.3	36.6	1,286
60-64	23.2	12.4	35.6	885
65-69	8.5	2.7	11.2	211
70-74	7.2	0.8	8.1	128
Total	**102.0**	**66.4**	**168.5**	**700**

Source: Deloitte Access Economics calculations based on Greene et al (2009).

There was limited available literature assessing the presenteeism impact of stroke. A recently published systematic review identified no new information regarding work limitations for stroke.[84] The review searched for articles published after April 2013 to July 2019. The lack of new evidence suggests that presenteeism is under researched.

The identified studies which measure the presenteeism impact of stroke are presented in Table 4.5. An average of the three studies was used to determine the presenteeism impact. The presenteeism impact of stroke was estimated to be 3.2% (= 7.74 days / 240 working days per year).

Table 4.5: Presenteeism literature for survivors of stroke

Study	Country	Sample size	Presenteeism outcome (days per year)
Allen et al (2018)[85]	United States	34	0.42*
Kotseva et al (2019)[171]	Seven European countries	198	9
Weighted average			**7.74**

Source: As noted in table. * adjusted from 0.8 minutes per day, assuming 240 working days per year. Presenteeism was estimated across 4 years so the impacts may have been moderated by greater adjustment of roles or responsibilities over the period.

4.4 Premature mortality

There were an estimated 8,700 deaths due to stroke in 2020 (see Section 2.3). Based on the age and gender distribution of these deaths and incorporating employment rates and average lifetime earnings for different age-gender groups, the present value of lost earnings due to premature mortality was estimated. The breakdown of the costs due to premature mortality is provided in Table 4.6. **Costs due to premature mortality from stroke were estimated to be $464.8 million in 2020.** It is noted the relatively low costs from premature mortality relative to other conditions are driven by the fact that a significant proportion of stroke deaths occur in people older than 75 (where future lifetime earnings are assumed to be zero).

Table 4.6: Costs due to premature mortality from stroke, 2020 ($, millions)

Age group	Male	Female	Total	Cost
		$Millions		$Per person
15-44	88.8	36.6	125.5	5,090
45-54	95.7	56.7	152.4	4,638
55-59	68.7	30.5	99.1	3,483
60-64	31.5	13.5	45.0	1,119
65-69	24.8	7.7	32.5	610
70-74	8.9	1.4	10.3	164
Total	**318.4**	**146.5**	**464.8**	**1,917**

Source: Deloitte Access Economics calculations.

4.5 Informal care

Survivors of stroke may require additional support in their everyday lives after experiencing stroke. This support may be provided by an informal carer, typically a spouse, friend or another member of the family. Though informal care is provided free of charge, the services are not free from an economic perspective. There is an opportunity cost to providing informal care, which is measured by what the carer could have earned had they been in the workforce.

It was estimated the total cost of informal care in 2020 was $730.9 million. The distribution of costs among survivors of stroke is shown in Table 4.7. It is noted the cost per person was assumed to be the same across all ages.

Table 4.7: Informal care costs due to stroke, 2020

Age group	Male	Female	Total	Cost
		$Millions		$Per person
0-44	17.3	23.2	40.5	1,643
45-54	26.5	27.5	54.0	1,643
55-59	22.2	24.6	46.8	1,643
60-64	36.4	29.7	66.1	1,643
65-69	55.2	32.2	87.5	1,643
70-74	68.0	35.5	103.5	1,643
75-79	61.6	43.7	105.3	1,643
80-84	56.6	46.5	103.2	1,643
85+	54.8	69.4	124.1	1,643
Total	**398.6**	**332.3**	**730.9**	**1,643**

Source: Deloitte Access Economics calculations.

The informal care requirements for survivors of stroke are significant. Sennfalt et al discovered in a study of 5,063 survivors of stroke, 10.1% of survivors of stroke were completely dependent upon caregivers, with a further 33.4% partially dependent on caregivers.[86] In the first year after stroke, caregiver assistance has been estimated to range from 9 to 17 hours per week.[87]

The estimated costs were derived from the SDAC data. The SDAC indicated that there were 29,300 survivors of stroke who required informal assistance where stroke produced their main disability.[88] This yielded an estimate of 34,041 people after adjusting for demographic changes in 2020. These people received an average of 36.7 hours of informal care per week. Comparatively, people with no condition and no disability received an average of 14.3 hours of care per week. The difference of 22.4 hours per week represents the additional number of care hours each week for a stroke survivor.

To derive the annual estimate of the provision of informal care, the number of people requiring care for stroke where stroke was their main disability was multiplied by the annual hour of care provided (=22.4 hours per week *52 weeks * 34,041 people). This yielded a total of 39.7 million hours of informal care, or approximately 1.7 hours per stroke survivor per week. Compared to the literature discussed above, this estimate is conservative. The likely driver of the comparatively low estimate is that less than 10% of survivors of stroke receive informal care with the parameters adopted in the SDAC. It is likely that many more survivors of stroke receive informal care, though these people may also receive care for additional conditions preventing an accurate estimate of the amount of informal care received from stroke. Therefore, it was likely conservatively assumed 39.7 million hours of informal care were provided to survivors of stroke in 2020.

The value of each hour of informal care was calculated by estimating the opportunity cost of an informal carer's time. This was calculated by multiplying the AWE (adjusted for age and gender) for the carers by the probability that they were employed. The estimated cost was derived by multiplying the opportunity cost of a carer's time by the total number of hours of care provided to survivors of stroke.

5 Other costs

There are other costs associated with stroke in addition to health system and productivity costs. In this chapter an estimate on the impact of stroke in relation to other costs has been based on Australian datasets and supplemented with international literature. These other costs include:

- Private expenditure on aids, equipment and home modifications
- Aged care – where a continuum of services is provided by federal and state governments for those aged 65 years and above.
- National Disability Insurance Scheme – a person who is less than 65 years old may receive support with daily life, through assistive technology and/or home modifications.
- Deadweight losses - many of the costs associated with stroke are publicly funded. To afford these costs the government must effectively increase tax revenue to achieve a budget neutral position.

Total other costs associated with stroke are summarised in Table 5.1. **Other costs were estimated to have been $1.3 billion in 2020.** Most of this cost was due to deadweight losses ($835.7 million). The remaining costs were due to the National Disability Insurance Scheme ($388.3 million), aged care ($78.2 million) and other costs ($12.3 million).

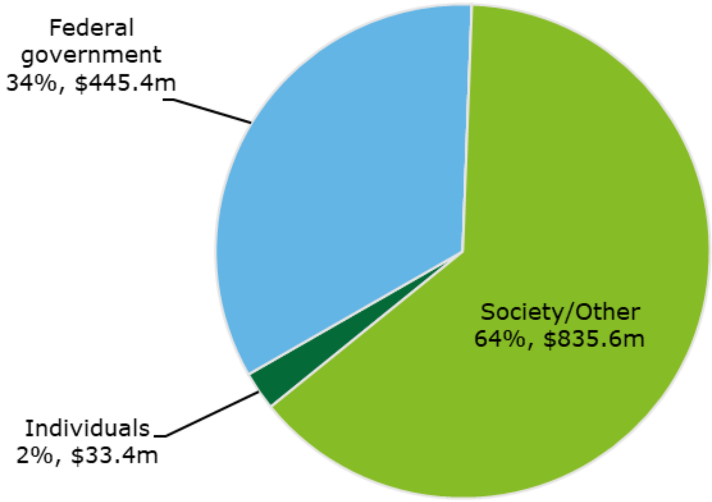
Table 5.1: Summary of other financial and economic costs, 2020 ($millions)

Cost component	Total cost
Private expenditure on aids, equipment and home modifications	12.3
Aged care	78.2
National Disability Insurance Scheme	388.3
Deadweight losses	835.7
Total	**1,314.4**

Source: Deloitte Access Economics estimates. Note: components may not sum to totals due to rounding.

Chart 5.1 outlines the other costs in 2020 by cost payer category. Federal Government paid a large proportion of other costs caused by stroke ($445.4 million, 34%). However, society paid for the largest proportion of the other costs ($835.7, 64%). The remaining costs were borne by individuals ($33.4 million, 2%).

Chart 5.1: Other financial costs due to stroke by cost payer category, 2020



Source: Deloitte Access Economics calculations.

5.1 Private expenditure on aids, equipment and home modifications

In 2020, total estimated cost was calculated by multiplying the item costs by the proportion of survivors of stroke who reported using aids and equipment or undergoing home modifications. Therefore, the **total cost for those living in a private dwelling and receiving informal care was estimated to have been $12.3 million.**

Aids, equipment and home modifications may be required by individuals following a stroke. So that private costs associated with purchasing any of these three may be captured, this section only considers those who are living in a private dwelling and receiving informal care. The SDAC was used to distinguish survivors of stroke by their living and caring arrangements.[89] Specifically, to remove those survivors of stroke who are living within assisted or aged care accommodation as well as those likely to be receiving support through the National Disability Insurance Scheme (NDIS). This ensured that there was no double counting across programs.

According to the SDAC, 66% of survivors of stroke required aids, 52% required equipment and 33% required home modifications. [90] Further work was then undertaken to understand within each of these categories, the proportion of survivors of stroke who required different types of aids, equipment and home modifications. Costs were attributed to items using price guides published by the NDIS and adjusted so that they were equivalent to their annual depreciated value. The cost and effective life of items can be seen in Table C.1.

Among survivors of stroke the items with highest reported use were 'manual wheelchairs', 'walking frames' and 'walking sticks'. 'Reading, writing or speaking aid not specified' as well as 'handrails or grab rails' were the two items of the highest reported use under the aids and home modification categories. In total, 63,812 survivors of stroke required aids, equipment and home modifications.

Table 5.2: Aids, equipment and home modification requirements and total cost, 2020

Support class	Persons	Total Cost ($millions)
Aids	11,140	$3.9
Equipment	43,270	$6.8
Home modifications	9,430	$1.6
Total	**63,812**	**$12.3**

Source: Deloitte Access Economics calculations.

5.2 Aged care

In order to estimate the costs associated with the provision of aged care service for survivors of stroke. Total expenditure data has been disaggregated to a per person level and updated for health inflation.[91] This cost is equivalent to $2,984 for those receiving assistance from the Commonwealth Home Support Program and $25,460 for those receiving assistance from the Home Care Packages Program. Increasing to $53,486 for each survivor of stroke receiving assistance whilst in residential aged care. **In 2020, total expenditure for all 5,373 survivors of stroke accessing aged care services was estimated to have been $78.2 million.**

A continuum of aged care services is provided by federal and state governments for those aged 65 years and above. These services can range from entry-level community-based care at home (Commonwealth Home Support Program) to higher levels of care at home (the Home Care Packages Program). When care at home is no longer an option, residential aged care is also available. There are other programs, but these three are the largest by number of clients and are the ones referred to in this report.

In 2020, 25% of survivors of stroke were receiving formal care.[92] Of those receiving formal care only 8% were receiving care provided by federal and state governments.[93] This is equivalent to 5,371 survivors of stroke who are aged 65 years and above. Many of whom continue to live in a private dwelling where they receive assistance from the Commonwealth Home Support Program and Home Care Packages Program. Fewer survivors of stroke received assistance whilst in residential aged care.

Those receiving assistance from the Commonwealth Home Support Program typically receive ongoing or short-term care and support services. This includes help with housework, personal care, meals and food preparation, transport, shopping, allied health, social support and planned respite.[94] Meanwhile, there are four levels within the Home Care Packages Program. Level one is for those receiving basic care assistance through to those on level four receiving more complex care assistance. Enabling older people with complex care needs to live independently in their own home by assisting with household tasks, aids and equipment, minor home modifications, personal care and clinical care such as nursing, allied health and physiotherapy services.[95] In total, 1,264 survivors of stroke receive assistance through these two programs.

5.3 National Disability Insurance Scheme

In 2020, total estimated expenditure was calculated by multiplying the number of individuals with a reported primary disability of stroke with the estimated annual plan amount. Therefore, **total expenditure for all 5,161 survivors of stroke was estimated to have been $388.2 million.**

The NDIS supports individuals with a permanent and significant disability who are under the age of 65 years. Providing individuals with the ability to create a support plan specific to their needs so they can achieve their goals and objectives. Funding is provided under the core, capacity and capital support classes. In total, there are fifteen category types across the three support classes including assistance with daily life, assistive technology, home modifications among others.[96]

In 2020, the NDIS provided support plans to 5,161 individuals with a reported primary disability of stroke.[97] On average, the committed annualised budget for individual's across Australia was $109,000.[98] However, utilisation can often mean annualised budgets may be higher or lower. For example, average plan utilisation between 2015-16 and 2018-19 was 69%.[99] By applying this adjustment to the committed annualised budget, the estimated annual plan amount for those with stroke was $75,210 in 2020 (refer to Table 5.3).

Table 5.3: Average committed annualised cost per support plan for stroke, 2020[xii]

Support class	Age band	Annualised cost	Recipients
Capacity Building	All	$11,730	5,123
Capital	All	$8,970	3,634
Core	All	$57,960	5,127
All	All	$75,210	5,161

Source: NDIS (2020)

5.4 Deadweight losses

Many of the costs associated with stroke are publicly funded. These include welfare payments as well as lost consumer, company and carer taxes. To afford these costs the government must effectively increase tax revenue to achieve a budget neutral position. To look at it another way, if all stroke costs were avoided, the government would need to raise less taxation revenue.

Although transfer payments are not an economic cost in themselves (they do not involve the use of resources) they have been estimated, along with public funding of health care for stroke to calculate the cost associated with a loss in allocative efficiency.

5.4.1 Welfare payments

In 2020, **8,886 persons received $142.1 million in welfare payments in the form of Disability Support Pension, Carer Allowance, Carers Payment and Carers Supplement due to stroke** (refer to Appendix C.2).

The Disability Support Pension is the primary social security payment available to individuals who are unable to work due to their physical, intellectual or psychiatric impairment. The Disability Support Pension is paid to individuals who are 15 years and above with a disability that precludes them from working 15 hours or more per week at or above the relevant minimum wage.[100] In 2020, 6,595 persons received the Disability Support Pension due to stroke accounting for $120.8 million or 85% of welfare payments. Meanwhile, carers of survivors of stroke received $21.3 million.

5.4.2 Average taxation rates

Reduced earnings from lower employment participation and lower output result in reduced taxation revenue collected by the Government. Alongside lower income taxation, there would also be a fall in indirect (consumption) taxes, as those with lower incomes spend less on the consumption of goods and services. Lost taxation revenue was estimated by applying an average personal income tax rate and average indirect taxation rate to lost earnings.

Applying these tax rates to the total productivity impacts (including informal care costs), the **total lost individual income tax revenue was estimated to be $1,022.5 million (including lost carer taxes), while the total lost company tax revenue was estimated to be $156.3 million in Australia in 2019–20.**

[xii] Individuals may receive care from categories that fall under different support classes

5.4.3 Marginal burden of taxation

To estimate the deadweight loss due to lost taxation revenue (given an assumption of no change in spending), taxes were assumed to be maintained by taxing either individuals or companies more as necessary (to replace the lost tax from either stream).

Table 5.4 shows the estimated reduced income, transfer payments, and health expenditure payments, the applied efficiency loss of levying taxes, and the resulting deadweight losses associated with stroke in Australia in 2020. All rates of efficiency loss include a 0.7% administrative loss which covers expenses of administering taxation.[101] The **total deadweight losses associated with stroke were estimated to be $835.6 million** in 2020.

Table 5.4: Deadweight losses due to stroke, 2020

Cost component	Rate of efficiency loss	Resulting deadweight loss ($million)
Commonwealth health system expenditure	29.8%	307.2
State and territory health expenditure	38.3%	134.1
Welfare	29.8%	42.3
Consumer tax	23.3%	199.0
Company tax	50.7%	89.3
Carers tax	23.3%	63.7
Total		**835.6**

Source: Deloitte Access Economics calculations. Note: components may not sum or multiply to totals due to rounding.

William Lo

"Recovery after stroke will inevitably come hand in hand with obstacles which are outside our control, such as cognitive and physical fatigue. One of the things I really struggled with was accepting I had to ask for help or do things differently to overcome my fatigue and physical limitations. It was difficult to accept I was different to before my stroke. But rather than focusing on the fact I was different, I recognised stroke was a learning opportunity - it took me a while to come to this realisation."

– William Lo, Survivor of stroke.

6 Loss of wellbeing

The long-term effect of stroke may vary based on the severity of the event, meaning that people may experience a wide range of health-related impacts to their quality of life. This chapter estimates the economic value of lost quality of life due to stroke in Australia in 2020 using the burden of disease methodology developed by the World Health Organization, the World Bank and Harvard University.[102]

The burden of disease methodology is a non-financial approach to quantifying the loss of wellbeing, where life and health are measured in terms of Disability Adjusted Life Years (DALYs). DALYs account for both YLDs and YLLs, and one DALY is equivalent to one year of health life lost.

DALYs can be converted into a dollar amount to estimate the value of lost quality of life due to stroke through the use of the value of a statistical life year (VSLY).[103] The VSLY is the value that society places on an anonymous life, which is an estimate of the value society places on reducing the risk of dying or avoiding certain health states and therefore living in better health. The Department of Prime Minister and Cabinet provides an estimate of the net VSLY (that is, subtracting financial costs borne by individuals) of $213,000 in 2019 dollar, and advises that this estimate be used to value changes in mortality and morbidity in cost benefit analysis and other forms of economic analysis.[104] This was adjusted to $216,626 when inflated to 2020 dollars.

The impact associated with stroke on the wellbeing of survivors of stroke was estimated as having been $26.0 billion in 2020. The wellbeing cost was borne entirely by individuals. The well-being of female survivors of stroke was disproportionately affected. This resulted in 5,150 additional DALYs compared to males over the same period. The economic impact associated with this difference is $1.1 billion – not an insignificant number.

Comparatively, males were most affected between 65 and 79 year of age. Whereas females were most affected after 75 years of age and especially beyond 85 years of age. This is consistent with incidence and prevalence trends explained in Chapter 2. The loss of wellbeing due to stroke is summarised in Table 6.1.

Table 6.1: YLDs, YLLs and DALYs due to stroke, 2020

Age group	YLD	YLL	DALYs	Cost ($millions)
Male				
0-19	193	288	481	104.2
20-44	902	1,395	2,298	497.7
45-49	620	1,163	1,783	386.2
50-54	1,057	989	2,046	443.2
55-59	1,403	2,272	3,676	796.2
60-64	2,303	1,838	4,142	897.2
65-69	3,497	4,296	7,793	1,688.1
70-74	4,309	2,961	7,270	1,574.8
75-79	3,898	6,308	10,206	2,210.9
80-84	3,586	3,110	6,696	1,450.5
85+	3,467	7,615	11,082	2,400.7

Age group	YLD	YLL	DALYs	Cost ($millions)
Male total	**25,236**	**32,236**	**57,471**	**12,449.8**
Female				
0-19	69	191	260	56.3
20-44	1,400	863	2,263	490.2
45-49	735	1,097	1,832	396.8
50-54	1,006	959	1,964	425.5
55-59	1,557	1,741	3,298	714.5
60-64	1,880	1,446	3,326	720.6
65-69	2,041	3,540	5,581	1,209.0
70-74	2,246	2,436	4,682	1,014.2
75-79	2,767	7,456	10,223	2,214.6
80-84	2,946	4,103	7,048	1,526.9
85+	4,392	17,752	22,144	4,797.0
Female total	**21,039**	**41,583**	**62,622**	**13,565.5**
Total	**46,275**	**73,818**	**120,093**	**26,015.3**

Source: Global Burden of Disease (2017), Burstein et al (2015), Deloitte Access Economics calculations.

6.1 Estimating the loss of wellbeing from stroke

People living after stroke experience significant detriment to their wellbeing, which is dependent on the severity of their stroke. The Global Burden of Disease Study (GBD) defines five levels of stroke severity described in Table 6.2.[105] It is noted that the definitions presented are for acute ischemic stroke, which is the most prevalent type of stroke. The corresponding disability weights for each severity level are also described.

Table 6.2: Severity level definitions for acute ischemic stroke / haemorrhagic stroke

Severity level	Description	Disability weight
Stroke, long-term consequences, mild	Has some difficulty in moving around and some weakness in one hand but is able to walk without help.	0.019
Stroke, long-term consequences, moderate	Has some difficulty in moving around, and in using the hands for lifting and holding things, dressing and grooming.	0.070
Stroke, long-term consequences, moderate plus cognition problems	Has some difficulty in moving around, in using the hands for lifting and holding things, dressing and grooming, and in speaking. The person is often forgetful and confused.	0.316
Stroke, long-term consequences, severe	Is confined to bed or a wheelchair, has difficulty speaking and depends on others for feeding, toileting and dressing.	0.552
Stroke, long-term consequences, severe plus cognition problems	Is confined to bed or a wheelchair, depends on others for feeding, toileting and dressing, and has difficulty speaking, thinking clearly and remembering things.	0.588

Source: Global Burden of Disease (2017).

In 2015, Burnstein et al estimated the distribution of acute ischemic stroke by severity level using survey data from the US Medical Expenditure Panel Survey, the National Epidemiologic Survey on Alcohol and Related Conditions, and the 1997 Australian National Survey of Mental Health and Wellbeing of Adults.[106] It is noted that Burnstein et al found 18.6% of strokes were asymptomatic. However, the estimated prevalence of stroke in the present analysis excludes asymptomatic (or 'silent') strokes.[xiii] To account for this, the distributions of stroke by severity level were proportionately adjusted as shown in Table 6.3. The resulting rates assume that all survivors of stroke have some adjustment to their quality of life as a result of their stroke.

Table 6.3: Distribution of stroke among severity levels, 2020

Severity level	Proportion of strokes	Adjusted rates	Number of survivors of stroke
Asymptomatic	**18.6%**	**0.0%**	**0**
Stroke, long-term consequences, mild	42.8%	52.6%	234,116
Stroke, long-term consequences, moderate	22.7%	27.9%	124,179
Stroke, long-term consequences, moderate plus cognition problems	11.7%	14.4%	64,093
Stroke, long-term consequences, severe	1.6%	2.0%	8,902
Stroke, long-term consequences, severe plus cognition problems	2.5%	3.1%	13,798

Source: Burstein et al (2015), Deloitte Access Economics calculations.

[xiii] Prevalence was calculated using rates from self-reported data in the SDAC. It is assumed that silent strokes are not represented in this data.

7 Improvements to stroke care

The expected benefits of improving stroke care on the burden of stroke in Australia were modelled, including changes in access to reperfusion therapies – thrombolysis and endovascular thrombectomy – and improvements to overall management of hypertension in the general population and in Australians living with stroke. Six improvements, or benchmarks, were considered for the analysis as summarised in Table 7.1.

Table 7.1: Modelled improvements to stroke care

Improvement number	Improvement description	Benchmark
1	Increases in patients receiving thrombolysis[107]	Achieve a thrombolysis rate of 20% of patients nationally (currently 10% nationally)
2	Increases in patients receiving thrombolysis within 30 minutes (door to needle)[108]	Achieve a door to needle time for thrombolysis of 30 minutes
3	Increases in patients receiving endovascular thrombectomy[109]	Achieve an endovascular thrombectomy rate of 10% of patients nationally (currently 3% nationally)
4	Increases in patients receiving endovascular thrombectomy within 60 minutes (door to groin)[110]	Achieve a door to groin time for endovascular thrombectomy of 60 minutes
5	Reduced rate of uncontrolled hypertension in the population[111]	Achieve a rate of 17% uncontrolled hypertension in the Australian population (currently 23%).
6	Improved antihypertensive prescription rate on discharge from hospital[112]	Achieve a rate of 91% for the proportion of stroke patients receiving antihypertensives on discharge from hospital (currently 77% nationally).

Source: benchmarks were supplied by Stroke Foundation and based on consultation with experts.

Each benchmark considered here has the substantial to offer large savings to the thousands of people impacted by stroke each year. **The benefits of meeting these benchmarks in 2020 were estimated to be worth $2.6 billion,** stemming not only from **improved wellbeing and reduced premature mortality** attributable to stroke (dollar savings of $2.4 billion over 5 years, in NPV terms), but also from **notable economic and financial savings** (dollar savings of $179 million over 5 years, in NPV terms) (see Table 7.2 and Chart 7.1). These benefits would accrue to government and other payers in society, in addition to Australians impacted by stroke.

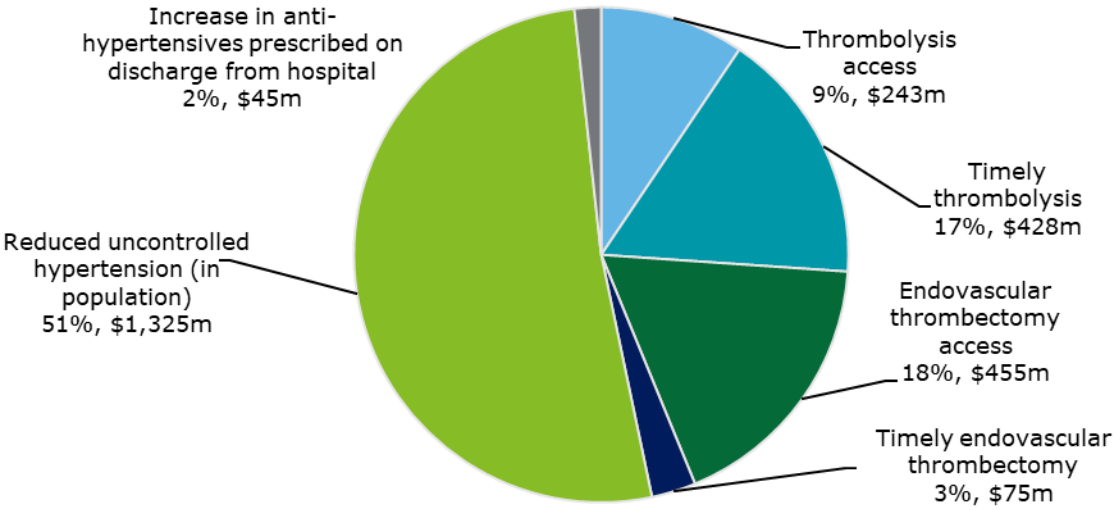
Table 7.2: Estimated benefits of interventions to improve stroke care, total and savings per additional patient treated, 2020 (savings over 5 years presented in NPV terms)

Intervention number	Economic and financial costs avoided, $m	Value of DALYs avoided, $m	Total costs avoided, $m	Savings per additional patient treated
Thrombolysis access	13.7	228.9	242.7	$88,485, 0.45 DALYs avoided
Timely thrombolysis	29.2	398.2	427.6	$155,897, 0.78 DALYs avoided
Endovascular thrombectomy access	26.1	429.1	455.4	$237,177, 1.2 DALYs avoided
Timely endovascular thrombectomy	1.9	72.8	74.7	$90,782, 0.47 DALYs avoided
Reduced uncontrolled hypertension (in population)	104.6	1,219.7	1,324.8	-*
Increase in antihypertensives prescribed on discharge from hospital	3.4	41.3	44.7	$11,633, 0.06 DALYs avoided
Total	**179.0**	**2,389.9**	**2,569.9**	-

Source: Deloitte Access Economics analysis.

Note: * no savings per additional patient treated are provided for this benchmark as it is not possible to determine how many additional patients would be treated to reduce hypertension from 23% to 17% in the population.

Chart 7.1: Estimated savings from improving stroke care to meet six national benchmarks, 2020 (% and $ millions, NPV of benefits accruing over 5 years)



Source: Deloitte Access Economics analysis.

Note: Increase in antihypertensives prescribed on discharge from hospital is a secondary prevention measure to prevent recurrent stroke. The modelling estimates potential benefits that accrue over a 5-year period for changes in the benchmarks in 2020.

Given the potential savings enabled by time-critical therapies for stroke, it is imperative progress continues to be made to consider how these interventions can be delivered cost-effectively across Australia. This includes in regional and remote populations where access to care has typically lagged behind that provided in metropolitan areas.

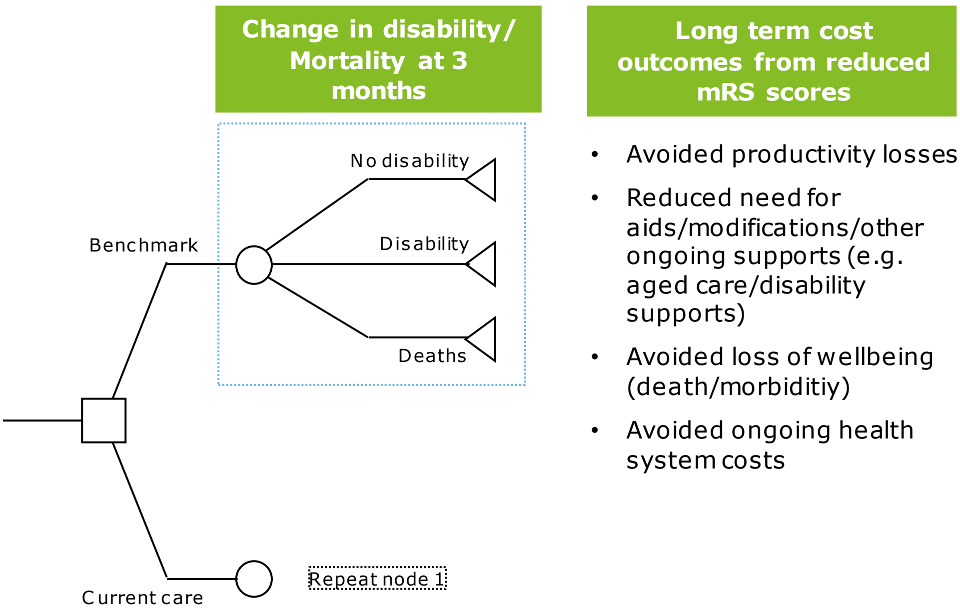
7.1 Overview of methodology to estimate benefits

The improvements in stroke care were modelled based on an assumed shift from current treatment to the national benchmarks provided by the Stroke Foundation. The benefits of reaching the proposed national benchmark were captured through savings to wellbeing, productivity, the health system and to other financial costs. Briefly, these benefits were modelled by:

- Determining the different in level of disability and functioning imposed by the stroke, 3 months following the stroke event
- Determining whether there is a difference in expected mortality at 3 months
- Modelling the longer term benefits and outcomes associated with a changing distribution of disability/functioning at 3 months. **These benefits were modelled for up to 5 years after the stroke and included differences in longer term health and social care costs, changes in mortality, and changes in quality of life over the 5 years**.[xiv]

The model structure shown in Figure 7.1 summarises the expected changes in disability and mortality at 3 months and their relationship with longer term cost outcomes. Disability outcomes were modelled for each level of the mRS, rather than dichotomising the results (e.g. a dichotomised outcome may summarise mRS scores of 0-2 as representing no disability, while 3-5 represents disability). Detailed tables summarising the mRS scores for the benchmark "intervention" and the standard "control", along with the expected effectiveness of achieving the benchmark, are available in Table D.1.

Figure 7.1: Simplified model structure demonstrating the impact of each intervention (thrombolysis and endovascular thrombectomy) on level of functioning and mortality outcomes over time



Source: Deloitte Access Economics analysis.

[xiv] Benefits of meeting the benchmarks in 2020 were modelled over 5 years given the availability of evidence for this time horizon. The benefits modelled here are likely to be conservative as the difference in outcomes at 5 years is likely to persist further into the future.

The benefits of each intervention for reperfusion therapies were modelled using patient outcomes 90 days post stroke treatment, measured using the modified Rankin Scale (mRS). The mRS measures the degree of disability or dependence in daily activities for people who have a neurological disability, where scores range from 0 (no symptoms) to 6 (death).

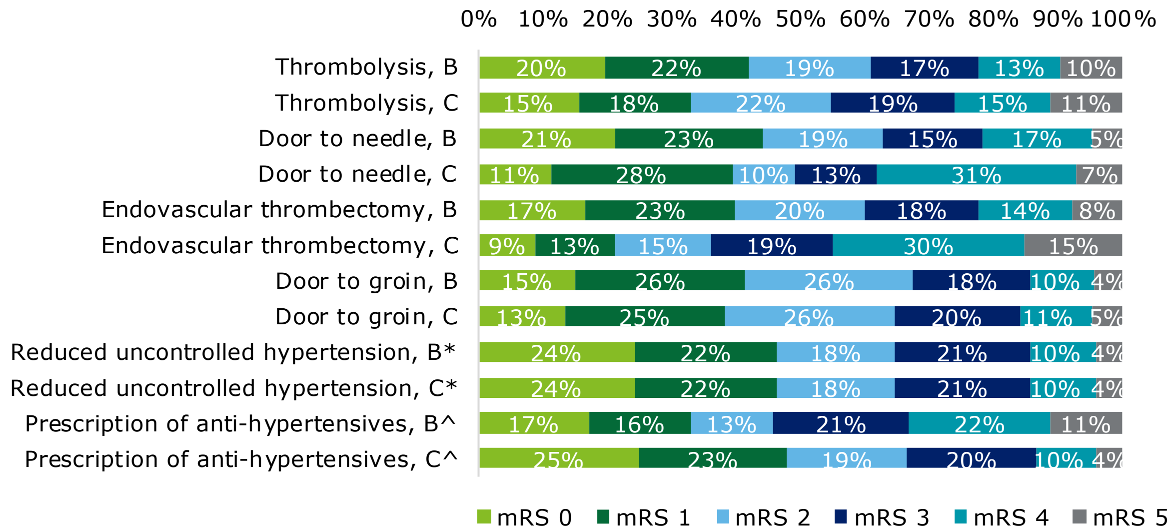
Table 7.3 outlines the sources used to provide the probability of being in each mRS category at 3-month follow up for each modelled benchmark, and also the outcomes used to inform changes in mortality and other longer-term outcomes for each intervention. [113]

Table 7.3: Sources used in the analysis for each benchmark

Brief intervention description	Sources used		
	Change in mRS at 3-month follow up	**Change in incidence/mortality**	**Change in longer-term outcomes modelled over 5 years***
Thrombolysis access	Tan Tanny et al (2013)[114]	Wardlaw et al (2014)[115] at 3-months	Ganesh et al (2020) [116]
Timely thrombolysis	Zinstok et al (2016)[117]	Zinstok et al (2016)[118] at 3-months	
Endovascular thrombectomy access	Campbell et al (2015)[119]	Goyal et al (2016)[120] at 3 months	
Timely endovascular thrombectomy	Saver et al (2016)[121]	Jahan et al (2019)[122] at 3 months	
Reduced uncontrolled hypertension (in population)	AuSCR (2018)[123]	Absolute risk reduction in incident stroke = 1.45% based on Li et al (2016).	Ganesh et al (2020) [124]
Increase in antihypertensives prescribed on discharge from hospital	AuSCR (2018) informed the distribution across mRS categories for non-recurrent strokes; Hankey et al (2007)[125] provided post-recurrent stroke mRS distribution	Absolute risk reduction of recurrent stroke = 1.45% based on Li et al (2016)[126];	Hazard ratio for mortality = 2.6 based on Khanevski et al (2019)[127]. Ganesh et al (2020)[113] for changes in medical and other costs, and changes in morbidity. Average cost of recurrent stroke in first year based on Gloede et al (2014).

Source: As noted. * longer-term outcomes included expected changes in medical costs, productivity and social care costs, and other related financial and economic costs, and a change in mortality and morbidity associated with each mRS score.

Chart 7.2: Distribution of mRS scores for survivors of strokes, by intervention



Source: As noted in Table 7.3.

Note: "B" refers to outcomes for each benchmark, "C" refers to outcomes for current care (not meeting the benchmark). * it has been assumed that there would be no improvement in stroke outcomes under this scenario, so the modelled benefits strictly come from a change in incidence resulting from reduced hypertension. ^ refers to the prescription of antihypertensives on discharge from hospital to prevent recurrent stroke.

Cost outcomes for changes in incidence in 2020 were modelled based on expected outcomes over a 5-year period. A 5-year period was used to be consistent with the data available in Ganesh et al – see Table 7.4. [128] The mRS outcomes for each intervention (as shown in Chart 7.2) were multiplied by the data shown in Table 7.5 to derive the average weighted probability of death, relative reduction in long-term health and social care costs, and change in quality of life over 5 years. The results are shown in Table D.2.

To model the benefits of reduced levels of uncontrolled hypertension in the community and the prescription of antihypertensives on discharge from hospital, the reduction in number of strokes was multiplied by the average cost of a stroke per incident/recurrent case. The average cost of a recurrent stroke was based on Gloede et al,[129] who reported that a recurrent stroke costs $37,195 (adjusted for health inflation of 2.0% per annum), while the cost of a stroke was based on the data presented in Table 7.5 (i.e. $29,395 per case). The changes in number of cases informed an immediate change in costs in the first year, which was then combined with changes in longer-term outcomes based on Ganesh et al.[130] Quality adjusted life expectancy for people who avoid stroke was based on a utility weight for mRS 0 of 0.93, as reported in Rebchuck et al.[131] The risk of mortality over 5 years for people with a recurrent stroke was also modelled to be 2.6 times higher than the risk observed across all strokes, as reported by Khanevski et al.[132] Data on the mRS outcomes from the AuSCR annual report, when combined with the results in Ganesh et al, [133] show that the average probability of death over 5 years is approximately 33%, and the annual risk of death is approximately 7% per year in Australia. For recurrent stroke this risk was modelled to be approximately 19% per year. Finally, the distribution of mRS outcomes at 3-months for survivors of recurrent stroke was based on data from Hankey et al.[134]

Table 7.4: Relationship between mRS at 3-month follow up and probability of death, health and social care costs, and quality adjusted life over 5 years

3-month mRS	Cumulative probability of death over 5 years	Cumulative health and social care costs over 5 years, £	Quality adjusted life over 5 years
0	0.13	9,692	3.88
1	0.19	19,539	3.49
2	0.28	24,643	3.01
3	0.55	57,595	1.87
4	0.57	77,071	1.30
5	0.74	96,343	0.063

Source: Ganesh et al (2020).

Longer term cost outcomes for stroke were based on the results derived in this report, as presented in chapters 3 through 6.

Each cost outcome was related to the expected incidence, prevalence or mortality driver of the cost: for example, total hospitalisation costs including outpatient care were divided by the incidence of stroke in 2020 to derive a unit cost for the benchmark modelling that could be applied to avoided stroke incidence.

Similarly, any costs that are typically ongoing were divided by prevalence to inform unit costs in the modelling. These included costs such as receipt of aged care, need for informal care and reduced ability to work, among others: for example, people living with stroke are far more likely to return to work with an mRS score of 0-2 compared to higher mRS scores.[135] These costs were assumed to be incurred over multiple years, and it was assumed that they represented the average annual cost of treatment after the acute phase of stroke (i.e. post-hospitalisation).

Finally, for deaths that could be avoided by meeting the benchmarks, premature mortality costs per death and YLLs per death were derived so they could be multiplied by the number of deaths occurring under each benchmark or for current standard care.

The sum of costs related to prevalence were taken as the ongoing annual costs for survivors of stroke, which were then aggregated over 5 years. The relative reduction in health and social care costs reported in Table D.2 were then multiplied by the average annual ongoing cost to derive costs when each benchmark is met compared to current standard care.

Table 7.5: Unit costs applied in the benefits modelling, 2020

Cost component	Cost ($millions)	Cases/ deaths	Measure	Cost per case/ death ($/units)
Health system costs				
Inpatient/outpatient/ambulance transfers	806.0	27,418	Incidence	29,395
Medical imaging and pathology	18.8	444,922	Prevalence	42
Pharmaceuticals	208.6	444,922	Prevalence	469
GPs and specialists	53.0	444,922	Prevalence	119
Other health professionals (community rehabilitation, complementary/alternative)	185.7	444,922	Prevalence	417
Productivity losses and other costs				
Reduced employment	1,768.5	444,922	Prevalence	3,975
Absenteeism	485.9	444,922	Prevalence	1,092
Presenteeism	168.5	444,922	Prevalence	379
Premature mortality	464.8	8,700	Deaths	53,424
Informal care	730.9	444,922	Prevalence	1,643
Private expenditure on aids and modifications	12.3	444,922	Prevalence	28
Aged care	78.2	444,922	Prevalence	176
NDIS	388.2	444,922	Prevalence	872
DWL	835.4	444,922	Prevalence	1,878
Loss of wellbeing				
YLDs	46,258	444,922	Prevalence	0.10
YLLs	73,794	8,700	Deaths	8.48

Source: Deloitte Access Economics estimates presented in chapters 2 to 6 .

7.2 Improvements to delivery of thrombolysis

Thrombolysis is a treatment used to dissolve clots in blood vessels to improve blood flow. In 2019, 82% of hospitals reported the availability of thrombolysis, yet the overall use of thrombolysis has remained relatively unchanged at 10%.[136] Suitability for thrombolysis limits this percentage from increasing significantly. Some people are not suitable for thrombolysis because:

- The person has a bleed in the brain
- The person cannot tell doctors when stroke symptoms commenced
- The person does not reach hospital in time
- The person has a bleeding disorder
- The person has recently had major surgery
- The person has had another stroke or head injury within the past three months
- The person has current medication which is not compatible with alteplase.

The expected benefits from improved access to thrombolysis were modelled for two scenarios, including:

1. An overall increase in the number of stroke patients receiving thrombolysis, with rates increasing from 10% of patients nationally today to 20% of patients nationally.
2. A reduction in the median door to needle time, or arrival at an emergency centre to treatment time, from 75 minutes to 30 minutes.

7.2.1 Access to thrombolysis

Target: Achieve a thrombolysis rate of 20% of patients nationally (currently 10% nationally)

The modelled change assumed that an additional 10% of stroke patients received thrombolysis, at the current median time to treatment. There was no significant improvement for in-hospital mortality given the change from standard care to thrombolysis, as demonstrated by Wardlaw et al,[137] so no benefits have been modelled here. Rather the benefits rely on improved functioning at 3-months and the expected outcomes over time as a result.

Based on the improvements to mRS scores from Tan Tanny et al,[114] and the longer-term outcomes reported in Ganesh et al, [138] it was estimated that approximately 84 deaths would be avoided over 5 years. **The potential savings from meeting this benchmark in 2020 were estimated to be $242.1 million over 5 years** (in NPV terms).

Table 7.6: Estimated benefits of achieving benchmark to improve access to thrombolysis treatment in 2020 (savings over 5-years in NPV terms)

Cost component avoided	Value
Health system costs, $millions	0.9
Productivity and other costs, $millions	12.9
DALYs (years)	1,056
Value of DALYs, $millions	228.9
Total costs, $millions	**242.6**
Savings per additional patient treated	$88,483, 0.45 DALYs avoided

Source: Deloitte Access Economics estimates based on Tan Tanny et al (2013).[114]

7.2.2 Timely access to thrombolysis

Target: Achieve a median door to needle time for thrombolysis of 30 minutes

The expected disability level of people receiving thrombolysis is also dependent on the time to treatment. Data from the National Stroke Audit report show that the median time to treatment with thrombolysis was 75 minutes.[58]

One study identified the mRS impact of reducing the time to thrombolysis from an average of 75 minutes down to 28 minutes.[139] The difference in mRS scores from this study were assumed to reflect the outcomes should the average time to thrombolysis be reduced to 30 minutes in Australia. There was no significant improvement for in-hospital mortality given the change from median door to needle time of 75 minutes to 28 minutes, so no benefits have been modelled here.[140] However, there would be expected benefits for patients who may be well outside the door to needle time from the pre-intervention group (median of 75 minutes).

The modelled change assumed that 10% of patients received thrombolysis (the current national rate) at a median time of 30 minutes. Based on the changes in mRS observed in Zinstok et al, [141] and the longer-term outcomes reported by Ganesh et al, [142] it was estimated that improved treatment times would avoid approximately 131 deaths over 5 years, and result in improvements in morbidity. **The potential savings from meeting this benchmark in 2020 were estimated to be $426.3 million over 5 years** (in NPV terms).

Table 7.7: Estimated benefits of achieving benchmark to reduce median arrival time to thrombolysis treatment in 2020 (savings over 5-years in NPV terms)

Cost component avoided	Value
Health system costs, $millions	2.1
Productivity and other costs, $millions	27.1
DALYs (years)	1,838
Value of DALYs, $millions	398.2
Total costs, $millions	**427.4**
Savings per additional patient treated	$155,894, 0.78 DALYs avoided

Source: Deloitte Access Economics analysis.

7.3 Improvements to delivery of endovascular thrombectomy

Endovascular thrombectomy is a treatment the physically removes a blood clot from the brain. The treatment is only used where the blood clot is in a large artery, and the treatment is time dependent. Currently, only 3% of strokes are treated with endovascular thrombectomy.[58]

The expected benefits from improved access to endovascular thrombectomy were modelled for two scenarios, including:

1. An overall increase in the number of stroke patients receiving endovascular thrombectomy, with rates increasing from 3% of patients nationally today to 10% of patients nationally.
2. A reduction in the median door to groin time, or arrival at an emergency centre to arterial puncture, from 108 minutes[xv] to 60 minutes.

7.3.1 Increases in patients receiving endovascular thrombectomy

Target: Achieve an endovascular thrombectomy rate of 10% of patients nationally (currently 3% nationally)

The modelled change assumed that an additional 7% of strokes are treated with endovascular thrombectomy, with each patient receiving treatment at the current national median time to treatment (either door to groin puncture, or onset to groin puncture).

Based on the improvements in mRS observed from Campbell et al,[143] and the 3.6% lower mortality risk at 3-months, as reported by Goyal et al,[144] increased rates of endovascular thrombectomy is likely to lead to almost 70 fewer deaths at 3-months, extending to 135 deaths over 5 years due to improved stroke outcomes. **The potential savings from meeting this benchmark in 2020 were estimated to be $454.2 million over 5 years** (in NPV terms).

[xv] Excluding patient transfers.

Table 7.8: Estimated benefits of achieving benchmark to improve access to endovascular thrombectomy treatment in 2020 (savings over 5-years in NPV terms)

Cost component avoided	Value
Health system costs, $millions	1.8
Productivity and other costs, $millions	24.3
DALYs (years)	1,981
Value of DALYs, $millions	429.1
Total costs, $millions	**455.2**
Savings per additional patient treated	$237,173, 1.2 DALYs avoided

Source: Deloitte Access Economics analysis.

7.3.2 Timely access to endovascular thrombectomy

Target: Achieve a door to groin time for endovascular thrombectomy of 60 minutes

The expected improvement from endovascular thrombectomy to a person's wellbeing after stroke is dependant upon the time taken to treatment. In Australia, the median time from arrival at a comprehensive stroke centre that can provide endovascular thrombectomy is 108 minutes (excluding patients who are transferred from another facility).[145] One study estimated mRS scores based on the time since symptom onset.[146]

The modelled mRS estimates assume that current time to endovascular thrombectomy treatment improved from a median of 180 to 240 minutes to less than 180 minutes since symptom onset. Reductions in stroke mortality at 3-month follow up were based on Jahan et al: the authors found that the treatment could reduce mortality by 3.8% when comparing 108 minutes to 60 minutes, which would reduce deaths at 3-month follow up by 31.[147] When combined with the results from Saver et al,[148] there are relatively modest savings from the intervention – the reduction in overall number of deaths is primarily driven by the expected change at 3-months, and the mRS distribution for a median treatment time of 108 minutes is quite comparable to a treatment time of 60 minutes. However, **the potential savings from meeting this benchmark in 2020 were still estimated to be $74.6 million over 5 years (in NPV terms)**.

Table 7.9: Estimated benefits of achieving benchmark to reduce median arrival time to endovascular thrombectomy treatment in 2020 (savings over 5-years in NPV terms)

Cost component avoided	Value
Health system costs, $millions	0.0
Productivity and other costs, $millions	1.9
DALYs (years)	336
Value of DALYs, $millions	72.8
Total costs, $millions	**74.7**
Savings per additional patient treated	$90,780, 0.47 DALYs avoided

Source: Deloitte Access Economics analysis.

7.4 Improved management of hypertension

7.4.1 Reduced rate of uncontrolled hypertension in the population

As discussed in Section 2.4, hypertension is considered to be a leading risk factor for stroke in the general population. Evidence has shown that effective control of blood pressure through antihypertensive intervention can reduce the overall incidence of stroke.[149] However, the rate of uncontrolled hypertension, defined as blood pressure ≥ 140/90 mm Hg, remains undesirably high in the Australian population.[150]

Target: Achieve a rate of 17% uncontrolled hypertension in the Australian population (currently 23%).

To model the impact of such a reduction in uncontrolled hypertension in the population, evidence was sought regarding the risk of experiencing a first-ever stroke among those with uncontrolled and controlled hypertension. The risk of first-ever stroke has been reported to be 2.1 times higher (relative risk=2.1) among those with uncontrolled hypertension compared to those with controlled hypertension.[151, xvi]

This relative risk (RR) was used to calculate a population attributable fraction (PAF), which describes the proportion of all incident stroke cases that can be directly attributed to uncontrolled hypertension. The PAF used in this analysis was calculated by following the formula:[152]

$$PAF = \frac{P(RR-1)}{P(RR-1)+1}$$

$$Where:$$

$$P = Prevalence\ of\ uncontrolled\ hypertension$$

$$RR = Relative\ risk\ of\ first-ever\ stroke$$

A PAF was calculated for both the current situation, with a 23% rate of uncontrolled hypertension, and the target rate of 17%. Using the RR of 2.1, a PAF of 20.2% was calculated for the current state and a PAF of 15.8% was calculated for the target state. This indicates that, at present, 20.2% of first-ever stroke cases are attributable to uncontrolled hypertension and that this share could be reduced to 15.8% if uncontrolled hypertension fell to 17%.

Table 7.10 presents the estimated number of incident cases of stroke attributable to uncontrolled hypertension in the current state and the target state. It also shows the reduction in incident cases that would be achieved if the rate of uncontrolled hypertension decreased from 23% to 17%. **Overall, it was estimated that 1,217 strokes could be avoided in 2020**.

Table 7.10: Incident cases and mortality of stroke attributable to uncontrolled hypertension

	Incidence of stroke attributed to hypertension (prev = 23%)	Incidence of stroke attributed to hypertension (prev = 17%)	Estimated strokes avoided in 2020
Value	5,536	4,319	1,217

Source: Deloitte Access Economics calculations based on Li et al. (2005).

Based on the reduction in stroke incidence in 2020 and the evidence available in Ganesh et al and from the AuSCR annual report,[153] there would also be around 386 fewer deaths over 5 years attributable to stroke because of uncontrolled hypertension. However, the reductions in uncontrolled hypertension may lead to relatively large wellbeing gains from reduced overall burden of stroke. **The potential savings from meeting this benchmark in 2020 were estimated to be $1.3 billion over 5 years** (in NPV terms). While these gains are quite large, there may be

[xvi] After controlling for other determinants of stroke, including age, gender, smoking, BMI, use of lipid-lowering drugs, history of diabetes and coronary heart disease.

other overlapping risk factors in the general population that reduce the potential benefits estimated here.

Table 7.11: Estimated benefits of achieving benchmark to reduce uncontrolled hypertension in the general population in 2020 (savings over 5-years in NPV terms)

Cost component avoided	Value
Health system costs, $millions	35.8
Productivity and other costs, $millions	68.8
DALYs (years)	5,630
Value of DALYs, $millions	1,219.7
Total costs, $millions	**1,324.3**
Savings per additional patient treated	-

Source: Deloitte Access Economics analysis.

7.4.2 Improved antihypertensive prescription rate on discharge from hospital

One way of achieving a reduction in uncontrolled hypertension is to improve the prescription rate of antihypertensive medication on discharge from hospital following stroke. Evidence has shown that antihypertensive prescription can have a beneficial impact on the rate of recurrent stroke in the population.[154] Despite this, there is variation in the rate of prescription of antihypertensives across Australia, with a 14-percentage point gap between the national average and benchmark hospitals.

Target: Achieve a rate of 91% for the proportion of stroke patients receiving antihypertensives on discharge from hospital (currently 77% nationally).

The impact of increasing the national average prescription rate to that of benchmark hospitals was modelled by first estimating the total number of recipients in the current state and the target state. As per Table 7.12, an estimated 21,112 people who experience their first-ever stroke receive antihypertensive medication on discharge (77% of 27,418 incident strokes in 2020). Achieving a national average in line with current benchmarks of 91% would increase the prescriptions by 3,839 to a total of 24,950. In a systematic review of studies, the use of blood pressure-lowering medication reduced the absolute risk of recurrent stroke by 1.45%.[155] Consequently, **the increase in prescriptions to the national benchmark was estimated to reduce the number of recurrent strokes by 56 in 2020**.

Table 7.12: Reduction in recurrent strokes from increased prescription of antihypertensive medication

	Current prescription rate	Target prescription rate	Change	Reduction in recurrent strokes in 2020
Value	**21,112**	**24,950**	**3,839**	**56**

Source: Deloitte Access Economics estimates based on Zonnevold et al (2018).

Based on the estimated reduction in recurrent strokes in 2020 and the evidence available in Ganesh et al and from the AuSCR annual report, [156] there would also be around 19 fewer deaths over 5 years attributable to stroke because of uncontrolled hypertension. **The potential savings from meeting this benchmark in 2020 were estimated to be $44.6 million over 5 years** (in NPV terms).

Importantly, the reduction in recurrent strokes was only modelled for 2020, such that any potential benefits of continuing lifelong or therapy over multiple years have not been included. This assumption may lead to conservative results, although it is likely to reflect real world circumstances to some extent as prescribing medications on discharge from hospital is likely to have a relatively short term impact on recurrent strokes given that they tend to cluster within the first couple of weeks of the first-ever stroke occurring.

Table 7.13: Estimated benefits of achieving benchmark to prescribe antihypertensive medications on discharge from hospital to prevent recurrent stroke in 2020 (savings over 5-years in NPV terms)

Cost component avoided	Value
Health system costs, $millions	1.8
Productivity and other costs, $millions	1.5
DALYs (years)	191
Value of DALYs, $millions	41.3
Total costs, $millions	**44.7**
Savings per additional patient treated	$11,633, 0.06 DALYs avoided

Source: Deloitte Access Economics analysis.

Appendix A Population projections and supplementary prevalence rates

A.1. Summary of population projection methodology

The Deloitte Access Economics' Demographic Model (DAE-DEM) uses a cohort component method for modelling population at the national and State level. Assumptions about fertility, mortality and migration are applied to a base year population, which is also aged by the relevant time period. These are informed by ABS projections although it has been assumed that observed short-term declines in fertility rates (which are now at record lows) will continue with a slight post-COVID bounce back. The modelling incorporates specific assumptions about:

- **Births**: The forecast number of births in a population is a function of both the assumed Total Fertility Rate (and its associated age-specific fertility rates), and the number of women of child-bearing age in a given period. The **sex ratio** at birth (i.e. the number of boys born per 100 girls) is expected to remain at 105.5 over the forecast period. This is consistent with the assumption used by the Australian Bureau of Statistics in their population projections.
- **Deaths**: The forecast number of deaths in a population is a function of both the assumed life expectancy at birth and the number of people in each age group. Mortality assumptions are based on life tables, with the summary measure being life expectancy at birth. This measure calculates the average number of years a person born in a particular period (typically a year) may expect to live if they experienced current age specific death rates at each age of their lives.
- **Net overseas migration** is driven by population growth and assumed policy settings. Age and gender specific splits of these totals are handled by using a profile of the total across ages – which is determined from an analysis of recent ABS data from various issues of the Migration, Australia publication (ABS Catalogue 3412.0). This profile is updated on an annual basis. International migration can be determined as a level (a specific absolute net gain to Australia each year) or as a share of starting population (across the last 10 years Australia has had an annual intake of migrants equivalent to around 0.56% of starting population). The age structure of migrants to each State and Territory varies in line with historical patterns, as does the assumed age profile of outgoing migrants from each State and Territory.
- **Net inter-region migration**. Like international movements, the longer-term assumptions for interstate migration can be set as absolute values (in net terms) or as a formula – which in this case is based on a regression of past rates of inward and outward population movements against time. There is an overall interstate movement rate (share of the national population that is assumed to move State in a given year) which is suppressed in the short-term but then rebounds. It does trend downward slightly in line with longer term trends.
- The **small area forecasts** (what is used to develop the projections for each Federal electoral division in Australia) are supplemented by information on past demographic trends (including fertility, mortality and inter-regional migration), as well as expected future residential developments, State and local planning instruments. The small area approach is a top-down, bottom-up hybrid approach which includes bottom up land use at a granular level. This small area modelling process is iterative and combines a consistent and coherent set of top-down population forecasts, while also considering localised land use and expected future changes. All

historical population and demographic component data were obtained from the Australian Bureau of Statistics. The SA2 forecasts are allocated such that they accommodate:

- Known approved residential developments,
- Proposed residential developments where there is strong evidence to support realisation,
- State planning policy identifying key activity centres or priority growth areas,
- Local planning instruments identifying priority areas for local governments,
- Neighbourhood planning identifying rejuvenation and local growth precincts,
- Availability of land for residential use,
- Effect of induced development caused by betterment of accessibility, services and transport.

At its simplest level, forecasting the population involves tracking groups of people through their lifetimes. This is done by taking a cohort's population as at 30 June in a given year (either a historical estimate from the Australian Bureau of Statistics population publication – ABS Catalogue 3101.0 – or a model forecast) and estimating what would happen to them across the following year. For example, the cohort will age by one year, decline due to deaths, decline or increase due to changes in migration to other countries and within regions in Australia.

In the model, the ageing occurs simply and as expected for those who are born during the course of the year – the group for which **fertility** rates are of particular importance. The second factor is obviously driven by factors related to **mortality** rates. The third factor is a result of the workings of the **migration** assumptions used in DAE-DEM (as described above). Chart A.1 and Chart A.2 summarise the expected trends in total fertility rate and completed fertility rate, and also the mortality profile over time.

Chart A.1: Total and completed fertility rates

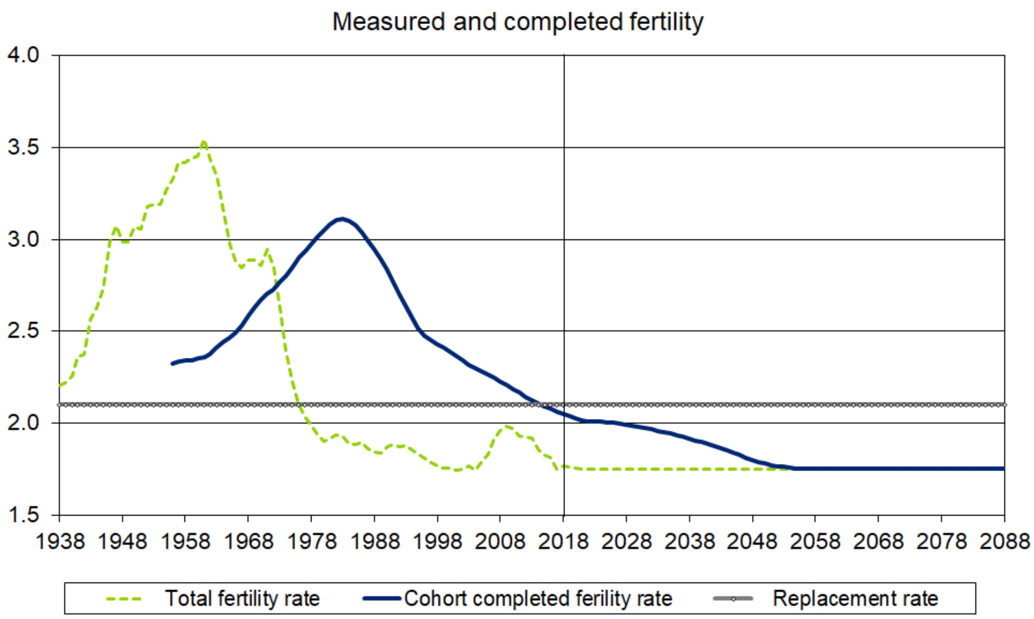
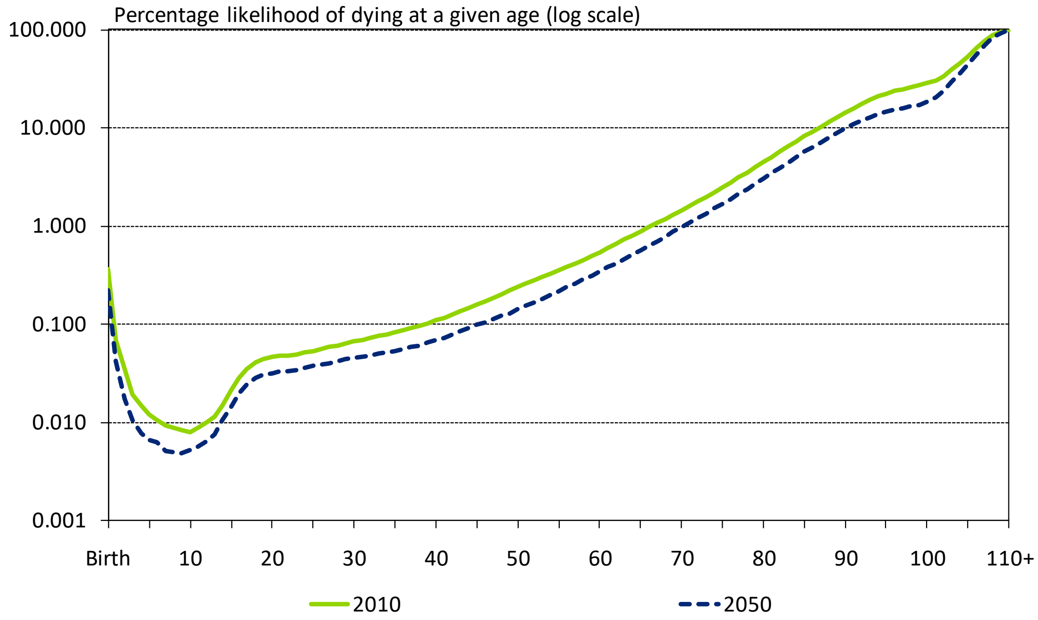


Chart A.2: Mortality profiles over time



The high-level results from the modelling are summarised further in section A.2.

A.2. Summary of demographic projections

Table A.1 summarises the population projections for Australia in 2020, 2030, 2040 and 2050. These estimates underly the estimated stroke prevalence, incidence and mortality presented in chapter 2.

Table A.1: Population projections by age and gender, '000s of people, 2020 to 2050

Age/gender	2020	2030	2040	2050
0-4	804.0	851.6	936.2	1,033.3
5-9	836.3	845.8	923.9	1,031.2
10-14	819.8	861.2	920.4	1,010.5
15-19	774.5	911.9	934.5	1,020.0
20-24	905.0	1,046.8	1,117.6	1,198.3
25-29	971.5	994.7	1,174.0	1,215.2
30-34	950.0	995.2	1,159.6	1,231.2
35-39	908.6	1,028.6	1,068.7	1,248.2
40-44	803.0	987.9	1,043.1	1,207.8
45-49	824.2	924.7	1,050.0	1,091.6
50-54	760.3	801.0	987.8	1,043.9
55-59	756.5	806.1	909.5	1,035.1
60-64	690.9	734.3	780.5	967.2
65-69	625.8	731.4	784.7	889.1

Age/gender	2020	2030	2040	2050
70-74	519.0	615.8	675.4	733.3
75-79	351.3	494.0	613.6	688.6
80-84	228.8	380.6	472.0	542.6
85-89	197.8	293.3	436.1	584.0
Total male	**12,727.4**	**14,304.8**	**15,987.9**	**17,771.1**
0-4	758.9	805.7	885.7	977.3
5-9	793.5	799.9	874.6	975.9
10-14	777.5	813.3	871.1	956.1
15-19	730.7	860.7	878.6	959.5
20-24	856.7	975.9	1,036.3	1,111.8
25-29	956.2	971.3	1,143.8	1,183.1
30-34	976.7	1,014.4	1,169.5	1,240.8
35-39	925.7	1,054.7	1,096.8	1,276.1
40-44	813.5	1,033.5	1,086.6	1,245.9
45-49	849.3	956.8	1,094.0	1,139.5
50-54	797.3	824.9	1,047.9	1,102.6
55-59	788.1	846.8	956.5	1,094.2
60-64	729.0	788.3	819.8	1,041.6
65-69	661.6	779.7	837.8	946.2
70-74	539.8	673.0	742.1	782.6
75-79	383.4	560.5	687.3	760.3
80-84	277.5	445.6	566.8	640.0
85-89	318.0	413.7	618.2	808.2
Total female	**12,933.4**	**14,618.7**	**16,413.2**	**18,241.7**
Total person	**25,660.8**	**28,923.5**	**32,401.1**	**36,012.7**

Source: Deloitte Access Economics demographic modelling.

A.3. Supplementary prevalence data

Table A.2: Stroke prevalence rates by age and gender

	Male	Female	Total
Age group			
0-4	0.06%	0.02%	0.04%
5-9	0.06%	0.02%	0.04%
10-14	0.06%	0.02%	0.04%
15-19	0.06%	0.02%	0.04%
20-24	0.08%	0.13%	0.10%
25-29	0.08%	0.13%	0.10%
30-34	0.16%	0.33%	0.24%
35-39	0.16%	0.33%	0.24%
40-44	0.53%	0.60%	0.57%
45-49	0.72%	0.83%	0.78%
50-54	1.34%	1.21%	1.27%
55-59	1.78%	1.90%	1.84%
60-64	3.21%	2.48%	2.83%
65-69	5.38%	2.97%	4.14%
70-74	7.99%	4.00%	5.95%
75-79	10.67%	6.94%	8.73%
80-84	15.07%	10.21%	12.41%
85+	16.86%	13.28%	14.65%
Total	**1.91%**	**1.61%**	**1.73%**

Source: ABS (2018, 2015, 2012, 2009).

Table A.3: Summary of Australian stroke incidence studies

Source	Region	Time Period	Study type	Crude rates (cases per 100,000 people)*	Sample size	Commentary
Clissold et al (2017)[157]	Victoria	2003-2008	Hospitalisation-based	Men 202 Women 188	2006: 4,932,422 people	No detailed age, gender specific rates
Sarink et al (2018)[158]	Western Australia	1995-2010	Hospitalisation based	Men 234 Women 164	1990: 787,115 people 2010: 1,150,467 people	Data available for ages between 35 and 84
Newbury et al (2017)[159]	South Australia	2009-2011	Population-based	Men 84 Women 104	95,054 (males), 97,018 (females)	Rural population

Source	Region	Time Period	Study type	Crude rates (cases per 100,000 people)*	Sample size	Commentary
Leyden et al (2013)[160]	South Australia	2009-2010	Population-based	Men 176 Women 146	72,559 (males), 75,468 (females)	Adelaide only
Anderlini et al (2020)[161]	Queensland	2002-2015	Hospitalisation based	Men 117 Women 99	2015: 4,778,854 people	Data available for people of all ages
Thrift et al (2009)[162]	Victoria	1996-1997	Population-based	Men 144 Women 157	133,816 people	North East Melbourne only

Source: As noted. * Crude incidence rates.

Appendix B Supplementary productivity data

Table B.1: Reduced employment literature for survivors of stroke

Study	Country	Sample	Employment outcome
Westerlind et al (2017)[163]	Sweden	174 survivors of stroke	• 74.7% return to work at 3 years post stroke • 48.3% return to work at one-year post stroke
Hackett et al (2012)[164]	Australia	271 people in paid work before stroke	• 75% of people returned to work at one-year post stroke
Larsen et al (2016)[165]	Denmark	294 survivors of stroke	• 50% returned to work at one-year post stroke
SDAC	Australia	2018 SDAC	• 47% of male survivors of stroke employed, 41% of female survivors of stroke employed (ages 15-64)

Source: As noted.

The SDAC dataset provides self-reported data on survivors of stroke and their employment.[166] There were several notable limitations to the employment rates in the SDAC. Firstly, it was not possible to control for comorbidities. It is likely that this had a significant impact on the overall results. For example, only 86,000 of the 387,000 survivors of stroke in the SDAC reported that stroke was their main condition. Therefore, almost 78% of survivors of stroke reported another condition which may affect their employment status. Another limitation was the limited stroke employment data for people aged 15-34.

Due to the limitations of the SDAC data, a review of additional literature was conducted to confirm any adjustment to employment rates. The findings of this literature review are presented in Table B.1.

Table B.2: Absenteeism literature for survivors of stroke

Study	Country	Sample	Absenteeism outcome
Vuong et al (2015)[167]	USA	27 survivors of stroke working full-time aged 18-64	Additional 17.01 days off work per year
Hackett et al (2012)[168]	Australia	271 people in paid work before stroke	People in full time work before stroke returned to work after an average of 65 days
Endo et al (2016)[169]	Japan	382 survivors of stroke	Median duration of sickness absence until either partial or full return to work was 106 days
Rossagnel et al (2005)[170]	Germany	-	A mean of 90 days off work was reported in the 12 months after stroke
Kotseva et al (2019)[171]	Europe	198 survivors of stroke	34 days absenteeism before returning to work followed by 13 days absenteeism after returning to work

Source: As noted.

Appendix C Supplementary assumptions other costs

C.1. Unit costs of aids, equipment and home modifications

Table C.1: Unit costs and effective life of various aids, equipment and home modification

Category	Item	Depreciated item cost	Effective life years
Aids	Hearing aid	$374	5
Aids	Cochlear implant	$391	5
Aids	Low tech reading and writing aids	$91	3
Aids	Low tech speaking aids	$78	7
Aids	High tech reading or writing aids	$469	7
Equipment	Canes (Sonar canes)	$11	5
Equipment	Crutches	$9	12
Equipment	Walking frame	$5	12
Equipment	Walking stick	$4	5
Equipment	Wheelchair (Manual)	$88	5
Equipment	Wheelchair (Electric)	$1,147	5
Equipment	Scooter/gopher	$847	3
Equipment	Braces/belts/corsets	$29	3
Equipment	Built-up shoes	$128	3
Equipment	Orthoses or orthotics	$139	3
Equipment	Electric operated lounge chairs and/or specialised seating	$142	10
Equipment	Lifting machine/Hoist	$339	10
Home modifications	Structural changes	$772	20
Home modifications	Ramps	$29	15
Home modifications	Toilet, bath or laundry modifications	$329	10
Home modifications	Kitchen modifications	$274	12
Home modifications	Doors widened	$11	10
Home modifications	Handrails or grabs	$7	15

Source: Australian Taxation Office (2020), National Disability Insurance (2015), Vision Australia (n.d.), Deloitte Access Economics calculations.

C.2. Welfare payments

C.2.1. Disability support pension

The Disability Support Pension is the primary social security payment available to individuals who are unable to work due to their physical, intellectual or psychiatric impairment. The Disability Support Pension is paid to individuals who are 15 years and above with a disability that precludes them from working 15 hours or more per week at or above the relevant minimum wage.[172]

In 2020, 23,523 individuals with a disability caused by their circulatory system were receiving Disability Support Pension.[173] Unfortunately, this figure was not provided at a disaggregated disability level. However, the Australian Bureau of Statistics provides information on the number of recipients receiving Disability Support Pension who identified stroke as their main condition.[174] Of those receiving Disability Support Pension, 28% who had a primary medical condition caused by their circulatory system were survivors of stroke.[175] This figure was applied to the total number of individuals reported as receiving the Disability Support Pension caused by their circulatory system, which provided a total of 6,595 individuals.

This figure was disaggregated down into household composition using the Australian Bureau of Statistics, so that fortnightly Disability Support Pension amounts could be best attributed.[176] For example, single person households received $860.60 a fortnight whilst those living in couple households received $648.70 each.[177] Table C.2 provides a summary of the number of recipients by household composition and total payment amounts. In 2020, the total estimated expenditure attributable to stroke was $120.8 million.

Table C.2: Disability payments by recipient's household composition, 2020 ($million)

Household composition	Recipients	Total payments
Husband, wife or partner	4,856	$81.9
Lone parent	301	$6.7
Non-dependent child	88	$2.0
Other related individual	120	$2.7
Non-family member	52	$1.2
Lone person	1,179	$26.4
Total	**6,595**	**$120.8**

Source: Department of Social Services (2020), Australian Bureau of Statistics (2019), Deloitte Access Economics calculations

C.2.2. Carer allowance

Carer Allowance is an income supplement available to people who provide daily care and attention in a private home to an individual who is 16 years or over with disability or a severe medical condition. It can be paid in addition to an income support payment.

In 2020, 53,183 individuals were receiving Carer Allowance in response to caring for an individual with a disability caused by their circulatory system.[178] This figure was disaggregated based on 3% of survivors of stroke receiving either informal and formal care or informal care only. [179] Based on this, it is estimated 1,523 individuals receive Carer Allowance.

Annually a recipient of Carer Allowance receives $3,429 or $131.90 per fortnight. When multiplied by the estimated number of recipients above, total expenditure in 2020 was $5.2 million.

C.2.3. Carer supplement

In addition to receiving Carers Allowance, carers are also eligible for Carers Supplement. This is paid once annually and is adjusted to reflect whether a carer is providing full-time or part-time care.

Information from the ABS on the average number of hours a primary carer spends each week caring for the main recipient, was used to estimate the number of part-time and full-time carers to survivors of stroke. Based on this information, 63% (961 persons) of carers provide part-time care or less than 35 hours care to the main recipient each week.[180] The remaining 37% (562 persons) of carers provide full-time care equivalent to or more than 35 hours of care to the main recipient each week.[181]

Annually a recipient of Carer Supplement providing part-time care would receive $300.00 increasing to $600.00 for those who provide full-time care. When multiplied by the estimated number of recipients receiving part-time and full-time care, total expenditure for 2020 was $625,503.

C.2.4. Carer payment

Carer Payment is an income support payment available to people who provide constant care to someone who has a severe disability, illness, or an adult who is frail aged.

In 2020, 26,833 individuals were receiving Carer Payment in response to caring for an individual with a disability caused by their circulatory system.[182] This figure was disaggregated based on 3% of survivors of stroke receiving either informal and formal care or informal care only. [183] Based on this, it is estimated 768 individuals receive Carer Payment.

This figure was disaggregated down into household composition using the Australian Bureau of Statistics, so that fortnightly Carer Payment amounts could be best attributed.[184] For example, single person households received $860.60 a fortnight whilst those living in couple households received $648.70 each.[185] Table C.3 provides a summary of the number of recipients by household composition and total payment amounts. In 2020, the total estimated expenditure attributable to stroke was $15.4 million.

Table C.3: Disability payments by recipient’s household composition, 2020 ($million)

Household composition	Recipients	Total payments
Husband, wife or partner	566	$10.5
Lone parent	35	$0.9
Non-dependent child	10	$0.3
Other related individual	14	$0.3
Non-family member	6	$0.1
Lone person	137	$3.4
Total	**768**	**$15.4**

Source: Department of Social Services (2020), Australian Bureau of Statistics (2019), Deloitte Access Economics calculations

Appendix D Supplementary benchmark data

Table D.1: MRS scores used to model changes from current care to the benchmark (number of patients)

Modelled benchmark/ mRS category	Benchmark	Current care
Thrombolysis		
mRS 0	60	46
mRS 1	68	52
mRS 2	58	65
mRS 3	51	57
mRS 4	39	44
mRS 5	29	33
mRS 6	73	82
Door to needle		
mRS 0	50	8
mRS 1	54	20
mRS 2	44	7
mRS 3	36	9
mRS 4	40	22
mRS 5	11	5
mRS 6	52	14
Endovascular thrombectomy		
mRS 0	15	7
mRS 1	21	10
mRS 2	18	12
mRS 3	16	15
mRS 4	13	24
mRS 5	7	12
mRS 6	10	19
Door to groin		
mRS 0	14	13
mRS 1	25	23
mRS 2	25	25
mRS 3	17	18
mRS 4	10	11
mRS 5	4	4
mRS 6	5	6

Source: Deloitte Access Economics analysis based on studies reported in Table 7.3.

Table D.2: Modelled change in probability of death, health and social care costs, and quality adjusted life over 5 years

Intervention	Cumulative probability of death over 5 years	Cumulative health and social care costs over 5 years, £/%	Cumulative change in quality adjusted life over 5 years
Greater access to thrombolysis	0.36	39,595	2.60
Current access to thrombolysis	0.39	43,492	2.43
Difference over 5 years (relative change for health and social care costs)	**-0.03**	**-9.0%**	**0.17**
Improved door to needle time	0.34	37,617	3
Current door to needle time	0.39	46,992	2
Difference over 5 years (relative change for health and social care costs)	**-0.05**	**-20.0%**	**0.34**
Greater access to endovascular thrombectomy	0.36	39,968	2.59
Current access to endovascular thrombectomy	0.46	55,359	1.98
Difference over 5 years (relative change for health and social care costs)	**-0.10**	**-27.8%**	**0.61**
Improved door to groin puncture time	0.33	35,253	2.77
Current door to groin puncture time	0.34	37,031	2.69
Difference over 5 years (relative change for health and social care costs)	**-0.01**	**-4.8%**	**0.07**
Reduced uncontrolled hypertension in the population	0.26	-*	2.64
Current uncontrolled hypertension	0.33	-*	2.07
Difference over 5 years (relative change for health and social care costs)	**-0.07**	-*	**0.57**
Greater prescription of antihypertensives on discharge	0.197	-*	0.331
Current prescription of antihypertensives on discharge from hospital	0.202	-*	0.315
Difference over 5 years (relative change for health and social care costs)	**-0.005**	-*	**0.016**

Source: Deloitte Access Economics analysis based on Ganesh et al (2020) and studies reported in Table 7.3.

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