IRISH HEART FOUNDATION
Fighting Heart Disease & Stroke

Irish Heart Foundation

Cost of Stroke in Ireland

Estimating the annual economic cost of stroke and transient ischaemic attack (TIA) in Ireland

September 2010

About the Irish Heart Foundation

The Irish Heart Foundation is the national charity fighting heart disease and stroke. More people in Ireland die from these causes than from cancer, road deaths and suicide combined. We work to bring hope, relief and a better future to Irish families.

We support pioneering medical research, campaign for improved patient care and provide vital patient support and information.

In hospitals, schools and workplaces, we support, educate and train people to save lives. As a charity we depend on your ongoing support – through your donations or by giving of your time as a volunteer or on a training course.

Cost of Stroke in Ireland:
Estimating the annual economic cost of stroke and transient ischaemic attack (TIA) in Ireland

Report prepared for the Irish Heart Foundation by the Economic and Social Research Institute (ESRI) and the Royal College of Surgeons in Ireland (RCSI)

September 2010

Research team and Steering group

Project research team

Dr Samantha Smith (ESRI)

Dr Frances Horgan (RCSI)

Ms Eithne Sexton (ESRI)

Prof Miriam Wiley (ESRI)

Steering group members

Prof Seamus Cowman (RCSI)

Dr Anne Hickey (RCSI)

Prof Peter Kelly (DAMC-Mater University Hospital/UCD)

Prof Hannah McGee (RCSI)

Prof Sean Murphy (Midland Regional Hospital Mullingar/RCSI)

Prof Desmond O'Neill (TCD/AMNCH)

Ms Maeve Royston (RCSI)

Dr Emer Shelley (HSE/RCSI)

Foreword

A message from the Irish Heart Foundation

High levels of avoidable death and dependency from stroke in Ireland provide a compelling case for major improvements to acute, rehabilitation and support services.

For example, it is generally accepted that the mortality rate from stroke would be cut by around 25 per cent if stroke unit care was available to everyone struck by the disease here. What has been less clear is how much better services will cost.

The economic realities make it more important than ever that health policy makers are fully informed about the cost of existing services and the cost implications of service improvements to inform their decisions on resource allocation.

This study provides the most comprehensive data ever assembled on the baseline economic burden of stroke in Ireland, as well as assessing the potential costs and potential economic benefits of key interventions such as stroke unit care and the clot-busting treatment, thrombolysis.

In particular it demonstrates the potential for extensive improvements in acute stroke services that could save hundreds of people each year from death and institutionalisation at an actual cost saving to the State. It also illustrates the dire future consequences of failing to overhaul these services due to a significant increase in stroke incidence in the years ahead driven by factors such as our ageing population.

Specifically the report shows that:

- The current cost burden of stroke could exceed €1 billion – of which the direct costs account for more than 4 per cent of total health expenditure. Around 40 per cent is spent on nursing home accommodation, a significant proportion of which would be saved if acute services were improved.

- By providing 95 per cent access to stroke unit care, 650 stroke victims could be saved each year from death or dependency at a potential annual SAVING of up to €10 million. Achieving a 20 per cent rate of thrombolysis could also save up to 100 people from death or dependency annually at a SAVING of up to €3 million a year.

- Without decisive action to prevent stroke, the number of stroke cases in Ireland could increase by more than 50 per cent by 2021. This could result in an increase of at least 50 per cent in the overall cost of stroke to the economy.

The Government receives many reports claiming that upgraded services will result in cost reductions at some stage in the future. The difference in this case is that better acute stroke services will lead to almost instant savings because increased access to stroke units and thrombolysis will result in immediate improvements in outcomes. For example, this means that fewer patients will require nursing home care – the single biggest cost factor in stroke service provision.

Of course, the purpose of improving Irish stroke services to acceptable international standards at the very least, is not to save money for the Exchequer, but to eliminate the catastrophic human cost of avoidable death and disability from stroke in Ireland.

The vast majority of people who have a stroke today will face bleak prospects: limited access to specialised stroke care; problems getting life-saving thrombolysis at weekends and at night; a chronic shortage of therapists and long waiting lists for the rehabilitation which should be provided from their first day in hospital; and for many people months, years, or even the rest of their lives in a nursing home because their potential for independence has diminished while waiting for proper care. These prospects would be transformed by the removal of constraints on service improvements that result from concerns over the cost implications.

This report is the product of exhaustive research, and although there are some data limitations that must be taken into account, it carries sufficient weight to place an onus on the Government and health authorities to make a clear judgment on the findings. Their response must be either to release the funding for the full implementation of the recommendations on stroke in the Cardiovascular Health Policy, or to state very clearly why they are unable to do so.

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Michael O'Shea
CEO, Irish Heart Foundation
September 2010

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- This study estimates the economic burden of stroke and transient ischaemic attack (TIA) in Ireland in the year 2007.
- The Irish National Audit of Stroke Care (INASC) made a number of recommendations to reconfigure and improve the delivery of stroke services. Many of these recommendations have cost implications (e.g., stroke units). Establishing the baseline economic burden of the status quo informs health policy makers about the current resource implications of stroke, and may guide future priorities and resource allocation decisions.
- Changing age patterns provide another motivating factor for estimating the cost of stroke in Ireland. Age is a key risk factor for stroke and there are concerns that growth in the number of older people in the population will lead to an increase in the number of people at risk. It is, therefore, important to understand current resource use and costs of stroke to inform health service planning.
- It is important, also, to consider the implications of epidemiological changes for future costs.

DATA AND METHODOLOGY

- This is a prevalence-based study, aggregating stroke-related costs over a one year period for all those who develop or already have the disease.
- The definition of stroke includes cases with subarachnoid haemorrhage, intracerebral haemorrhage, and cerebral infarction.
- Costs are collected for a range of direct costs (e.g., acute hospital, in-patient rehabilitation, nursing home, specialist out-patient, general practitioner (GP) and community rehabilitation care, stroke-related medications, and others) and indirect costs (informal care, morbidity and mortality costs).
- Age and sex specific stroke incidence rates are adopted from the North Dublin Population Stroke Study. Constraints in data availability resulted in a 'low' and 'high' estimate of stroke prevalence being adopted. The low estimate of stroke prevalence combines data from the Health Module of the Quarterly National Household Survey (2001) with an estimate of the number of stroke patients residing in nursing homes. The high estimate of stroke prevalence is adopted from the World Health Organization. Incidence and prevalence rates are applied to the 2007 Irish population.
- Cost and resource utilisation data are collected from a number of national and international sources.

KEY FINDINGS AND DISCUSSION

Total stroke costs

- Conservative estimates indicate that total direct and indirect stroke costs were between €489 million (low prevalence) and €805 million (high prevalence) in Ireland in 2007 (at baseline incidence rates and low estimates of hospital, rehabilitation, and indirect costs).
- Total estimated direct expenditure on stroke accounted for between 2–4 per cent of total health expenditure and between 0.2–0.3 per cent of GNP in Ireland in 2007. This is in line with international estimates of the cost of stroke.
- The mean direct cost per stroke patient for incident cases in the first year of stroke was approximately €18,751 in 2007 at baseline incidence rates, equivalent to 50 per cent of GNP per capita.
- The main cost items included direct costs for acute hospital and in-patient rehabilitation, nursing home care costs, and indirect costs. Relative to other countries, nursing home care accounted for a higher proportion of total direct costs in Ireland.

Total TIA costs:

- The total cost of TIA in Ireland in 2007 is estimated to have been €11 million, the majority of which was accounted for by hospital costs.
- The mean TIA cost of €4,925 per case is less than 30 per cent of the mean total stroke cost per patient, consistent with international evidence.

Source of funding:

- Public resources accounted for the majority of direct expenditure on stroke and TIA services.
- Out-of-pocket payments were required for approximately 25 per cent of the costs of stroke-related drugs, nursing home and GP care, with implications for equity and efficiency in stroke service resource allocation.

Data limitations:

- There are a number of data limitations that need to be addressed. In particular, data gaps on the provision of services for stroke patients outside of the hospital setting (e.g. community rehabilitation) are highlighted.

Sensitivity analysis:

- Sensitivity analysis examines the implications for total stroke costs of adjustments in stroke incidence, costing methods and cost parameters.
- Under these alternative scenarios, the full range of total stroke costs in Ireland in 2007 was €470–€1,008 million.

Future costs:

- This study also examines future costs of stroke in Ireland. Adjusting for demographic change alone, total stroke costs in 2021 are estimated to increase by more than 50 per cent from 2007 (to €743 million in the low prevalence scenario and €1,266 million in the high prevalence scenario).
- Changes in stroke epidemiology could increase this cost further.
- Introducing changes to stroke service provision (e.g., stroke units) will have important implications for health outcomes and for costs. Drawing on available international evidence, and on the data compiled for this study, additional analysis (Appendix 3) examines the potential benefits and costs of implementing key stroke care interventions in the Irish health care system. There are indications that at the aggregate level there are potential cost savings that accrue from improving the way in which stroke care is delivered, and these costs savings may offset, or potentially more than offset, the costs associated with implementing the changes.

1 INTRODUCTION

1.1 WHAT IS STROKE?

This study estimates the economic burden of stroke and transient ischaemic attack (TIA) in Ireland in the year 2007.

A stroke is a brain attack caused by a blockage of a blood vessel or a haemorrhage that disrupts the flow of blood to the brain, causing a focal or global neurological deficit (affecting bodily functions or mental processes) lasting more than 24 hours, or causing death within 24 hours.

A TIA is a focal or global neurological deficit of presumed vascular origin which lasts less than 24 hours and is a warning sign that a full stroke may occur. A TIA can cause a brief loss of vision, loss of speech, or weakness on one side of the body (Irish Heart Foundation, 2009).

Stroke accounts for 10 per cent of total world deaths and is the second most common cause of death in the world, after ischaemic heart disease (Luengo-Fernandez et al., 2009; di Carlo, 2009). Patients who survive an acute stroke episode are often left with some degree of disability and many become dependent on others to carry out daily activities (Moon et al., 2003). Stroke is the leading cause of disability in Europe (Rossnagel et al., 2005; Saka et al., 2009a).

In Ireland, stroke accounts for approximately 7 per cent of mortality (DOHC, 2007b) and in 2007 there were a total of 5,834 discharges from acute public hospitals with a principal diagnosis of subarachnoid haemorrhage, intracerebral haemorrhage, or cerebral infarction (ICD 10-AM codes I60, I61, I63, I64[1]) and with an average length of stay in excess of 20 days (ESRI, 2007).

1.2 WHAT IS A COST OF ILLNESS STUDY?

A cost of illness study aims to evaluate the economic burden that a specific illness imposes on society in terms of the consumption of health care resources and production losses (Tarricone, 2006). Direct and indirect costs that can be attributed to a specific illness are included. Direct costs refer to those that are directly related to the provision of health care (e.g., in-patient costs, medication); indirect costs include the costs of productivity foregone due to absenteeism from work and from informal care. The perspective of the study determines what costs are included. A societal perspective includes costs associated with the disease

[1] 10th Revision of the International Classification of Diseases, Australian Modification (ICD-10-AM): I60 (subarachnoid haemorrhage); I61 (intracerebral haemorrhage); I63 (cerebral infarction); I64 (stroke, not specified as haemorrhage or infarction)

that are incurred by a range of institutions/individuals in the economy (e.g., health care provider, patient, patient carer). A cost of illness study can be based on prevalence or incidence rates. This study adopts a prevalence-based approach, which examines the costs of an illness to society in a given year, aggregating the costs associated with all those who already have the particular disease or who develop it during the year. An incidence-based study estimates the lifetime costs of a disease for the new cases in a specific year.

1.3 WHY COST OF ILLNESS STUDY?

Knowledge of resource use and costs is useful to provide an estimate of the socioeconomic impact of a disease (Rossnagel et al., 2005). Information on the prevalence-based costs of different illnesses can inform health policy makers when setting priorities, evaluating existing services, allocating resources, and planning new services (Finkelstein and Corso, 2003; Rossnagel et al., 2005; Saka et al., 2009a).

The delivery of stroke care has received a lot of attention in Ireland, particularly following the Irish National Audit of Stroke Care (INASC) (Irish Heart Foundation, 2008), which examined in detail the state of hospital and community stroke care in Ireland. The INASC highlighted the need for a 'radical and urgent review of stroke services in Ireland' (Irish Heart Foundation, 2008: 56) and made a number of recommendations to reconfigure and improve the delivery of stroke services. These are also reflected in a recent stroke manifesto published by the Irish Heart Foundation (2009). Many of these recommendations have cost implications (e.g., development of stroke units, processes for early supported discharge, 24-hour availability of thrombolysis therapy, access to specialist stroke rehabilitation services). It is important, therefore, to establish the baseline economic burden of the status quo. This informs health policy makers about the current resource implications of stroke, and can guide resource allocation decisions and future priorities.

Changing age patterns provide another motivating factor for estimating the cost of stroke in Ireland. Age is a key risk factor for stroke and there are concerns that the growth in the number of older people in the world population will lead to an increase in the number of people at risk (di Carlo, 2009). The current proportion of the population aged 65 years and older in Ireland is 11 per cent and this is projected to increase to 15 per cent by 2021 (Layte et al., 2009). Dewey et al. (2001) noted that future increases in the number of stroke cases could place a strain on available stroke health care services and resources. It is therefore important to understand current resource use and costs of stroke to inform future priority setting and health service planning. It is also important to consider the implications of epidemiological changes for future costs.

Interpreting the economic burden of a disease is complex. First, there is a distinction between the proportion of the costs of existing hospital, rehabilitation services etc. that are attributed to treating stroke patients, and the costs associated with services specifically focused on stroke patients. In the Irish context, stroke patients are treated within the overall system and the focus is on identifying the proportion of the costs of those services taken up by care of stroke patients. Second, there is a tension between estimating the costs of health care services that exist, and those that should exist. For some services, the level of expenditure may be lower than it would otherwise be if the service were provided at a recommended level. To illustrate, in Ireland, the INASC report has documented a shortage of community rehabilitation services for stroke patients (Irish Heart Foundation, 2008). The cost attributed to community rehabilitation in this study is likely to be an underestimate of what the cost should be if all stroke patients received the required level of community rehabilitation. Conversely, greater access to community rehabilitation may lessen the burden on other services (e.g., in-patient hospital services). The costs of these other services may be overestimated compared with the alternative where services are configured appropriately to provide more community rehabilitation. This study focuses on estimating the baseline costs of stroke services as they are currently provided in Ireland. Areas of under-provision are noted where appropriate.

There is separate analysis of the implications for future costs of changes in stroke care delivery. As noted by Pendlebury et al. (2004), the relatively under-funded nature of stroke research throughout the developed world means that the needs of those with stroke have not yet been fully characterised as is the case with other illnesses, and the economic costs of these needs, and meeting them, are probably underestimates. It is also noted that investment in programmes to improve heart health (e.g., smoking cessation programmes, healthy eating, exercise promotion, etc.) will have implications for the onset of cardiovascular-related illnesses, including stroke, with knock-on effects on the cost burden of the disease, but these are not addressed in this study.

1.4 WHAT ARE THE COSTS OF STROKE?

With a high mortality and disability burden, the economic cost of stroke is expected to be high. It is estimated that cerebrovascular diseases account for between 2 per cent and 5 per cent of total health care costs in industrialised countries (Rossnagel et al., 2005). In the Irish context there has been limited investigation of the costs of stroke. In a recent European study, estimates of the cost of stroke in Ireland were based on non-Irish specific prevalence and cost data (McHugh, 2007). This study draws on a range of up-to-date Irish data resources to develop current estimates of direct and indirect costs of stroke in Ireland. The costs of TIA are also estimated.

1.5 AIMS AND OBJECTIVES

The overall aim of the study is to estimate the prevalence-based cost of stroke and TIA in Ireland in 2007, adopting a societal perspective.

Specific objectives are to:

- estimate direct costs of stroke care in Ireland in 2007
- estimate indirect costs of productivity foregone due to informal care, stroke morbidity, and stroke mortality in Ireland in 2007
- estimate direct costs of TIA care in Ireland in 2007
- estimate future costs of stroke in Ireland in 2021 based on projected demographic and epidemiological changes
- examine outcome and cost implications of changing existing stroke services (e.g., increased number of stroke units).

1.6 REPORT STRUCTURE

The report is structured as follows: section 2 introduces the data and methodology; results are presented in section 3 and discussed in section 4; and section 5 presents conclusions.

2 DATA AND METHODOLOGY

2.1 DEFINITION OF STROKE

Where possible, cost data are collected for stroke and TIA cases that align with the definitions outlined in Table 1.[2]

TABLE 1
Definition of stroke and TIA

ICD-10-AM code	Code description
Stroke	
I60	Subarachnoid haemorrhage
I61	Intracerebral haemorrhage
I63	Cerebral infarction
I64	Stroke, not specified as haemorrhage or infarction
Transient cerebral ischaemic attacks (TIA)	
G45.0	Vertebro-basilar artery syndrome
G45.2	Multiple and bilateral precerebral artery syndromes
G45.3	Amaurosis fugax
G45.9	Transient cerebral ischaemic attack, unspecified

Source: National Centre for Classification in Health, ICD-10-AM

2.2 EPIDEMIOLOGICAL DATA

The epidemiological data for this study are drawn from the most up-to-date, Irish-specific data available. Identifying stroke incidence and prevalence is complex and full details on the selection of appropriate data are outlined in Appendix 1.

Incidence data

Age and sex specific stroke and TIA incidence rates are adopted from the North Dublin Population Stroke Study (NDPSS),[3] and applied to the 2007 Irish population. As noted in the literature, caution is required when extrapolating local incidence rates to wider populations (Dewey et al., 2001, Truelsen et al., 2006). Sensitivity analysis adopts incidence rates at the upper and lower bounds of the 95 per cent confidence interval around the baseline (Tables A.1–A.2). Incidence includes first ever and recurrent strokes. The treatment costs of a recurrent stroke are estimated to be the same as those for a first-ever stroke in line with analysis by Spieler et al. (2003).

[2] These definitions are consistent with those adopted in the North Dublin Population Stroke Study, from which the incidence of stroke is drawn for this study. The definition of stroke is also consistent with the INASC report, including the same codes that were used in the clinical audit (I61, I63, I64), and adding I60 for this cost study.

[3] The NDPSS is a prospective cohort study of stroke and TIA in 294,592 individuals in North Dublin city, following internationally recommended methods for measuring incidence. Individuals with stroke and TIA occurring in the one-year period from 01/12/2005 to 30/11/2006 were identified from multiple overlapping hospital and community data sources.

Prevalence data

A number of data sources provide varying estimates of stroke prevalence in Ireland. For sensitivity, two estimates of stroke prevalence in Ireland are adopted for this study. The first, a low estimate, combines data from the Health Module of the Quarterly National Household Survey (QNHS) (2001) with an estimate of the number of stroke patients residing in nursing homes. The second, a high estimate of stroke prevalence, is adopted from the World Health Organization (WHO) Global Burden of Disease project (Table A.5).

This generates six alternative epidemiological scenarios:

1) low prevalence with incidence at baseline
2) low prevalence with incidence at the lower boundary of the 95 per cent confidence interval
3) low prevalence with incidence at the upper boundary of the 95 per cent confidence interval
4) high prevalence with incidence at baseline
5) high prevalence with incidence at the lower boundary of the 95 per cent confidence interval
6) high prevalence with incidence at the upper boundary of the 95 per cent confidence interval.

Cost estimates are presented for the low and high estimates of prevalence, with incidence at the baseline (i.e., scenarios 1 and 4) in the main body of the report. Results from the sensitivity analysis around the baseline incidence rates are presented in Appendix 2.

2.3 COST DATA AND METHODOLOGY

2.3.1 General approach

As outlined in section 1.5, this study adopts a societal perspective, including costs associated with stroke that are incurred by State institutions (e.g., public health services) and by private bodies/individuals (e.g., out-of-pocket payments). Where possible, this study identifies the distribution of the cost of services by source of finance (i.e., public resources, out-of-pocket payments, private health insurance). This is a prevalence-based study, examining the total costs of stroke and TIA in Ireland in the year 2007.

Direct and indirect costs are estimated, detailed in Table 2. Direct costs refer to those that are directly related to the provision of health care for patients. Indirect costs refer to costs to the economy of lost productivity due to stroke illness. This study calculates the indirect costs associated with informal care-giving for stroke patients, and the costs of productivity foregone due to stroke illness/mortality in the year 2007. The focus on the services outlined here is consistent with the

literature (Payne et al., 2002) and with available data. Intangible costs, such as the cost of suffering and loss of quality of life, are not included here due to data limitations. Thus, the economic costs of disability are likely to represent an underestimate of the impact on employment, relationships and social inclusion, in the same way that this has been recognised for other illnesses (e.g., mild traumatic brain injury, Petchprapai and Winkelman, 2007). Equally, the impact of cognitive impairment, dementia and other psychological sequelae after stroke are likely to be large, but underestimated, in terms of their economic and social consequences (Flynn et al., 2008).

TABLE 2
Direct and indirect costs included in estimate of economic burden of stroke/TIA

	Stroke	TIA
Direct		
Acute hospital care	✓	✓
In-patient rehabilitation	✓	✓
Nursing home care	✓	
Specialist out-patient care	✓	
General practitioner care	✓	
Drugs	✓	✓
Community rehabilitation	✓	
Aids, appliances, home modifications	✓	
Voluntary stroke services	✓	
Indirect		
Informal care-giving	✓	
Morbidity/mortality	✓	

Data and methodology for estimating the stroke-related cost of each of the above services are outlined in the following sections. Methods for examining the future annual cost of stroke are outlined in section 2.3.12. Where possible, a bottom-up approach is adopted, whereby unit costs for specific services are combined with estimates of treatment utilisation rates. For some costs (e.g., hospital costs, community rehabilitation), alternative methods are applied to make best use of available data.

2.3.2 Hospital care

Methods

The costs of acute hospital care for stroke/TIA discharges recorded in the Hospital In-patient Enquiry (HIPE) are calculated using two alternative methodologies: cost per bed day and casemix-based costs. Cost per bed day is a top-down method which allocates total hospital costs across all hospital discharges on the basis of length of stay.

The method is outlined in equations 1) and 2):

(1) $\frac{\text{Total costs per hospital}}{\text{Total number of bed days per hospital}}$ = Cost per bed day (per hospital)

(2) Cost of stroke/TIA in one hospital (C_{bed}):

$$C_{bed} = \sum_{n=1}^{n=n} (\text{Cost per bed day in hospital A x Length of stay per discharge})$$

where n refers to the number of acute stroke/TIA discharges. Equation (2) is repeated for each hospital using 2007 cost and utilisation data. The total costs over all hospitals are summed.

The casemix approach is also a top-down approach which allocates total hospital costs across all discharges on the basis of casemix units rather than length of stay. Each discharge is assigned to a Diagnosis Related Group (DRG).[4] DRGs group together cases which share common clinical attributes and similar patterns of resource use. A casemix unit (CMU) measures the complexity (in terms of resource use) of the DRG to which a case has been assigned, relative to all other DRGs, and is adjusted to take into account the specific length of stay of the case.[5] The total casemix cost for stroke patients is calculated as follows:

(3) $\frac{\text{Total costs per hospital}}{\text{Total number of CMUs per hospital}}$ = Cost per CMU (per hospital)

(4) Cost of stroke/TIA in one hospital ($C_{casemix}$)

$$C_{casemix} = \sum_{n=1}^{n=n} (\text{Cost per CMU in Hospital A x No. of CMUs per discharge})$$

where n refers to the number of acute stroke/TIA discharges. Repeat equation (4) for each hospital and sum the total costs. The CMUs per discharge are obtained for 2007, together with the cost per casemix unit for each hospital.

Hospital care is financed by a mix of public resources, out-of-pocket payments, and private health insurance. The breakdown of acute care costs by source of funding is estimated using information on the medical card and public/private status of the hospital discharges.[6]

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4 The Irish casemix system has adopted the Australian system of diagnosis-related groups (Australian Refined Diagnosis Related Groups, AR-DRG).

5 E.g., a normal delivery without complications and a length of stay within the average range would be assigned a CMU = 0.37, while an acute stroke with catastrophic complication and a length of stay within the average range would be assigned a CMU = 5.37 (HSE, 2009).

6 Medical card status indicates whether or not the discharge was covered by a medical card. Public/private status refers to whether the patient saw the consultant publicly or privately. This is not an indicator of the type of bed that was occupied or whether or not the patient has private health insurance. However, in the absence of more information, the two variables are combined to proxy the payment mechanism for each discharge: medical card and public status (100 per cent public funding); medical card and private status (36 per cent public, 64 per cent private health insurance); no medical card and public status (100 per cent public funding less out-of-pocket payment of €60

The number of stroke cases recorded in HIPE diverges from the estimated number of incident stroke cases (see Appendix 1) due to a range of factors. A proportion of stroke cases are treated at home,[7] or at an Emergency Department (ED) without being admitted (e.g., dying in the ED), or at a hospital not included in HIPE.[8] Without further details on these cases, the acute hospital costs associated with these cases are not known. To correct for under-counting of costs, this study applies the national mean cost per ED attendance to all incident cases not recorded in HIPE.[9]

Data

Hospital discharge data are drawn from HIPE for the year 2007 (covering all 56 acute public hospitals in the system).[10] Total hospital costs and casemix data are available from the Health Service Executive's national casemix programme for the year 2007. Using the ICD-10-AM codes to categorise discharges, hospital discharges (mainly in-patient) with a principal diagnosis of I60/I61/I63/I64 (stroke) or G45.0/G45.2/G45.3/G45.9 (TIA) are included in the acute care costs. To avoid double counting, stroke/TIA discharges from rehabilitation hospitals, or where all procedures refer to rehabilitation, are excluded from acute care costs.

2.3.3 In-patient rehabilitation care

Methods

In-patient hospital rehabilitation for patients with stroke/TIA is recorded in HIPE. The cost of in-patient hospital rehabilitation for patients with stroke/TIA in HIPE, and the breakdown by source of funding, is estimated using the same methods that were employed for acute hospital costs.

statutory charge per in-patient bed day); no medical card and private status (36 per cent public, 64 per cent private health insurance).

Notes:

The statutory charge for a public in-patient bed per day in 2007 was €60 per day up to maximum of €600 in a 12 month period (DOHC, 2007a).

Available estimates indicate public subsidisation of privately insured care within public hospitals (excluding additional subsidisation via tax relief on private health insurance premiums) was 59 per cent, based on 2004 data (Smith, 2008). Private accommodation charges in public hospitals increased by an average of 55 per cent from 2004 to 2007. Adjusting for this increase gives an estimated private contribution of 64 per cent to the cost of in-patient care in public hospitals (i.e., a public subsidy of 36 per cent).

7 Data from the NDPSS indicate that approximately 10 per cent of stroke cases are treated at home without attendance at a hospital.

8 Note that HIPE only includes acute hospitals and not long-stay facilities.

9 Casemix-adjusted costs are not available for ED attendances.

10 There are approximately 20 private hospitals in the Irish health care system (McDaid et al., 2009).

The cost of in-patient rehabilitation for patients with stroke/TIA that takes place in non-HIPE hospitals is estimated using a bottom-up approach as per equation (5):

(5) Proportion of incident stroke/TIA cases receiving off-site in-patient rehabilitation x number of weeks x cost per rehabilitation bed per week

It is estimated that all off-site in-patient rehabilitation costs are covered from public resources.

Data

Discharge data are drawn from the HIPE scheme for the year 2007 to estimate the costs of in-patient rehabilitation in HIPE hospitals. Costs are estimated for the following cases:

- in-patient[11] discharges with a principal diagnosis of I60/I61/I63/I64 (stroke) in rehabilitation hospitals or where all procedures refer to rehabilitation
- in-patient discharges with a second diagnosis of I60/I61/I63/I64 and a principal diagnosis in the range Z00–Z99[12]
- in-patient discharges with a principal diagnosis of G45.0/G45.2/G45.3/G45.9 in rehabilitation hospitals or where all procedures refer to rehabilitation
- in-patient discharges with a second diagnosis of G45.0/G45.2/G45.3/G45.9 and a principal diagnosis in the range Z00–Z99.

To estimate the cost of off-site (non-HIPE) in-patient rehabilitation for patients with stroke[13] the following data are used:

- proportion of incident stroke cases discharged to off-site in-patient rehabilitation units estimated from the INASC clinical audit (19 per cent)
- length of time spent in off-site in-patient rehabilitation unit estimated to be 6 weeks on average
- unit cost per week for off-site in-patient rehabilitation estimated from average public nursing home cost in 2007 (€1,259, see nursing home care costs section 2.3.4).

[11] 53 day cases recorded in HIPE are not included to avoid double counting with community rehabilitation costs.

[12] These codes refer to factors influencing health status and contact with health services, and include Z50 which refers to care involving the use of rehabilitation procedures.

[13] It is assumed that TIA patients are not referred for off-site in-patient rehabilitation.

2.3.4 Nursing home care

Methods

The long-term nursing home care costs for stroke patients are calculated using a bottom-up approach, multiplying the unit cost of a nursing home bed per week by the estimated number of stroke patients residing in nursing homes (and by the number of weeks in one year).

The unit costs are stratified by type of nursing home and by dependency level of the patient. Table 3 outlines the average number of weeks per patient for which nursing home costs are calculated in one year. For incident cases who remain alive during the year, the average length of hospital in-patient stay is taken into account. The average length of hospital in-patient stay for stroke patients who are discharged to a nursing home is approximately 4 weeks (ESRI, 2007). It is estimated that the remainder of the year is spent in a nursing home (i.e., maximum of 11 months). Assuming that the incidence of strokes is spread evenly throughout the year, the average length of stay in a nursing home is estimated at 24 weeks (i.e., 11 months/2). This follows the approach proposed by Rice (1966).[14] For net prevalent cases who remain alive during the year, the total length of stay is estimated at 52 weeks for each case. For net prevalent cases who die during the year, the estimated average length of say is 26 weeks, assuming deaths are spread evenly throughout the year (i.e., 12 months/2).

TABLE 3
Average number of nursing home weeks in one year for stroke patients

Nursing home stroke patients	Average no. of weeks in hospital in one year	Average no. of weeks in nursing home in one year	
		Formula	No.
Incident (alive)	4	(52 weeks – 4 weeks[a])/2	24
Incident (deaths)	4	0	0
Net prevalent (alive)	0	52 weeks	52
Net prevalent (deaths)	0	(52 weeks)/2	26

Note: [a] Data source: ESRI, 2007

Nursing home bed costs are funded from public resources and from out-of-pocket payments by the patients. The breakdown of public and out-of-pocket payments is calculated using the following information:

- In 2007, in public nursing homes, patients paid a weekly contribution and the balance was funded from public resources. In public nursing homes where nursing care was provided on a 24 hour basis,[15] the out-of-pocket charge from 2005 to 2007 was €120 (or weekly income less €35 whichever was the lesser

[14] This approach has also been more recently adopted by Navarrete-Navaro et al. (2007) in their estimation of lifetime stroke costs.

[15] For this study, it is estimated that all stroke patients who reside in nursing homes are in homes where nursing care is provided on a 24 hour basis.

amount) and in 2008 it increased to €153.25 (or weekly income less €44.70 whichever was the lesser amount).

- An estimated 17 per cent of beds in private nursing homes are contracted by the public sector (DOHC, 2006; Interdepartmental Working Group on Long Term Care, 2006). Out-of-pocket charges applied as for public nursing home beds (i.e., €120 per week in 2007) and the balance of the private nursing home charge was paid from public resources.
- An estimated 58 per cent of private nursing home beds are publicly subsidised. A flat rate public subvention of €300 per week was introduced in 2007.[16] Out-of-pocket payments were required to cover the balance of the private bed cost.
- Approximately 25 per cent of private nursing home beds do not receive public subsidisation and the full private bed cost is paid out-of-pocket.

Data

The number of stroke patients residing in nursing homes is estimated as part of the epidemiological analysis (see Appendix 1).

Table 4 presents the estimated weekly costs of nursing home beds (in 2007 prices), stratified by type of nursing home and by dependency level of the patient.

TABLE 4
Weekly unit costs of nursing home care

Level of dependency	Nursing home bed charge per week, 2007 (€)	
	Public nursing homes[a]	Private nursing homes[b]
Baseline	1,259[c]	666
High	1,637	825
Maximum	2,141	983

Notes:

[a] The mean public nursing home bed charge is adjusted to take into account variations in level of dependency of the stroke patients. Prior to 2007, public subventions were granted at three rates (medium, high, maximum) to reflect variations in the level of dependency of the applicants. A higher, enhanced subvention was also granted but this was to reflect financial hardship rather than the degree of dependency/disability in the applicant. These rates are applied to the mean nursing home bed charge to calculate baseline, high and maximum bed charges.

[b] The baseline charge in a private nursing home refers to the mean lowest rate for a single en suite room and the maximum charge refers to the mean highest rate for a single en suite room in a private nursing home (NHI, 2007).

[c] Mean baseline public nursing home bed charge of €1,100 in 2005 prices (Interdepartmental Working Group on Long Term Care, 2006) inflated to 2007 prices, assuming a long-term care inflation rate of 7 per cent (HSE, personal communication, 2 April 2009).

The INASC nursing home survey provides an estimate of the variation in dependency, as measured by the Barthel index of dependency, amongst a sample[17] of stroke patients (Irish Heart Foundation, 2008). A total of ninety-six per cent of the patients are assigned to the severe disability category. The

[16] www.citizensinformation.ie (Accessed 26/03/09)

[17] n = 253 patients out of sample of 30 nursing homes.

proportional breakdown by dependency in the sample is applied to the estimated number of nursing home stroke patients.

Total nursing home costs are obtained by multiplying the average number of weeks (Table 4) by the total number of stroke patients in nursing homes, stratified by level of dependency and level of public subsidisation (e.g., purely public, contract, subvented, purely private). The total numbers of person weeks are multiplied by the relevant unit costs.

2.3.5 Ambulatory care

Methods

The costs of out-patient (OPD) specialist consultations and GP visits are included under ambulatory care. These costs are calculated using a bottom-up approach of multiplying the unit cost of an OPD or GP visit by the estimated number of stroke-related OPD/GP visits per stroke patient per year.

Ambulatory care is mainly funded from public resources and out-of-pocket payments. It is estimated that all stroke-related specialist OPD visits take place within the public hospital system. For GP care, medical card holders receive GP visits free of charge and are thus fully funded by public resources. Non medical card holders pay the private GP fee in full with no public subsidisation.[18] The medical card status of stroke patients residing at home and in nursing homes is estimated using data from HIPE and the NDPSS.

Data

There are no published estimates of the cost of OPD or GP visits in Ireland. The cost of an OPD visit is proxied by the average cost per OPD attendance obtained by dividing total public hospital OPD expenditure by total OPD attendances, 2007 (approximately €160).

The cost of a GP visit is proxied by:

- the capitation payment received by GPs in respect of medical card patients
- the private fee charged per GP visit for non medical card patients.

Public capitation payments to GPs for medical card patients are stratified by age, sex and distance to the GP surgery. These capitation rates are paid on an annual basis. To estimate the capitation payment per GP visit, the average capitation rates (2007 rates) for each age group are divided by the average number of GP

[18] There is some publicly funded GP care available to non medical card holders: specific schemes (e.g., Methadone Treatment Scheme, Heartwatch programme, etc.) and tax relief on GP expenses, but these are not considered in this analysis. An increasing number of private health insurance policies provide partial cover for GP expenses although the proportion of privately insured individuals with out-patient cover is not known.

visits per annum by medical card holders in each age group (see Table 5).[19] Data on the average number of GP visits per year by medical card holders, stratified by age group, are available from the 2007 Health Module of the Quarterly National Household Survey (Central Statistics Office, 2008).

TABLE 5
Average GP capitation rates and GP visits per annum by medical card holders (2007)

Age group	Average capitation rate	Average no. GP visits per annum	Average capitation per GP visit
0–5	93.7	4.1	22.9
5–15	55.0	4.1	13.4
16–44	87.5	4.6	19.2
45–64	141.9	6.2	22.9
65–69	175.3	5.6	31.3
70+[a]	414.2	5.3	78.1

Note: [a] Includes separate capitation rates for means-tested and non-means-tested 70+ medical card holders.
Sources: PCRS, 2007, Central Statistics Office, 2008

Private GP fees are estimated to fall in the range of €45–€60 (The Competition Authority, 2009).[20] This study applies the average cost of €50 per private non medical card GP visit. An estimated private charge per home visit of €70 is applied (consistent with an average payment of €72.35 for out-of-hours nursing home visits under the medical card scheme).

It is difficult to identify the number of specialist OPD visits per year specifically related to stroke. Adopting an approach used in the international literature (Brown et al., 2006, Saka et al., 2005) each stroke patient (incident and net prevalent) is assumed to make one stroke-related specialist OPD visit per year.[21] While this approach is likely to underestimate the number of specialist OPD visits in the first year of stroke, it is expected that this is balanced to some degree by over-estimating the number of specialist OPD visits in subsequent years of stroke. It is estimated that all stroke-related specialist OPD visits take place within the public hospital system.

The study estimates two stroke-related GP visits per year per stroke patient (incident and net prevalent).[22] This is based on the estimate that patients require a ratio of 2 GP visits per 1 OPD visit. To attach appropriate unit costs the proportion of GP visits taking place outside of the GP surgery needs to be

19 From 2001 to 2009 there were three separate capitation rates payable in respect of patients aged 70+ (standard means tested rate, non-means tested rate, private nursing home rate).
20 Average of €45-€60 is rounded to €50.
21 Although it is noted that the more recent analysis of the cost of stroke in the UK estimated the cost of 2 visits to a stroke specialist clinic, and 1 visit to a GP (Saka et al., 2009a).
22 Detailed data on the number of GP visits made by stroke patients are not available in Irish stroke studies (e.g., NDPSS, INASC).

identified. For community dwelling stroke patients, an estimated 25 per cent of GP visits occur in the patient's home.

2.3.6 Drugs

Methods

This study focuses on the categories of stroke-related medications outlined in the INASC clinical audit (Irish Heart Foundation, 2008). These include antithrombotic medications, lipid lowering medications and anti-hypertensives. For each stroke-related medication, the estimated population of stroke and TIA patients is multiplied by the proportion of stroke/TIA patients taking new medication post-stroke. These patient numbers are multiplied by the estimated mean monthly cost of the medications. The mean monthly cost depends on the medical card status of the patient, outlined in more detail below.

These costs are adjusted for the estimated number of months in a year during which out-of-hospital drugs are taken (drug costs for hospital in-patients are covered under hospital costs) (see Table 6).

- For incident stroke cases who remain alive during the year, the average length of hospital in-patient stay is approximately 2+ weeks (mean 22.5 days, median 12 days, ESRI, 2007). It is estimated that the remainder of the year is spent at home or in a nursing home (i.e., maximum of 11.5 months). Assuming that the incidence of stroke is spread evenly throughout the year, the average number of months for which out-of-hospital drugs are taken is estimated at 5.75 months. This follows the approach adopted by Rice (1966).
- For incident stroke deaths, the costs of drugs are covered under the incident hospital in-patient episode.
- For net prevalent stroke cases who remain alive during the year, the total number of months for which out-of-hospital drugs are taken is estimated at 12 months for each case.
- For net prevalent stroke cases who die during the year, the estimated number of months for which out-of-hospital drugs are taken is estimated at 6 months, assuming deaths are spread evenly throughout the year (i.e., 12 months/2).
- A similar approach is adopted for TIA patients, adjusting for the lower average length of in-patient hospital stay (mean 6.8 days, median 5 days, ESRI, 2007).

TABLE 6
Number of months of out-of-hospital drug utilisation in one year for stroke/TIA patients

	No. of months of out-of-hospital drug utilisation in one year
Stroke patients	
Incident (alive)	5.75
Incident (deaths)	0
Net prevalent (alive)	12
Net prevalent (deaths)	6
TIA patients	
Incident (alive)	5.875
Incident (deaths)	0

Data

Data from the NDPSS (n = 545) and from the INASC clinical audit (n = 2,173) are used to determine the proportions of stroke and TIA patients taking selected medications. In both datasets, the medication profile before and after stroke is identified. The medication profile of TIA patients is only available in the NDPSS. Many of the medications taken by stroke/TIA patients are also used for other cardiovascular complaints and it is difficult to identify what is taken specifically for stroke/TIA. Analysis focuses on patients who have not had a previous stroke/TIA, identifying the proportion of those patients who are taking the selected medications for the first time (i.e., no utilisation of the drug prior to the stroke/TIA, utilisation of the drug after the stroke/TIA). This increases the likelihood of capturing stroke specific drug utilisation patterns.

For stroke patients, there is close correspondence between the two datasets in terms of the proportions of patients on new medications (with the exception of dipyridamole). Variations in the proportions by the categories of age, sex and medical card status are examined. There are some statistically significant variations (using the Chi-Square statistic) in the proportions of patients on new medications by age group. The utilisation proportions from the INASC clinical audit are used for the cost analysis, given the larger sample size relative to the NDPSS sample. NDPSS data determine the utilisation proportions for ARB Antagonists, as these are not recorded in the INASC dataset. Table 7 presents the utilisation proportions for stroke patients, by age group. Table 8 presents the utilisation proportions for TIA patients, taken from NDPSS data.

TABLE 7
Proportion of stroke patients with new medication post-stroke

Drug category	Age					
	16–34	35–44	45–54	55–64	65–74	75+
Antithrombotic						
New aspirin	0.32	0.32	0.32	0.32	0.32	0.32
New clopidogrel	0.05	0.05	0.05	0.05	0.05	0.05
New dipyridamole	0.07	0.07	0.07	0.07	0.07	0.07
New warfarin	0.10	0.10	0.10	0.10	0.10	0.10
Anti-hypertensive						
New diuretic	0.05	0.05	0.05	0.05	0.05	0.05
New beta blocker	0.09	0.09	0.09	0.09	0.09	0.09
New calcium channel blocker	0.06	0.06	0.06	0.06	0.06	0.06
New ace inhibitor	0.07	0.07	0.27	0.27	0.27	0.21
New arb antagonist	0.03	0.03	0.03	0.03	0.03	0.03
New alpha blocker	0.02	0.02	0.02	0.02	0.02	0.02
Lipid lowering						
New statin	0.24	0.24	0.49	0.49	0.49	0.35

Source: Irish Heart Foundation, 2008

TABLE 8
Proportion of TIA patients with new medication post-TIA

Drug category	Age							
	0–14	15–34	35–44	45–54	55–64	65–74	75–84	85+
Antithrombotic								
New aspirin	0.87	0.87	0.87	0.51	0.51	0.51	0.38	0.38
New clopidogrel	0.87	0.87	0.87	0.51	0.51	0.51	0.38	0.38
New dipyridamole	0.87	0.87	0.87	0.51	0.51	0.51	0.38	0.38
New warfarin	0.87	0.87	0.87	0.51	0.51	0.51	0.38	0.38
Anti-hypertensive								
New diuretic	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
New beta blocker	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
New calcium channel blocker	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
New ace inhibitor	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
New arb antagonist	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
New alpha blocker	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
Lipid lowering								
New statin	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51

Source: North Dublin Population Stroke Study

Details on the drug names, dosage, and costs are not available from the INASC or NDPSS.[23] National data are available on all prescriptions paid for under the General Medical Services (GMS) Scheme for medical card holders (2007). Total prescriptions, doses, costs, etc. are detailed for each drug reimbursed under this

[23] Details on dosage are available in the hard copy patient files in the NDPSS but not extracted to the dataset.

scheme. For a specific drug name, different doses (and costs) of that drug are identifiable by a unique drug code. As illustrated in Table 9, for one drug name, Lipitor, two different drug codes are indicated, distinguishing between tablets with strengths of 20 mg and 10 mg.

TABLE 9
Drug labelling

Code	Name	Strength	Pack size	Ingredient cost per pack
31798	Lipitor	20 mg	28 tablets	€39.69
31892	Lipitor	10 mg	28 tablets	€25.17

Table 10 outlines the dose and cost data from the national prescriptions database[24] used to estimate the mean monthly ingredient cost per drug code.

TABLE 10
Defined daily dose and ingredient cost data

Indicator	Description
Defined daily dose (DDD) (per drug code)	One DDD is equal to the average adult recommended dose (e.g., 10 mg/25 mg, etc.).
Total DDD (per drug code)	Total number of DDDs consumed in one year
Mean DDD (per drug code)	Average number of DDDs per patient per month Example 1: If all patients taking a specific drug are receiving the average adult recommended dose, the mean DDD per patient per month is 30–31. Example 2: If for a specific drug, every patient is taking twice the adult recommended dose, the mean DDD per patient per month is 60+.
Total ingredient cost (per drug code)	Total ingredient cost paid by the Primary Care Reimbursement Service per drug code per year
Mean ingredient cost (per drug code)	Mean monthly ingredient cost per drug code is calculated as: (1) (Total ingredient cost per drug code/Total DDD per drug code) = ingredient cost per DDD (2) (Ingredient cost per DDD) x (Mean DDD) = mean monthly ingredient cost

For each of the stroke-related medications outlined above, the most commonly used drug code/s (and the associated mean monthly ingredient cost) in the national prescriptions database are identified.[25]

[24] For the provision of these data, we are grateful to the Health Service Executive/Primary Care Reimbursement Service and Department of Pharmacology & Therapeutics, Trinity Centre, St James's Hospital.

[25] To be identified as the most commonly used, a drug code (or a combination of drug codes) accounts for at least 50 per cent of total patients receiving that medication.
Examples: For Aspirin, 50 per cent of patients receive Nu-Seals Aspirin, 75 mg strength tablets (drug code: 37308). For Clopidogrel, 99 per cent of patients receive Plavix, 75 mg strength tablets (drug code: 41059). For Warfarin, more than 70 per cent of patients receive one of: Warfarin, 1 mg strength tablets (drug code: 61721), Warfarin, 3 mg strength tablets (drug code: 61736) or Warfarin, 5 mg strength tablets (drug code: 61748).

To determine the total monthly cost, the medical card status of the patient is estimated (outlined in section 2.3.5 on GP costs). The GMS data record the total ingredient cost and total expenditure cost (i.e., including additional fees paid to pharmacists) of prescriptions issued to medical card holders. Drug utilisation for medical card stroke/TIA patients is multiplied by mean monthly expenditure, which includes the dispensing fees and ingredient costs.

It is estimated that all non medical card stroke and TIA patients receive subsidisation through the Drugs Payment Scheme. For these patients, the mean monthly ingredient cost, adopted here from the GMS, is factored up by an estimate of the margin given to pharmacists under the Drugs Payment Scheme. In 2007, pharmacists received an average margin of 67–70 per cent on the ingredient cost of drugs covered by the Drugs Payment Scheme (combination of dispensing fees and mark-up). In 2009 a new policy of paying pharmacists was introduced and the average margin has since reduced to 50 per cent.[26] In this study, the mean monthly cost of medications for non medical card holders is calculated as the mean monthly ingredient cost (from the GMS) plus a conservative margin of 50 per cent.

The burden of drug costs is also influenced by medical card status. Medical card holders receive all prescribed medicines free of charge. Non medical card holders are eligible for subsidisation through the Drugs Payment Scheme (DP). In 2007, under this scheme, prescribed drugs were provided free of charge to patients above a monthly payment threshold of €85 per month. Where a patient receives subsidisation every month of the year (i.e., pays up to the threshold of €85 each month), the annual out-of-pocket payment would be €1,020 per year. The average DP cost per claimant in 2007 was €460.23 (PCRS, 2007). For a patient who receives subsidisation every month of the year, the estimated total annual prescription drugs expenditure would be €1,480.23. Of this, the patient is estimated to pay 69 per cent of the total cost out-of-pocket with the balance covered by public funding.[27]

2.3.7 Community rehabilitation care

Methods

A bottom-up approach is adopted to estimate the staff costs for community rehabilitation for stroke. The average number of hours per week provided for stroke care by Local Health Office (LHO) rehabilitation staff is multiplied by weekly salary. Costs are estimated for each of the following disciplines: public health nursing, dietetics, physiotherapy, occupational therapy, and speech and

[26] Department of Pharmacology & Therapeutics, Trinity Centre, personal communication, 12 November 2009.

[27] Further data and sensitivity analysis are required to refine this estimate. The average patient contribution to the DP Scheme was estimated by the PCRS to be less than €300 in 2009 prices (Brick et al., 2010). In this study, it is assumed that stroke patients are more likely to be making prescription medicine payments that reach the monthly threshold on a regular basis.

language therapy. Separate cost calculations are performed for each staff grade within each discipline, due to variations in salary and standard working week.

The total cost for each staff grade within each discipline is obtained by equation (6):

(6) $C_{community}$ =

$$\frac{\text{Estimated mean total stroke hours per week per LHO}}{\text{Standard working week in hours}^{29}} \times \text{Mean salary} \times \text{No. of LHOs}^{28}$$

Equation (6) is repeated for each staff grade within each discipline, and summed to give total costs of community rehabilitation for stroke cases. These costs are increased by 15 per cent to factor in overhead costs (e.g., LHO running costs, transport costs, etc.).

Data

Providers of rehabilitation services through LHOs were asked to estimate the number of allied health professionals involved in caring for stroke and the hours spent on stroke by each staff member. Separate datasheets were completed for each discipline (nursing,[30] speech and language therapy, dietetics, physiotherapy, and occupational therapy) and respondents specified the staff grade, e.g. senior, basic, assistant (see Appendix 5).

Table 11 presents the mean total hours per week, per LHO, stratified by discipline and grade, along with the number of LHOs that responded. The majority of rehabilitation hours are provided by staff at the senior grade.

[28] Number of Local Health Offices = 32.

[29] The standard working week for each staff type was obtained from datasheets completed by service providers. For nursing staff the standard working week was 37.5 hours, while for allied health professionals at basic grade and above the standard was 33.75 hours. Information was not available on the standard for the assistant grade – a 35 hour week was used for the estimates.

[30] There are a small number of specialist stroke nurses working in the community but data on workload are not available.

TABLE 11
Response rate and mean total hours of stroke rehabilitation per week per LHO

Discipline	Grade	Mean total hours per week per LHO	Response rate number (%)
Nursing	Public health[a]	43.6	7 (21.9)
Speech and language therapy	Senior	18.5	17 (53.1)
	Basic	4.2	
	Clinical specialist	0.8	
Dietician	Senior	1.9	19 (59)
	Basic	1.5	
Physiotherapy	Senior	32.1	10 (31)
	Basic	2.4	
	Assistant	0.9	
Occupational therapy	Senior	23.2	6 (18.7)
	Basic	0.9	
	Assistant	0.9	
	Manager	0.3	

Note: [a] Includes some Community Registered General Nurses.
Source: Data were collected from LHOs for this study.

Sensitivity analysis

Community rehabilitation is an important part of stroke care. As highlighted by the INASC report, assessment of community rehabilitation for stroke patients in Ireland is limited by the absence of systematically recorded, centrally pooled data, and by large gaps in service provision.[31] This has implications for cost estimation. The methodology for estimating the cost of stroke-related community care is adapted to make the most appropriate use of available data. However, it is important to underline the uncertainty surrounding the data for this service. A range of sensitivity analyses are also included.

Based on equation (6), the total costs for public health nursing are obtained by dividing the mean total stroke hours per week per LHO by the standard working week, and multiplying by the mean salary and number of LHOs. The procedure is repeated for each staff grade in each discipline. This approach assumes that the service level profile of non-responding LHOs is equivalent to those responding. To provide sensitivity analysis around this estimate, the costs are re-calculated as follows:

- Low: Non-responding LHOs provide fewer stroke hours per week than the average (25th percentile)
- High: Non-responding LHOs provide more stroke hours per week than the average (75th percentile).

[31] While data on community care services may be collected at a local level there are no national guidelines for what data should be collected and in what format, and there are no mechanisms for pooling data at a national level.

The data collected from the LHOs for this study can also be compared with data from the INASC survey of allied health professionals and public health nurses (Irish Heart Foundation, 2008). Mean stroke case-load for each discipline is estimated from the data collected from the LHOs, using equation (7):

(7) Estimated mean case-load =

$$\frac{\text{Estimated mean total stroke hours per week per LHO}}{\text{Estimated mean number of WTE}^{32}\text{ staff per LHO x Standard working week in hours}}$$

Comparing the mean case-load calculated for each discipline using equation (7) (COSI[33] estimate) with INASC findings on stroke case-load shows that the estimates from this study are within the ranges of the estimated case-loads reported in the INASC survey (Table 12).

TABLE 12
Case-load estimates (percentage of working time), INASC and COSI

Discipline	INASC estimate[a] (management)	INASC estimate[a] (frontline staff)	COSI estimated mean case-load
Public health nursing	Not available	0.1–9%	5%
Occupational therapy	12–25%	10–25%	12%
Dietetics	0.7–10%	Not available	6%
Speech and language therapy	30–40% of adult case-load	0–100%	37%
Physiotherapy	10%	8–25%	11%

Note: [a] Irish Heart Foundation, 2008

Estimated staff numbers are also compared (Table 13). While the INASC survey measured total staff numbers, this study only collected data for staff involved in stroke (a lower estimate of staff numbers is expected from this study). With the exception of occupational therapy and dieticians basic grade, the estimated total whole time equivalent staff from this study (i.e., COSI estimate) is low relative to the staff estimates in the INASC survey. As indicated in Table 11, the response rate from occupational therapists to the data request in this study is less than 20 per cent. The cost estimate for occupational therapy is adjusted to take into account this likely over-estimation.

[32] Whole Time Equivalent
[33] Cost of Stroke in Ireland

TABLE 13
COSI and INASC estimates of staff numbers

Discipline	Grade	COSI estimated mean WTE staff per LHO	COSI estimated total staff (mean WTE staff per LHO x 32)	INASC estimated total staff
Nursing	Public health nursing[a]	24.0	769.2	1,186.7
Speech and language therapy	Senior	1.4	43.5	166.2
	Basic	0.4	14.1	72.4
Dietician	Senior	0.9	29.6	64.8
	Basic	0.6	20.2	6.4
Physiotherapy	Senior	8.8	283.2	297.0
	Basic	0.2	6.4	26.3
Occupational therapy	Senior	5.4	173.9	124.6
	Basic	0.3	8.6	10.6

Note: [a] Includes Community Registered General Nurses.
Sources: Irish Heart Foundation, 2008 and data collected from LHOs for this study

2.3.8 Aids, appliances and home modifications

Methods

The costs of aids, appliances and home modifications used by stroke patients are estimated using a bottom-up approach. Unit costs of aids, appliances and home modifications are combined with estimated utilisation by stroke patients.

With the exception of the high pressure mattress and cushion, stroke aids, appliances and home modifications are estimated to be once-off expenditures in the year in which the stroke occurs. Thus, the cost of aids, appliances and home modifications are estimated for all incident stroke cases in the year 2007. The rental cost of the high pressure mattress and cushion is estimated on a monthly basis. To estimate the number of weeks in a year for which the mattress and cushion is rented, the approach outlined by Rice (1966) is adopted:

- incident alive stroke cases: 25 weeks (assuming the incidence of stroke is spread evenly throughout the year, and deducting an average of 2 weeks for in-patient hospital stay, i.e., 50/2)
- incident deaths: 0 weeks
- net prevalent alive stroke cases: 52 weeks
- net prevalent deaths: 26 weeks (assuming stroke deaths are spread evenly throughout the year, i.e., 52/2).

Data

Packages of aids and appliances for stroke patients are identified, stratified by level of disability. Data on stroke patient utilisation of selected aids and appliances are available from the Survey of Health, Ageing and Retirement in

Europe (SHARE).[34] Analysis of the total European dataset indicates that 2.4 per cent of stroke patients use electric wheelchairs, 11 per cent use manual wheelchairs and almost 30 per cent use walking sticks. Utilisation in the Irish sample in SHARE is consistent with this pattern.[35] It is assumed that patients using an electric wheelchair will also use a hoist, electric bed and other aids identified as necessary for those with severe disability. The same approach is applied to users of manual wheelchairs (moderate disability) and walking sticks (mild disability). Table 14 displays the packages of aids, appliances and home modifications identified for each level of disability, and the estimated stroke patient utilisation of each package. Unit costs are outlined in Table 15.[36]

TABLE 14
Estimated aids, appliances and home modifications for stroke patients, stratified by disability

Aid/appliance/home modification	Disability	Estimated utilisation by stroke patients (proportion)
High pressure relieving mattress and cushion	Severe	0.02
Hoist	Severe	
Electric wheelchair (tilt-in space)	Severe	
Electric bed	Severe	
Home modifications	Severe	
Orthopaedic chair	Severe	
Commode	Severe, Moderate	0.13
Raised toilet seat	Severe, Moderate	
Toilet surround	Severe, Moderate	
Shower chair	Severe, Moderate	
Wheelchair	Moderate	0.11
Bathroom modifications	Moderate	
Pressure relieving cushion	Moderate	
Walking stick	Mild	0.29
Ankle foot orthosis	Mild	
Splints	Mild	

Source: SHARE, 2008[37]

[34] n = 34,380, community dwelling individuals aged 50+ in 15 European countries.

[35] Similar proportions in the Irish sample of SHARE used walking sticks (31 per cent) and manual wheelchairs (9 per cent). However, 12.5 per cent of the Irish sample used electric wheelchairs, compared with only 2.4 per cent in the European sample. It was decided to use the European data as they are derived from a larger sample, and yield more conservative cost estimates. The estimate of 2.4 per cent is also consistent with data from the INASC clinical audit where 3 per cent of stroke patients discharged to the community have severe disability (Irish Heart Foundation, 2008).

[36] Unit costs were obtained from a public health nurse working in the area of stroke and from Irish suppliers. Home adaptation costs are estimated from the average Disabled Persons Grant awarded in 2007. Bathroom modification costs are estimated from the average standard grant available for this type of adaptation.

[37] This study uses data from SHARE Waves 1 & 2, as of December 2008. SHARE data collection in 2004-2007 was primarily funded by the European Commission through its 5th and 6th framework programmes (project numbers QLK6-CT-2001-00360; RII-CT-2006-062193; CIT5-CT-2005-028857). Additional funding by the US National Institute on Aging (grant numbers U01 AG09740-13S2; P01AG005842; P01 AG08291; P30 AG12815; Y1-AG-4553-01; OGHA 04-064; R21 AG025169) as well as by various national sources is gratefully acknowledged (see http://www.share-project.org for a full list of funding institutions).

TABLE 15
Estimated unit cost of aids, appliances and home modifications

Aid/appliance/home modification	Annual rental cost €	Once-off cost €	Source
High pressure relieving mattress and cushion	4,866[a]		Public Health Nurse
Hoist		5,889	Public Health Nurse
Electric wheelchair (tilt-in space)		4,841	Supplier
Electric bed		1,108	Public Health Nurse
Home modifications		10,190[b]	Annual Housing Statistics Bulletin 2007
Orthopaedic chair		110	Public Health Nurse
Commode		30	Public Health Nurse
Raised toilet seat		22	Public Health Nurse
Toilet surround		18	Public Health Nurse
Shower chair		99	Public Health Nurse
Wheelchair		225	Public Health Nurse
Bathroom modifications		3,171[c]	National Disability Authority
Pressure relieving cushion		360	Public Health Nurse
Walking stick		61	Public Health Nurse
Ankle foot orthosis		46	Suppliers
Splints		67	Supplier

Notes:
[a] Annual rental costs are adjusted for the number of estimated stroke deaths during a year, and the length of time incident stroke patients are in hospital.
[b] The average Disabled Person's grant to cover home adaptations was €9,170.91 in 2007. As the grant covers 90 per cent of the cost, the full average cost was estimated at €10,190. The average grant applies to the first nine months of the year only, as the Disabled Person's Grant was replaced by the Home Adaptations Grant in October 2007. Data for October–December 2007 were not available (Department of the Environment, 2008).
[c] Three local authorities specified a standard grant for bathroom modifications in 2005, ranging from €1,500 to €5,000 (National Disability Authority, 2006). The average standard grant was €2,854. As the grant covers 90 per cent of the cost, the full cost was estimated as €3,171.

2.3.9 Voluntary agency expenditure on stroke

For voluntary agency expenditure, data are collected from relevant voluntary agencies on services provided to stroke patients, numbers of clients with stroke, and costs of services for stroke.

Data for voluntary agency expenditure on stroke:

- Data are collected from four agencies involved in stroke care: Headway, Acquired Brain Injury Ireland (ABI), Volunteer Stroke Scheme, Irish Wheelchair Association (IWA).
- Costs of stroke-related services are also estimated for Cheshire and the Centres for Independent Living. Both agencies provide services primarily to patients with physical disability (similar to the IWA where 8.5–18.6 per cent of clients are stroke patients). Stroke patients are estimated to account for 5 per cent of the services provided by these agencies and this estimate is applied to the total expenditure of these agencies in 2007.

2.3.10 Informal care

Methods

The value of informal care provided to stroke patients is estimated using the human capital approach. This is consistent with the measurement of indirect costs of productivity foregone due to ill-health/death following stroke (see section 2.3.11).

In the application to informal care, the human capital method calculates the amount of lost production, measured in terms of lost earnings, of caregivers. The amount of work time lost due to caregiving is multiplied by the estimated earnings of the caregivers. The value of foregone leisure time is also estimated by multiplying time lost from leisure by an estimated market value of leisure (e.g., proportion of earnings).

Data

Data on the percentage of stroke patients in receipt of informal care are available from the 2006/07 wave of the SHARE dataset (SHARE, 2008). Cross-sectional analysis of all countries in the dataset (including Ireland) indicates that 30–65 per cent of stroke patients receive informal care (from persons outside the household and/or personal informal care received from persons inside the household). The percentage increases by age group (i.e., 30–40 per cent amongst 50–64 year olds, 65 per cent amongst 85+ year olds).[38] Just under 60 per cent of community dwelling stroke patients surveyed by INASC (n = 134) were in receipt of informal care (Irish Heart Foundation, 2008), consistent with the SHARE estimates. The SHARE proportions are adopted in this study given the larger sample size, and hence more robust estimates of age distribution relative to the INASC survey (Table 16).

TABLE 16
Estimated proportion of stroke patients receiving informal care

	Age group							
	0–14	15–34	35–44	45–54	55–64	65–74	75–84	85+
Proportion with informal carer	-	-	-	0.30	0.36	0.39	0.52	0.65

Source: SHARE, 2008

Estimates of the number of hours of informal caregiving received per week by stroke patients are obtained from the literature (Dewey et al., 2002; Hickenbottom et al., 2002; Patel et al., 2004; van Exel et al., 2004; Tooth et al.,

[38] Regression analysis indicates that the probability of receiving informal care in Ireland is not significantly different from the other countries in the sample. There is also no evidence that stroke patients have a higher probability of receiving informal care, controlling for a range of demographic, socioeconomic and health status factors.

2005; Hervas et al., 2007).[39] The range of 9–20 hours of informal care per week is adopted to give a low and high estimate of informal care for stroke patients.

To estimate the number of weeks of informal care received by stroke patients in one year the approach outlined by Rice (1966) is adopted:

- incident alive stroke cases: 25 weeks (assuming the incidence of strokes is spread evenly throughout the year, and deducting an average of 2 weeks for in-patient hospital stay, i.e., 50/2)
- incident deaths: 0 weeks
- net prevalent alive stroke cases: 52 weeks
- net prevalent deaths: 26 weeks (assuming stroke deaths are spread evenly throughout the year, i.e., 52/2).

Census 2006 data provide the breakdown of caregivers in the population by principal economic status (Central Statistics Office, 2007). These data are used to estimate the proportion of stroke caregivers who are either engaged in paid employment or are economically inactive (e.g., domestic work, retired, unemployed, student, etc.).

Using the human capital approach, the number of hours of informal care provided by caregivers in paid employment is multiplied by the productive value of paid work, proxied by earnings. The median wage in 2007 is used to proxy the value of productivity foregone (€16.29 per hour, Central Statistics Office, 2009a). This estimates that all informal care is at the expense of paid work in the case of the caregivers who are in paid employment.

The number of hours of informal care provided by economically inactive caregivers is multiplied by the value of leisure time, proxied by 1/3rd of the median wage in 2007 (i.e., 1/3rd of €16.29). This is the approach adopted by Dewey et al. (2002).[40]

The proportion of stroke patients receiving informal care is combined with estimates of the number of hours and weeks of care received in one year, multiplied by the value of care (proxied by the median wage where the carer is

[39] SHARE data record the number of hours of informal care received from persons outside the household, but not from persons inside the household.

[40] There is no widespread agreement on how to value leisure time (Tarricone, 2006). An alternative approach would be to use the replacement approach, where the time lost is valued at the cost of substituting the unpaid activity. In this case the leisure time lost due to informal caregiving would be valued at the cost of replacing the informal care with formal paid care. In the Irish context, detailed wage data on specific occupations (e.g., formal carers) are not published in the National Employment Survey (Central Statistics Office, 2009a). Also, Dewey et al. (2001) indicate that this could overestimate the true cost of informal care as it would be unlikely that there would be funding available to replace all of the informal care provided by relatives/friends with a formal substitute (i.e., a distinction would be made between essential and non-essential informal care).

engaged in paid employment, and by 1/3rd of the wage where the carer is not economically active).

2.3.11 Morbidity and mortality

Methods

There are three ways to calculate the loss of productivity due to morbidity and mortality: the human capital approach, the friction cost method, and the willingness to pay method.

This study adopts the human capital approach to estimate the cost of production foregone in one year due to stroke morbidity and mortality. The human capital method calculates the amount of lost production, measured in terms of lost earnings of patients. The amount of work time lost due to illness is multiplied by the estimated earnings of the patients. The value of foregone household work can also be estimated by multiplying time lost from household work by an estimated market value of household work (e.g., replacement cost of a domestic worker).

It is argued that the human capital approach overestimates the costs of foregone productivity. Short-term, illness-related work absences may be covered by others, or made up by the sick person on his/her return to work. Longer-term, illness-related work absences can be covered by employing someone who was previously unemployed. Absence from work may incur a cost for the individual person, but from a societal perspective there may be fewer losses in overall productivity. Thus, one alternative, the frictional cost approach, focuses on the loss of productivity experienced during the period of time required to replace a sick worker (Tarricone, 2006).

A third approach for calculating indirect costs measures the amount an individual would be willing to pay to reduce the probability of illness/mortality. The willingness to pay method addresses another criticism of the human capital approach. The human capital method focuses on the production value lost due to illness, as measured by earnings. For those who are not in paid employment/household work, the time lost to illness (and hence any valuation of that time) is not included. This can lead to biases in comparisons of the costs of different illness, where the working age profile can vary by disease (e.g., a low level of production foregone is expected for stroke relative to illnesses that affect a younger age group). The willingness to pay approach is an attempt to resolve this problem by attaching a value for all individuals regardless of their work status.

The human capital approach is adopted in this study for the following reasons:

- The human capital approach is the most common method used to estimate indirect costs of illness (Payne et al., 2002; Segel, 2006).
- The frictional cost approach assumes a specific macroeconomic context: less than full employment and flexible labour market conditions to allow replacement of appropriately skilled and experienced workers within a limited period. These conditions can change over time and vary by occupation. In the Irish context, employment was close to full employment in the period (including 2007, the period under observation) preceding the recent macroeconomic crisis. The high level of employment increases the likelihood that replacement periods are relatively long as the pool of unemployed workers is small.
- The focus of this study on one year further limits the extent to which the human capital approach overstates the time period during which productivity is foregone.
- The frictional cost approach requires a large amount of detailed information (e.g., estimated replacement time periods for different occupations, labour force characteristics by occupation, etc.) that is not available in the Irish context.
- The willingness to pay approach requires detailed survey level data (e.g., preference surveys) that are not available in the Irish context.

Data

Data are required on the employment profile of stroke patients, prior to and following the stroke. Census 2006 data provide the breakdown of the population by principal economic status. These data are used to estimate the proportion of stroke patients who are engaged in paid employment, unpaid domestic employment (i.e., housework), or otherwise economically inactive (e.g., retired, unemployed, student, etc.) prior to stroke.

Estimates are available in the literature on the proportion of stroke patients giving up paid work due to ill health following stroke (e.g., 42–61 per cent) (Saeki et al., 1993, 1995; Wozniak et al., 1999; Teasdale and Engberg, 2005; Glozier et al., 2008; van Velzen et al., 2009). Irish specific estimates are available from the INASC community dwelling patient survey (47 per cent of those in paid work prior to stroke gave up work following stroke), and an unpublished study based in the Adelaide and Meath Hospital at Tallaght (65 per cent give up work) (Tan et al., 2009) and these are consistent with international estimates. This study adopts the low and high estimate of the proportion of stroke patients giving up paid work due to ill health following stroke from the two Irish studies.

There are fewer estimates of the proportion of stroke patients giving up unpaid domestic work due to ill health following stroke. One Irish specific estimate is

available from Tan et al. (2009), with an estimated 18 per cent giving up domestic work post-stroke due to ill health, and this is adopted in this study.

Table 17 presents the estimated proportions of stroke patients by age/sex that were in paid employment prior to stroke. The estimated proportions of stroke patients (by age/sex) engaged in domestic work prior to and following stroke are also presented.

TABLE 17
Estimated employment profile of stroke patients prior to stroke (proportions)

Principal economic status (proportion)	Age group							
	0–14	15–34	35–44	45–54	55–64	65–74	75–84	85+
Males								
Paid work	-	0.67	0.88	0.83	0.64	0.12	0.12	0.12
Unpaid domestic work	-	0.00	0.01	0.02	0.01	0.01	0.01	0.01
Otherwise economically inactive	1.00	0.33	0.11	0.15	0.34	0.87	0.87	0.87
Total	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Females								
Paid work	-	0.57	0.65	0.62	0.38	0.03	0.03	0.03
Unpaid domestic work	-	0.09	0.26	0.26	0.37	0.35	0.35	0.35
Otherwise economically inactive	1.00	0.34	0.09	0.12	0.25	0.61	0.61	0.61
Total	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Source: Central Statistics Office, 2007

To estimate the number of weeks of work lost in one year due to stroke illness by those engaged in paid work/unpaid domestic work the approach outlined by Rice (1966) is adopted as follows:

- incident stroke cases: 26 weeks (assuming the incidence of strokes is spread evenly throughout the year, i.e., 52/2)
- net prevalent alive stroke cases: 52 weeks
- deaths: 26 weeks (assuming stroke deaths are spread evenly throughout the year, i.e., 52/2).

For stroke patients engaged in paid work or in unpaid domestic work prior to stroke but who did not give up work following stroke, the production costs foregone during the time spent in hospital are estimated. In their calculation of indirect costs, Dewey et al. (2001) assumed that for every day spent in hospital, 2 additional days were required for recovery before return to work. This approach is adopted here and a total of 6 weeks sick leave is estimated for stroke patients returning to paid/unpaid domestic work following stroke.[41]

[41] The average length of hospital in-patient stay is 2+ weeks for all stroke patients (ESRI, 2007), plus 4 weeks to take into account additional sick days (2 additional days for every day spent in hospital).

Using the human capital approach, the number of hours of paid/domestic work lost due to ill health is multiplied by the productive value of paid/domestic work, proxied by earnings. The median wage in 2007 is used to proxy the value of productivity foregone (€16.29 per hour, approx. €560 per week[42]) for those in paid work. For unpaid domestic work, the productive value is proxied by the minimum wage in the economy in 2007 (€8.65 per hour, approx. €298 per week[43,44]).

The proportion of stroke patients[45] giving up paid/domestic work following stroke is combined with estimates of the number of weeks of work lost to ill health in one year, multiplied by the value of production foregone (proxied by median weekly wage/weekly minimum wage). The cost of production foregone from in-patient hospital stays is calculated for stroke patients who did not give up work following stroke.

2.3.12 Future costs of stroke in 2021

Demographic change

This section estimates the total annual cost of stroke in Ireland in the year 2021, based on projected demographic patterns between 2007 and 2021. The stroke incidence and prevalence rates outlined above are applied to the projected population in 2021, following the approach used by Struijs et al. (2005). Population projections are based on estimated trends in fertility, mortality and migration and are adopted from the recent study of health care utilisation and demographic change (Layte et al., 2009). Using the methodologies outlined earlier, the direct and indirect costs of stroke are re-estimated based on the projected number of stroke incidence and net prevalent cases in 2021.

Additional adjustment is required to estimate the cost of hospital care in 2021. The cost of hospital care for stroke patients in 2007 is based on HIPE discharges (and microdata on length of stay and number of casemix units per discharge). To estimate these hospital costs for 2021, the number of HIPE discharges in 2007 is multiplied by the estimated average population growth over the period 2007–2021. The number of discharges is multiplied by the average cost per case identified in 2007 (i.e., average cost per case using the cost per bed day methodology, and average cost per case using the casemix methodology).

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42 The average working week is estimated to be 34.4 hours in 2007 (Central Statistics Office, 2009a).

43 www.citizensinformation.ie [Accessed 13/10/09]

44 Other studies have valued time lost from domestic activity using the replacement cost approach, where the time lost is valued at the cost of substituting the unpaid activity with a paid worker (Dewey et al., 2001). However, in the Irish context, detailed wage data on specific occupations (e.g., domestic workers) are not published in the National Employment Survey (Central Statistics Office, 2009a) and the minimum wage is used as a proxy.

45 Data were not available to estimate the proportion of stroke patients newly institutionalised into a nursing home following stroke and having to give up work. The estimate focuses on the change in work status for the community dwelling stroke population only.

Demographic change plus epidemiological change

This section adjusts the above estimated future costs of stroke in 2021 for changes in stroke epidemiology between 2007 and 2021. Estimates of changes in stroke epidemiology up to 2020 were used in a recent review of hospital bed capacity (PA Consulting Group, 2007). Using these projections, male stroke is factored up by 32 per cent, and female stroke by 8 per cent, to reflect the estimated cumulative change in stroke incidence and prevalence between 2007 and 2021.

The adjusted incidence and prevalence rates are applied to the projected population in 2021 and costs are re-estimated on the basis of this revised stroke population using the methods outlined for the demographic change scenario. In this scenario the cost estimates adjust for both demographic (i.e., population change given projected fertility, mortality and migration patterns) and epidemiological change (i.e., changes in stroke morbidity) over the period 2007 to 2021.

Changes to stroke service provision

A number of different changes to stroke service provision in Ireland have been recommended. Appendix 3 examines the implications of selected interventions for stroke patient outcomes, costs, and long-term cost savings. The findings are presented and discussed in Appendix 3 and summarised in section 4.

3 RESULTS

3.1 HOSPITAL CARE

Total acute hospital costs in 2007 are estimated to have been between €71 and €96 million (Table 18) for stroke patients, and between €9 and €12 million for TIA patients (Table 19), based on the casemix and cost per bed day methodologies. Older age groups accounted for the largest proportion of costs (e.g., stroke patients aged 75 years and older accounted for more than 48 per cent of total acute hospital costs). The cost estimate based on the cost per bed day method is higher than that based on casemix. Public resources accounted for the largest proportion of total acute hospital costs (more than 80 per cent), followed by private health insurance, with a small proportion of out-of-pocket payments (Figures 1 and 2).

TABLE 18[46]

Total acute hospital costs, stroke patients, 2007 (€000 and %)

Age group	Cost per bed day methodology[a]		Casemix methodology[a]	
	€000	Total (%)	€000	Total (%)
0–14	332	0.3	374	0.5
15–34	2,110	2.2	2,197	3.1
35–44	2,473	2.6	2,715	3.8
45–54	7,348	7.7	6,637	9.4
55–64	11,635	12.1	9,906	14.0
65–74	20,601	21.5	14,877	21.0
75–84	34,496	36.0	22,947	32.4
85+	16,855	17.6	11,144	15.7
Total	95,849	100.0	70,798	100.0

Note: [a] Includes estimated costs of non-HIPE incident cases (incidence at baseline).

TABLE 19

Total acute hospital costs, TIA patients, 2007 (€000 and %)

Age group	Cost per bed day methodology				Casemix methodology			
	€000			Total (%)	€000			Total (%)
	Male	Female	Total		Male	Female	Total	
0–14	-	1	1	0.0	-	4	4	0.0
15–34	31	91	121	1.0	43	62	106	1.1
35–44	148	127	275	2.3	134	115	248	2.7
45–54	304	244	548	4.6	325	264	589	6.3
55–64	742	742	1,484	12.4	766	661	1,427	15.3
65–74	1,283	1,383	2,667	22.3	1,146	1,172	2,318	24.8
75–84	2,114	2,563	4,677	39.1	1,503	1,781	3,285	35.2
85+	555	1,637	2,191	18.3	353	1,009	1,362	14.6
Total	5,177	6,788	11,965	100.0	4,271	5,069	9,340	100.0

[46] Figures and percentages are subject to rounding in the tables of results.

FIGURE 1
Acute hospital costs, stroke patients, by source of funding, 2007 (%)

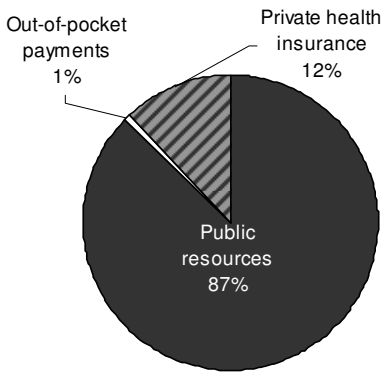
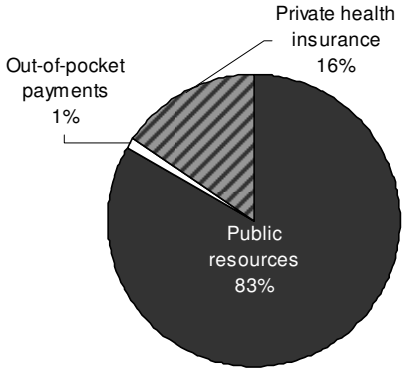


FIGURE 2
Acute hospital costs, TIA patients, by source of funding, 2007 (%)



3.2 IN-PATIENT REHABILITATION CARE

The cost of in-patient rehabilitation care for 2007 is estimated to have been between €16 and €22 million for stroke patients and between €0.6 and €1 million for TIA patients (Tables 20 and 21), based on the casemix and cost per bed day methodologies. As for acute hospital care, older age groups accounted for the largest proportion of in-patient rehabilitation costs. The cost estimate based on length of stay is higher than that based on casemix. More than 90 per cent of total costs in 2007 are estimated to have been financed from public resources (Figures 3 and 4) for stroke and TIA patients.

TABLE 20
Total in-patient rehabilitation costs, stroke patients, 2007 (€000 and %)

Age group	Cost per bedday methodology		Casemix methodology	
	€000	%	€000	%
0–14	189	0.8	168	1.0
15–34	699	3.1	470	2.9
35–44	876	3.9	575	3.6
45–54	2,630	11.8	1,580	9.8
55–64	3,823	17.2	2,401	14.9
65–74	4,900	22.0	3,761	23.3
75–84	5,752	25.8	4,615	28.5
85+	3,423	15.4	2,597	16.1
Total	22,291	100.0	16,167	100.0

TABLE 21
Total in-patient rehabilitation costs, TIA patients, 2007 (€000 and %)

Age group	Cost per bedday methodology		Casemix methodology	
	€000	%	€000	%
0–14	-	-	-	-
15–34	2	0.2	3	0.5
35–44	3	0.3	3	0.5
45–54	8	0.8	10	1.7
55–64	34	3.1	25	4.3
65–74	204	18.7	135	22.8
75–84	594	54.6	290	48.9
85+	243	22.4	126	21.3
Total	1,089	100.0	592	100.0

FIGURE 3
In-patient rehabilitation costs, stroke patients, by source of funding, 2007 (%)

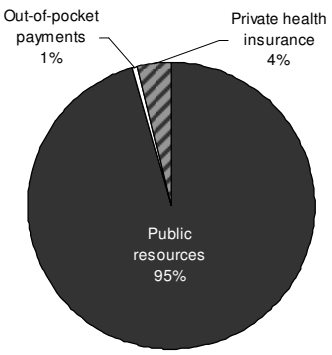
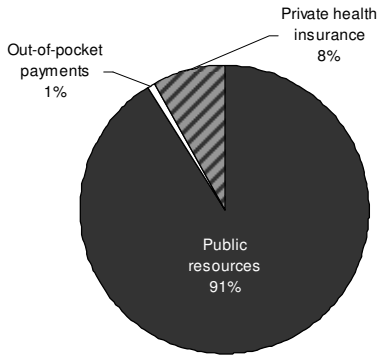


FIGURE 4
In-patient rehabilitation costs, TIA patients, by source of funding, 2007 (%)



3.3 NURSING HOME CARE

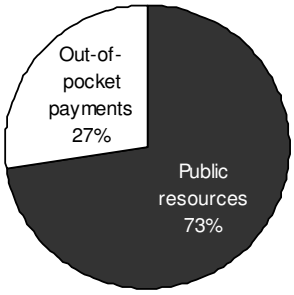
Table 22 presents the estimated nursing home costs based on the low and high estimates of prevalence, at baseline incidence rates. Nursing home care for stroke patients is estimated have cost between €217 and €414 million in 2007, depending on the prevalence of stroke in the country. Care provided to stroke patients in public nursing homes accounted for approximately 65 per cent of the total cost. More than 70 per cent of total nursing home care for stroke patients in 2007 was funded from public resources, and the balance was funded from out-of-pocket payments (Figure 5). This is consistent with the estimate that long-term care is funded two-thirds by the government and one-third by individuals (DOHC, 2006).

TABLE 22
Total nursing home costs, stroke patients, 2007 (€000 and %)

Nursing home type	Low prevalence[a]		High prevalence[a]	
	€000	%	€000	%
Public nursing home	139,931	64.6	267,608	64.6
Private nursing home	76,661	35.4	146,608	35.4
Total	216,591	100.0	414,216	100.0

Note: [a] Incidence at baseline

FIGURE 5
Nursing home costs, stroke patients, by source of funding, 2007 (%)



3.4 AMBULATORY CARE

The estimated cost of out-patient visits for stroke patients is presented in Table 23 for the two prevalence scenarios (at baseline incidence rates). The total cost of OPD care for stroke patients in 2007 ranged from €4 to €7 million, depending on the prevalence of stroke. Public resources are estimated to have accounted for 100 per cent of the cost of OPD care for stroke patients. The estimated cost of GP care for stroke patients in 2007 ranged from €4 to €6 million, depending on the prevalence of stroke (at baseline incidence rates) (Table 24). Approximately 71 per cent of GP costs in 2007 were financed by public resources, with 29 per cent covered by out-of-pocket payments, based on the estimated breakdown of the stroke population by medical card status (Figure 6).[47] However, the costs of GP care for stroke patients with a medical card are based on capitation payments and do not take into account additional payments made to GPs for special items

[47] Medical card holders received GP care free at the point of use while non medical card holders are required to pay out-of-pocket for GP care.

of services (e.g., vaccinations, suturing, etc.) and are thus likely to be underestimates of the total public stroke-related GP costs.[48]

TABLE 23
Total specialist OPD costs, stroke patients, 2007 (€000 and %)

Age group	Low prevalence[a]		High prevalence[a]	
	€000	%	€000	%
0–14	3	0.1	3	0.0
15–34	25	0.6	129	1.8
35–44	85	1.9	207	2.8
45–54	486	11.1	840	11.4
55–64	826	18.9	1,280	17.4
65–74	1,511	34.6	2,090	28.5
75–84	1,047	24.0	2,036	27.8
85+	385	8.8	749	10.2
Total	4,369	100.0	7,336	100.0

Note: [a] Incidence at baseline

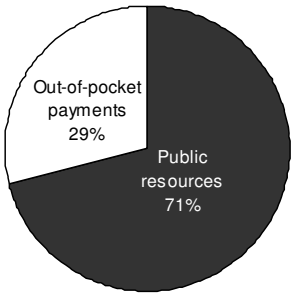
TABLE 24
Total GP costs, stroke patients, 2007 (€000 and %)

Age group	Low prevalence[a]		High prevalence[a]	
	€000	%	€000	%
0–14	2	0.1	2	0.0
15–34	14	0.4	73	1.1
35–44	48	1.3	117	1.8
45–54	280	7.5	484	7.6
55–64	474	12.7	734	11.6
65–74	1,225	32.8	1,719	27.1
75–84	1,132	30.3	2,165	34.1
85+	562	15.0	1,048	16.5
Total	3,737	100.0	6,342	100.0

Note: [a] Incidence at baseline

[48] See Brick et al. (2010) for discussion of the additional non-capitation payments made to GPs in respect of care provided to medical card patients.

FIGURE 6
GP costs, stroke patients, by source of funding, 2007 (%)



3.5 DRUGS

The estimated cost of stroke-related drugs administered to stroke patients, outside of hospital in 2007 was between €9 and €16 million, depending on the prevalence of stroke (at baseline incidence rates) (Table 25). Relative to hospital costs, middle age groups (45–74 years) accounted for a higher proportion of stroke-related drug costs. This is consistent with the focus in this study on the proportion of stroke patients taking new medication since stroke (a larger proportion of older people are likely to have already been taking cardiovascular medications pre-stroke). The estimated cost of stroke-related drugs administered to patients with TIA, outside of hospital, was €1 million in 2007 (Table 26). More than 70 per cent of drug costs for stroke and TIA patients in 2007 were financed from public resources, with the balance financed from out-of-pocket payments, based on the estimated breakdown of the stroke and TIA population by medical card status (Figures 7 and 8).

TABLE 25
Total drug costs, stroke patients, 2007 (€000 and %)

Age group	Low prevalence[a]		High prevalence[a]	
	€000	%	€000	%
0–14	3	0.0	3	0.0
15–34	24	0.3	200	1.2
35–44	102	1.1	314	1.9
45–54	1,223	13.0	2,231	13.6
55–64	2,018	21.5	3,318	20.2
65–74	3,559	37.9	5,048	30.7
75–84	1,879	20.0	3,969	24.2
85+	584	6.2	1,336	8.1
Total	9,393	100.0	16,419	100.0

Note: [a] Incidence at baseline

TABLE 26
Total drug costs, TIA patients, 2007 (€000 and %)

Age group	€000	%
0–14	1	0.1
15–34	22	2.0
35–44	52	4.6
45–54	98	8.7
55–64	213	18.8
65–74	295	26.1
75–84	331	29.2
85+	121	10.7
Total	1,134	100.0

FIGURE 7
Drug costs, stroke patients, by source of funding, 2007 (%)

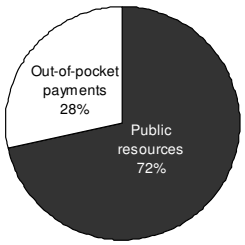
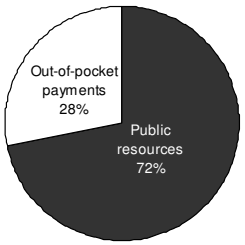


FIGURE 8
Drug costs, TIA patients, by source of funding, 2007 (%)



3.6 COMMUNITY REHABILITATION

The baseline estimate of the cost of community rehabilitation for stroke patients in 2007 was €7 million, including provision for overheads of 15 per cent (Table 27).

TABLE 27
Total community rehabilitation costs, baseline estimate, stroke patients, 2007 (€000 and %)

Discipline	€000	%
Public health nursing	1,900	27.1
Speech and language therapy	1,364	19.5
Dietetics	182	2.6
Physiotherapy	2,069	29.5
Occupational therapy	1,488	21.2
Total	7,003	100.0

Sensitivity analysis examines the variation in the cost of community rehabilitation when adjustment is made for the non-responding LHOs (low and high provision around the average) (Table 28). The cost range for 2007 is between €4 and €9 million. Further sensitivity analysis adjusts the cost estimate for occupational therapy, following the comparison of estimated case-load and staffing levels with data from the INASC report (Table 29). The adjusted cost of community rehabilitation in 2007 is €6 million.

TABLE 28
Total community rehabilitation costs, adjusted for non-responding LHOs, stroke patients, 2007 (€000 and %)

Discipline	Low		High	
	€000	%	€000	%
Public health nursing	1,382	32.8	2,425	27.4
Speech and language	724	17.2	1,508	17.0
Dietetics	108	2.6	276	3.1
Physiotherapy	1,161	27.5	2,961	33.4
Occupational therapy	840	19.9	1,686	19.0
Total	4,216	100.0	8,856	100.0

TABLE 29
Total community rehabilitation costs, adjusted for low response on occupational therapy, stroke patients 2007 (€000 and %)

Discipline	€000	%
Public health nursing	1,900	29.9
Speech and Language	1,364	21.5
Dietetics	182	2.9
Physiotherapy	2,069	32.6
Occupational Therapy	840	13.2
Total	6,355	100.0

It is estimated that 100 per cent of community rehabilitation costs were covered by public funding in 2007.

3.7 AIDS, APPLIANCES, HOME MODIFICATIONS

The total cost of aids, appliances and home modifications for stroke patients in 2007 is estimated to have been between €8 and €10 million, depending on the prevalence of stroke (at baseline incidence rates) (Table 30). Data on the distribution of these costs across public and private resources are not available.

TABLE 30
Total aids, appliances, home modifications costs, stroke patients, 2007 (€000 and %)

Age group	Low prevalence[a]		High prevalence[a]	
	€000	%	€000	%
0–14	22	0.3	22	0.2
15–34	137	1.7	214	2.2
35–44	343	4.4	431	4.4
45–54	989	12.6	1,242	12.7
55–64	1,928	24.5	2,248	22.9
65–74	2,349	29.8	2,696	27.5
75–84	1,833	23.3	2,466	25.1
85+	270	3.4	491	5.0
Total	7,872	100.0	9,811	100.0

Note: [a] Incidence at baseline

3.8 VOLUNTARY AGENCY SERVICES

Voluntary agencies are estimated to have spent €10 million on services for stroke patients in 2007 (Table 31). The largest proportion of this was spent by the Irish Wheelchair Association (on day care and assisted living services). Acquired Brain Injury Ireland provides rehabilitation and assisted living services for stroke (17 per cent of total voluntary agency stroke expenditure in 2007). Headway provides community rehabilitation services (10 per cent of total voluntary agency stroke expenditure in 2007). These voluntary services receive the majority of their funding from the Health Service Executive (Irish Wheelchair Association, 2008; Cheshire, 2008; Headway, 2007), although other sources of funding include private fundraising and service user contributions.

TABLE 31
Total voluntary expenditure, stroke patients, 2007 (€000 and %)

Agency	€000	%
Headway	999	10.0
Acquired Brain Injury Ireland	1,704	17.1
Volunteer Stroke Scheme	70	0.7
Irish Wheelchair Association	5,186	52.1
Others (e.g., Cheshire, Centres for Independent Living)	1,986	20.0
Total	9,945	100.0

3.9 INFORMAL CARE

The cost of foregone productivity due to informal care varies by the estimated amount of informal care received by stroke patients (Table 32). For low stroke prevalence (at baseline incidence rates), the human capital cost of informal care is estimated to have been between €44 and €98 million in 2007, depending on the average amount of stroke-related informal care received (i.e., 9 hours versus 20 hours per week). For high stroke prevalence (at baseline incidence rates), the human capital cost of informal care in 2007 ranged from €79 to €174 million, depending on the amount of informal care received per week. Informal care was concentrated on the 65–84 age groups.

TABLE 32
Total informal care costs, stroke patients, 2007 (€000 and %)

Age group	Low prevalence[a]				High prevalence[a]			
	Low no. of informal hours		High no. of informal hours		Low no. of informal hours		High no. of informal hours	
	€000	%	€000	%	€000	%	€000	%
0–14	-	-	-	-	-	-	-	-
15–34	-	-	-	-	-	-	-	-
35–44	-	-	-	-	-	-	-	-
45–54	4,330	9.8	9,622	9.8	7,894	10.1	17,541	10.1
55–64	8,352	18.8	18,559	18.8	13,699	17.4	30,443	17.4
65–74	17,006	38.4	37,791	38.4	23,751	30.2	52,781	30.2
75–84	12,646	28.5	28,103	28.5	27,399	34.9	60,887	34.9
85+	1,980	4.5	4,401	4.5	5,781	7.4	12,846	7.4
Total	44,314	100.0	98,476	100.0	78,524	100.0	174,498	100.0

Note: [a] Incidence at baseline

3.10 PRODUCTIVITY LOSS FROM MORBIDITY AND MORTALITY

The cost of productivity foregone due to stroke illness varies depending on the proportion of patients required to leave work due to illness (Table 33). At low stroke prevalence, the total costs of productivity foregone from stroke morbidity and mortality in 2007 is estimated to have been between €99 and €128 million, depending on the proportion of stroke patients leaving work due to illness (i.e., 47 per cent versus 65 per cent). At high stroke prevalence, the 2007 total cost of productivity foregone is estimated to have been between €169 and €222 million.

TABLE 33
Total morbidity and mortality costs, stroke patients, 2007 (€000 and %)

Age group	Low prevalence[a]				High prevalence[a]			
	Low no. of patients stopping work due to illness		High no. of patients stopping work due to illness		Low no. of patients stopping work due to illness		High no. of patients stopping work due to illness	
	€000	%	€000	%	€000	%	€000	%
0–14	-	-	-	-	-	-	-	-
15–34	1,105	1.1	1,340	1.0	6,605	3.9	8,906	4.0
35–44	4,617	4.7	5,886	4.6	12,725	7.5	16,964	7.6
45–54	30,547	30.8	40,979	31.9	52,039	30.7	70,233	31.6
55–64	37,722	38.0	50,204	39.1	57,694	34.1	77,099	34.7
65–74	13,852	14.0	17,102	13.3	18,963	11.2	23,622	10.6
75–84	8,869	8.9	10,330	8.0	17,124	10.1	20,736	9.3
85+	2,469	2.5	2,556	2.0	4,152	2.5	4,603	2.1
Total	99,182	100.0	128,397	100.0	169,303	100.0	222,163	100.0

Note: [a] Incidence at baseline.

3.11 TOTAL COST ESTIMATES

Table 34 presents the estimated total costs of stroke in Ireland in 2007.

TABLE 34
Total costs, stroke patients, 2007 (€000 and %)

Cost element	Low prevalence[a]			High prevalence[a]		
	€000	%	% of total	€000	%	% of total
Direct costs						
Acute hospital care[b]	70,798	20.5	14.5	70,798	12.7	8.8
In-patient rehabilitation	16,167	4.7	3.3	16,167	2.9	2.0
Nursing home care	216,591	62.7	44.3	414,216	74.3	51.4
GP care	3,737	1.1	0.8	6,342	1.1	0.8
OPD care	4,369	1.3	0.9	7,336	1.3	0.9
Drugs	9,393	2.7	1.9	16,419	2.9	2.0
Community rehabilitation[c]	6,355	1.8	1.3	6,355	1.1	0.8
Aids, appliances, home modifications	7,872	2.3	1.6	9,811	1.8	1.2
Voluntary agency services	9,945	2.9	2.0	9,945	1.8	1.2
Total direct costs	345,227	100.0	70.6	557,387	100.0	69.2
Indirect costs						
Informal care[d]	44,314	30.9	9.1	78,524	31.7	9.8
Productivity loss from morbidity and mortality[e]	99,182	69.1	20.3	169,303	68.3	21.0
Total indirect costs	143,496	100.0	29.4	247,827	100.0	30.8
Total cost of stroke care	488,723		100.0	805,214		100.0
Incident costs	174,374		35.7	174,108		21.6
Net prevalent costs	314,349		64.3	631,106		78.4
Total cost of stroke care	**488,723**		**100.0**	**805,214**		**100.0**

Notes:
[a] Incidence at baseline
[b] Costs based on the casemix methodology.
[c] Cost based on adjusted occupational therapy provision.
[d] Cost based on the low estimate of number of informal care hours.
[e] Cost based on the low estimate of number of patients stopping work due to illness.

Total direct costs of stroke in 2007 are estimated to have been between €345 and €557 million, depending on the prevalence of stroke (at baseline incidence rates). Nursing home costs accounted for the largest proportion of total direct costs (more than 60 per cent), followed by hospital costs (more than 15 per cent including in-patient rehabilitation), and drug costs accounted for approximately 3 per cent of total direct costs.

Indirect costs were between €143 and €248 million in 2007, depending on the prevalence of stroke (at baseline incidence rates). The largest proportion of indirect costs was due to the loss of productivity from stroke morbidity/mortality (more than 68 per cent).

Total estimated direct and indirect costs were between €489 and €805 million in 2007. These are lower bound estimates as they are based on the low estimates for acute hospital care and indirect costs (see sections 3.1, 3.9, 3.10 on acute hospital care and indirect costs). Nursing home care accounted for more than 44 per cent of total costs. Productivity losses from stroke morbidity/mortality were the next largest category (more than 20 per cent), followed by hospital care (more than 10 per cent including in-patient rehabilitation) and informal care (more than 9 per cent).

The breakdown of costs is different for incident stroke patients (i.e., in the first year of stroke) compared with net prevalent cases (Tables 35[49] and 36). The largest difference is in the balance between hospital and nursing home costs. Hospital costs accounted for 59 per cent (including in-patient rehabilitation) of total direct costs for incident cases. Nursing home care accounted for 30 per cent of direct costs for incident cases, compared with more than 86 per cent for net prevalent cases.

TABLE 35
Total incident costs, stroke patients, 2007 (€000 and %)

Cost element	Low prevalence[a]			High prevalence[a]		
	€000	%	% of total	€000	%	% of total
Direct costs						
Acute hospital care[b]	70,798	48.1	40.6	70,798	48.3	40.7
In-patient rehabilitation	16,167	11.0	9.3	16,167	11.0	9.3
Nursing home care	44,693	30.4	25.6	43,957	30.0	25.2
GP care	966	0.7	0.6	977	0.7	0.6
OPD care	1,072	0.7	0.6	1,086	0.7	0.6
Drugs	1,245	0.8	0.7	1,259	0.9	0.7
Community rehabilitation[c]	6,355	4.3	3.6	6,355	4.3	3.7
Aids, appliances, home modifications	5,802	3.9	3.3	5,919	4.0	3.4
Voluntary agency services	-	-	-	-	-	-
Total direct costs	147,098	100.0	84.4	146,519	100.0	84.2
Indirect costs						
Informal care[d]	5,362	19.7	3.1	5,549	20.1	3.2
Productivity loss from morbidity and mortality[e]	21,914	80.3	12.6	22,041	79.9	12.7
Total indirect costs	27,276	100.0	15.6	27,590	100.0	15.8
Total incident cost of stroke care	**174,374**		**100.0**	**174,108**		**100.0**

Notes:
[a] Incidence at baseline
[b] Costs based on the casemix methodology.
[c] Cost based on adjusted occupational therapy provision.
[d] Cost based on the low estimate of number of informal care hours.
[e] Cost based on the low estimate of number of patients stopping work due to illness.

[49] Note that costs for incident stroke cases are at baseline rates for both low and high prevalence and any variation between low and high prevalence in Table 35 is due to rounding issues.

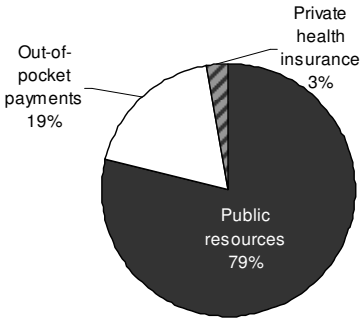
TABLE 36
Total net prevalent costs, stroke patients, 2007 (€000 and %)

Cost element	Low prevalence[a]			High prevalence[a]		
	€000	%	% of total	€000	%	% of total
Direct costs						
Acute hospital care[b]	-	-	-	-	-	-
In-patient rehabilitation	-	-	-	-	-	-
Nursing home care	171,898	86.8	54.7	370,258	90.1	58.7
GP care	2,771	1.4	0.9	5,365	1.3	0.9
OPD care	3,297	1.7	1.0	6,250	1.5	1.0
Drugs	8,148	4.1	2.6	15,159	3.7	2.4
Community rehabilitation[c]	-	-	-	-	-	-
Aids, appliances, home modifications	2,070	1.0	0.7	3,892	0.9	0.6
Voluntary agency services	9,945	5.0	3.2	9,945	2.4	1.6
Total direct costs	198,129	100.0	63.0	410,868	100.0	65.1
Indirect costs						
Informal care[d]	38,953	33.5	12.4	72,975	33.1	11.6
Productivity loss from morbidity and mortality[e]	77,268	66.5	24.6	147,262	66.9	23.3
Total indirect costs	116,220	100.0	37.0	220,237	100.0	34.9
Total net prevalent cost of stroke care	**314,349**		**100.0**	**631,106**		**100.0**

Notes:
[a] Incidence at baseline
[b] Costs based on the casemix methodology.
[c] Costs assumed to be concentrated on incident stroke cases.
[d] Cost based on the low estimate of number of informal care hours.
[e] Cost based on the low estimate of number of patients stopping work due to illness.

The distribution of costs between public and private resources is presented in Figure 9. The majority of total direct stroke expenditure in 2007 was publicly funded (approximately 79 per cent) with out-of-pocket payments accounting for 19 per cent of the total, and a small amount of private health insurance funding (3 per cent).

FIGURE 9
Total direct costs, stroke patients, by source of funding, 2007 (%)[a]



Note:
[a] The percentage breakdown is similar for the low and high prevalence scenarios.

To facilitate international comparison, Table 37 presents a range of statistics, including stroke and TIA expenditure as a proportion of total health expenditure and national income (GNP[50]). Tables 38 and 39 compare the proportional breakdown of total stroke expenditure for Ireland with studies from Australia (Cadilhac et al., 2009), France (Spieler et al., 2003), Germany (Rossnagel et al., 2005), the Netherlands (Evers et al., 1997), and the UK (Saka et al., 2009a).

TABLE 37
Key statistics based on costs of stroke in Ireland, 2007 (%)

Indicator	Low prevalence[a]	High prevalence[a]
Percentage of population (%)		
Stroke patients	0.7	1.1
TIA patients	0.1	0.1
Percentage of GNP (%)		
Total stroke expenditure	0.30	0.50
Total direct stroke expenditure	0.21	0.35
Total TIA expenditure	0.01	0.01
Percentage of total public health expenditure (%)		
Total public stroke expenditure	2.0	3.2
Total public TIA expenditure	0.1	0.1
Percentage of total health expenditure (%)		
Total direct stroke expenditure	2.4	3.9
Total TIA expenditure	0.08	0.08

Note: [a] Incidence at baseline

[50] In view of the large proportion of profit repatriation out of the country by foreign companies, GNP is held to be a more reliable measure of national income for Ireland.

TABLE 38

Total incident stroke costs in Ireland, Australia, France and Germany[51] (€ and %)

	Ireland[a]		Australia		France		Germany	
	% of direct/ indirect costs	% of total costs	% of direct/ indirect costs	% of total costs	% of direct/ indirect costs	% of total costs	% of direct/ indirect costs	% of total costs
Direct costs								
Acute hospital care	48.3	40.7	48.0	45.7	46.5	na[c]	63.4	52.9
In-patient rehabilitation	11.0	9.3	31.2	29.7	26.3	na	15.4	12.9
Nursing home care	30.0	25.2	11.5	11.0	9.6	na	2.3	1.9
GP care	0.7	0.6	0.7	0.7	[b]	na	3.4	2.9
OPD care	0.7	0.6	0.8	0.7	[b]	na	1.2	1.0
Drugs	0.9	0.7	1.9	1.9	4.7	na	9.1	7.6
Community rehabilitation	4.3	3.7	3.4	3.3	11.4	na	1.5	1.2
Aids, appliances, home modifications	4.0	3.4	2.4	2.3	1.5	na	3.6	3.0
Voluntary agency services	-	-	na	na	na	na	na	na
Total direct costs	100.0	84.2	100.0	95.3	100.0		100.0	83.5
Indirect costs								
Informal care	20.1	3.2	100.0	4.7	na	na	na	na
Productivity loss from morbidity and mortality	79.9	12.7	na	na	na	na	100.0	16.5
Total indirect costs	100.0	15.8	100.0	4.7			100.0	16.5
Mean costs per stroke patient (2007, €)								
Direct costs (incident cases)		18,751		15,673		23,798		11,087
Indirect costs (incident cases)		3,531		708				2,197
Total costs (incident cases)		22,282		16,381		23,798		13,285

Mean costs per stroke patient (% of GDP/GNP per capita)				
	% of GNP	% of GDP	% of GDP	% of GDP
Direct costs (incident cases)	50.5	52.9	93.0	34.0
Indirect costs (incident cases)	9.5	2.6	na	7.7

Notes: [a] High prevalence and incidence at baseline

[b] GP and OPD costs included with community rehabilitation costs.

[c] na = not available

Sources: Australia: Cadilhac et al., 2009; France: Spieler et al., 2003; Germany: Rossnagel et al., 2005

[51] Mean cost per patient expressed in 2007 prices. Cost estimates from Australia, France and Germany converted to euro and inflated to 2007 prices using average annual health cost inflation indicators.

TABLE 39
Total prevalent stroke costs in Ireland, the Netherlands and UK (%)

	Ireland[a]		Netherlands		United Kingdom	
	% of direct/indirect costs	% of total costs	% of direct/indirect costs	% of total costs	% of direct/indirect costs	% of total costs
Direct costs						
Acute hospital care	13.3	9.1	32.6	24.6	20.8	11.3
In-patient rehabilitation	3.0	2.1	[b]	[b]	[b]	[b]
Nursing home care	78.0	53.2	60.1	45.5	65.2	35.4
GP care	1.2	0.8	1.2	0.9	2.5	1.4
OPD care	1.4	0.9	na [c]	na	[d]	[d]
Drugs	3.1	2.1	6.2	4.7	11.5	6.3
Community rehabilitation	excluded for comparison		excluded for comparison		na	na
Aids, appliances, home modifications	excluded for comparison		na	na	na	na
Voluntary agency services	excluded for comparison		na	na	na	na
Total direct costs	100.0	68.2	100.0	75.7	100.0	54.3
Indirect costs						
Informal care	31.7	10.1	na	na	64.5	29.5
Productivity loss from morbidity and mortality	68.3	21.7	100.0	16.1	35.5	16.2
Total indirect costs	100.0	31.8	100.0	16.1	100.0	45.7

Notes: [a] High prevalence and incidence at baseline
[b] Rehabilitation costs are included with acute hospital care.
[c] na = not available
[d] OPD costs are included with GP costs.
Sources: The Netherlands: Evers et al., 1997; UK: Saka et al., 2009a

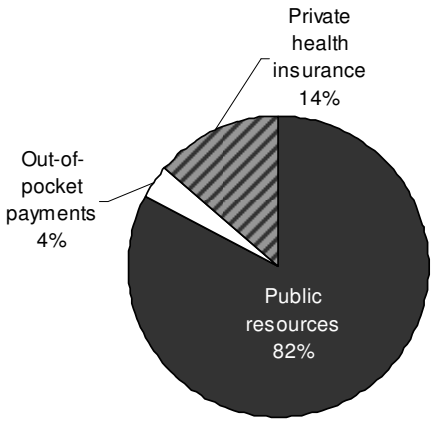
The costs of acute hospital care, in-patient rehabilitation and drugs are estimated for TIA patients (Table 40). The total cost of TIA in 2007 is estimated to have been €11 million, the majority of which was accounted for by hospital costs. Public resources funded more than 80 per cent of total estimated TIA costs in 2007 (Figure 10). Private health insurance accounted for 14 per cent of estimated TIA costs, due to the predominance of hospital funding (private health insurance mainly funds hospital care).

TABLE 40
Total costs, TIA patients, 2007 (€000 and %)

Cost element	€000	%
Direct costs		
Acute hospital care[a]	9,340	84.4
In-patient rehabilitation	592	5.4
Drugs	1,134	10.2
Total cost of TIA care	**11,067**	**100.0**

Note: [a] Costs based on the casemix methodology.

FIGURE 10
Total direct costs, TIA patients, by source of funding, 2007 (%)



Sensitivity analysis

The sensitivity of cost estimates to changes in stroke prevalence from low to high has been presented for each cost element. Total costs of stroke based on the high level of stroke prevalence are 65 per cent larger than those based on the low level of stroke prevalence. Details on the sensitivity of cost estimates to changes in incidence rates, and to changes in other cost parameters, are presented in Appendix 2.

3.12 FUTURE COST ESTIMATES

Demographic change plus epidemiological change

Table 41 presents the estimated costs of stroke in 2021 based on demographic change alone (i.e., costs based on projected population in 2021 with no change in stroke epidemiology), and for the combined effect of demographic and epidemiological change. The cost estimates for 2007 are also presented for comparison.

The population is projected to increase by approximately 18 per cent between 2007 and 2021 (19 per cent for males and 17 per cent for females). Adjusting for demographic change alone, the future cost of stroke is estimated to increase by more than 50 per cent between 2007 and 2021: to €743 million in the low prevalence scenario, and to €1,266 million in the high prevalence scenario. Total costs in 2021 increase by more than 80 per cent over 2007 when epidemiological change is also taken into account: €881 million in the low prevalence scenario, and €1,500 million in the high prevalence scenario.

TABLE 41
Projected total costs, stroke patients, 2021 (with and without epidemiological change) (€000 and %)

	Low prevalence[a]			High prevalence[a]		
		2021			2021	
	2007	Demographic change	Demographic and epidemiological change	2007	Demographic change	Demographic and epidemiological change
Direct costs						
Acute hospital care[b]	70,798	84,487	101,210	70,798	84,487	101,210
In-patient rehabilitation	16,167	22,717	27,138	16,167	22,717	27,138
Nursing home care	216,591	364,240	426,138	414,216	711,133	834,222
GP care	3,737	6,111	7,304	6,342	10,362	12,371
OPD care	4,369	6,977	8,391	7,336	11,652	13,958
Drugs	9,393	14,755	17,769	16,419	25,794	30,893
Community rehabilitation[c]	6,355	7,499	7,499	6,355	7,499	7,499
Aids, appliances, home modifications	7,872	13,163	16,073	9,811	16,117	19,588
Voluntary agency services	9,945	9,945	9,945	9,945	9,945	9,945
Total direct costs	345,227	529,893	621,467	557,387	899,705	1,056,824
Indirect costs						
Informal care[d]	44,314	71,553	85,901	78,524	128,205	153,828
Productivity loss from morbidity and mortality[e]	99,182	141,194	174,079	169,303	238,376	289,041
Total indirect costs	143,496	212,747	259,980	247,827	366,580	442,869
Total cost of stroke care	**488,723**	**742,640**	**881,447**	**805,214**	**1,266,285**	**1,499,693**
Percentage change 2007–2021		**52.0**	**80.4**		**57.3**	**86.2**

Notes:
[a] Incidence at baseline
[b] Costs based on the casemix methodology.
[c] Cost based on adjusted occupational therapy provision.
[d] Cost based on the low estimate of number of informal care hours.
[e] Cost based on the low estimate of number of patients stopping work due to illness.

4 DISCUSSION

Stroke epidemiology in Ireland

The estimated incidence and prevalence of stroke and TIA in Ireland are important determinants of the total costs of stroke and TIA. This study has drawn on the best available evidence on stroke epidemiology in Ireland. Incidence estimates for stroke are obtained from the NDPSS which followed the international standards for estimating stroke incidence developed by the Oxford Vascular Study (Feigin and Vander Hoorn, 2004). WHO and NDPSS incidence rates applied to 2007 population numbers yielded similar estimates of total stroke incidence. Prevalence rates were obtained from WHO estimates (high estimate of prevalence) and from the Health Module of the Quarterly National Household Survey (QNHS), combined with an estimate of the proportion of stroke patients residing in nursing homes (low estimate of prevalence).

Incidence and prevalence rates are higher for older age groups and are generally higher for males than for females and this demographic profile is consistent with international patterns (Moon et al., 2003; Truelsen et al., 2006).

These data are subject to limitations. The demographic and socioeconomic profile of the North Dublin population varies from the national profile indicating the need for some adjustment when extrapolating stroke incidence rates to the rest of the population. The use of local incidence rates to estimate national incidence is not new in the cost of stroke literature (examples include: Dewey et al., 2001; Saka et al., 2005; Brown et al., 2006; Navarrete-Navarro et al., 2007; Saka et al., 2009a), but researchers note the limitations of this approach and most adopt sensitivity analysis as in this study. Estimating total stroke prevalence in Ireland is also complicated, as shown in Appendix 1, with the most recent estimate indicating that total stroke prevalence could be as high as 58,778 (Balanda et al., 2010).

Under-reporting of TIA cases is also an important issue and a large number may go undetected or unreported (e.g., older people living in nursing homes or in the community attended to by their GP). Thus, the costs of TIA in this report are underestimates.

National and international comparisons

This study provides the first available detailed analysis of total annual stroke and TIA costs using Irish-specific data. The total cost of stroke in 2007 is estimated to have been between €489 and €805 million in the baseline scenario (see below for discussion of sensitivity analysis). This is a societal-based cost and includes both direct and indirect costs. Public costs are estimated to have been between €272

and €427 million (in the baseline scenario), and this is in line with the recent stroke manifesto published by the Irish Heart Foundation which estimates that the State spends €422 million per year on stroke services (Irish Heart Foundation, 2009).

The only other societal-based cost estimate for stroke in Ireland was generated by a European study of the cost of disorders of the brain (McHugh, 2007). The European study estimated a cost of stroke for incident cases in Ireland of €127 million.[52] This is lower than the estimated cost of stroke for incident cases in this study of €174 million (at baseline incidence rates). The estimates from the European study are based on non-Irish data and evidence here indicates they have underestimated the costs of stroke for incidence cases by more than 25 per cent.

Comparisons across countries are complicated by variations in methodologies, data sources and the range of costs included. Total estimated direct expenditure on stroke accounted for between 2 per cent and 4 per cent of total health expenditure and 0.2 per cent and 0.3 per cent of GNP in Ireland in 2007. This is broadly consistent with estimates in other countries. Available studies estimate that between 2 per cent and 5 per cent of total health care costs, and 0.27 per cent of GDP are due to cerebrovascular diseases in western countries (Ghatnekar et al., 2004; Evers et al., 2004; Rossnagel et al., 2005). Saka et al. (2009a) estimate that the total annual direct cost of stroke in the UK is equivalent to 5.5 per cent of total UK health expenditure.

To compare the mean cost of stroke per patient with other countries, the focus is on the costs in the first year of stroke (i.e., incident cases only) as the majority of cost of stroke studies are incidence based studies. The mean direct cost per incident stroke case in Ireland (€18,751) is higher than estimated in Australia (€15,673) and Germany (€11,087), and lower than estimated in France (€23,798), in 2007 prices.[53] These comparisons are treated with caution and require further examination of the costs included, the data sources and methods, and international unit cost variations. Measured as a proportion of national income (i.e., per cent of GNP or GDP), there is greater consistency across the sample of countries in per capita stroke expenditure for incident cases (e.g., 50 per cent in Ireland, 53 per cent in Australia, 34 per cent in Germany), although the French estimate is an outlier here (93 per cent).

[52] Expressed as €136 million in €PPP (at 2004 prices) in McHugh et al. (2007), converted to € and inflated to 2007 prices using annual health inflation (available from Central Statistics Office, http://www.cso.ie/statistics/consumpriceindex.htm Accessed 14/12/09).

[53] Stroke costs from Australia, France and Germany have been inflated to 2007 prices and converted to Euro where necessary.

Despite the variations in methods, there is broad consistency across countries in the breakdown of stroke costs by cost element. For incident cases, hospital, in-patient rehabilitation and nursing home care together account for the largest proportion (more than 80 per cent) of direct stroke costs in each of the studies included here. However, in-patient rehabilitation accounts for a lower proportion, and nursing home care accounts for a higher proportion, of total direct stroke costs for incident cases in Ireland relative to the other studies. A similar pattern is observed in the comparison of prevalence-based costs across Ireland, the Netherlands and the UK.

The higher proportion of nursing home costs in Ireland relative to other countries requires further investigation. This could be due to a number of factors. Firstly, there is evidence that the unit cost of nursing home care is higher in Ireland than in other countries. The weekly nursing home unit cost in the UK[54] is approximately 70 per cent of the average nursing home unit cost estimated in Ireland. The weekly nursing home charge in Australia estimated by Cadilhac et al. (2009) is less than 40 per cent of the average nursing home charge in Ireland. However, the unit cost of other elements of care may also be relatively high in Ireland but data are not available to compare all unit costs across countries. Secondly, the length of stay in a nursing home in Ireland may be longer than in other countries. However, this study has adopted a conservative estimate of the number of weeks within a year spent in a nursing home by patients experiencing stroke for the first time (adjusting for the month in which the stroke may have occurred), and, separately, the number of weeks spent by those who experienced a stroke in a previous year.

Third, the level of disability in patients who survive a stroke, and the related need for long-term care, may be higher in Ireland relative to other countries. A higher level of disability in stroke survivors has been observed in a comparison of data from the NDPSS and Oxford Vascular Stroke Studies.[55] Similarly, the INASC clinical audit found that 30 per cent of stroke patients had a severe/very severe level of disability on discharge from hospital relative to 21 per cent identified in the UK Sentinel stroke audit (Irish Heart Foundation, 2008). This may reflect greater frequency of stroke sub-groups associated with more disabling stoke (e.g., intracerebral haemorrhage) or stroke associated with atrial fibrillation. The reason for higher disability could also be related to the way in which treatment is organised and delivered at the acute hospital phase. As discussed below, delivery of acute stroke care in stroke units is associated with better stroke outcomes and lower levels of disability, which could reduce the number of stroke patients requiring long-term nursing care. As highlighted in the INASC report, an estimated

[54] Nursing home cost per week of STG£570 in 2005 prices was reported by Saka et al. (2009a), and is converted to € and inflated to 2007 prices: €857.

[55] Presented to Irish Heart Foundation Annual Stroke Conference, 2009.

2 per cent of stroke patients are treated in a stroke unit in Ireland and this is out of line with international experience (e.g., 62 per cent in the UK in 2006, Irish Heart Foundation, 2008). The relatively high levels of disability, together with high unit costs provide some explanation for the greater proportion of total stroke resources taken up by nursing home care in Ireland relative to other countries.

Overall, the main cost items for stroke cases (incident and prevalent) include direct costs for acute hospital care, in-patient rehabilitation, nursing home care, and indirect costs. In a literature review of the cost of stroke, a similar breakdown of costs was identified across a number of, mainly incidence-based, studies with the exception of nursing home care (Ekman, 2004).

Drug costs accounted for 1 per cent of total direct stroke costs for incident cases in Ireland in 2007 compared with 2 per cent in Australia, 5 per cent in France, and 9 per cent in Germany. For prevalent cases, expenditure on stroke-related medication accounted for approximately 3 per cent of total direct costs in Ireland in 2007, compared with 6.2 per cent in the Netherlands and 11.5 per cent in the UK. This pattern could be partly due to the focus in this study on stroke-related medications taken for the first time post-stroke (i.e., controlling for stroke-related medications taken prior to stroke).

Unlike other cost of stroke studies, this study has included expenditure by voluntary agencies on stroke services. This expenditure is estimated to account for 2–3 per cent of total direct expenditure in 2007, similar in proportion to expenditure on stroke-related medications (taken for the first time post-stroke), and on aids, appliances and home modifications. Data on this area are limited and the magnitudes estimated here suggest the need for further analysis of the role of voluntary agencies in the provision of stroke services.

Indirect costs accounted for more than 29 per cent of total stroke costs in 2007, adding more than €143 million to direct costs of stroke in Ireland. This, together with the cost of nursing home care, and other out of hospital care, indicates that the chronic phase of stroke care has the most important impact on total stroke costs. This is also raised in the literature as an issue that highlights the need for measures to improve long-term functional outcomes in stroke patients (Navarrete-Navarro et al., 2007), and for more information on the effectiveness and cost-effectiveness of long-term and follow-up stroke care (Saka et al., 2009a).

The estimated total cost of TIA in Ireland in 2007 was €11 million. The mean TIA cost per case is less than 30 per cent of the mean total per patient stroke cost (or 41 per cent of the mean direct per patient stroke cost). There are few international comparators for the cost of TIA. The estimate in this study is

consistent with that by Rossnagel et al. (2005) where TIA costs are equivalent to approximately one-third of the costs of stroke. Also, this study has focused on the costs of acute care, in-patient rehabilitation care, and medication for TIA patients. In their study of the costs of TIA, Porsdal and Boysen (1998) found that resource use after hospital discharge can account for a high proportion of TIA costs (47 per cent). Further data on the use and cost of non-hospital services by TIA patients in the Irish context is therefore needed. As outlined above, the total cost of TIA in Ireland is likely to be higher with more accurate data on the total number of TIA cases in any one year. This has wider cost implications as the occurrence of a TIA can be a warning signal for a stroke. The detection of a greater proportion of TIAs could lead to a greater uptake of stroke prevention measures (e.g., preventative medication) with a subsequent potential reduction in the number of strokes, and hence a reduction in total stroke costs (also discussed below).

Distribution of costs

The large proportion of public funding for stroke (approximately 77–79 per cent) and TIA (82 per cent) care is consistent with the estimated age and medical card profile of the stroke/TIA population. Between 2001 and 2008 all individuals aged 70 and older were automatically entitled (i.e., non-means-tested) to a medical card, granting them free access to primary and public hospital care. It is estimated that more than 80 per cent of stroke patients aged 65 and older were medical card holders in 2007. Out-of-pocket payments have implications for health-care seeking behaviour and equity. Out-of-pocket payments account for an important source of financing for specific cost estimates (25–29 per cent of stroke-related drug, nursing home and GP care) and their implications for equity and efficiency in stroke resource allocation need to be examined in more detail.

Data and methodological issues

This study has drawn on a large range of data sources, with variations in the methods applied, to estimate the costs of the main health goods and services provided to stroke and TIA patients. Important issues, including limitations in the data, and their implications for the cost estimates, are identified here.

Hospital cost estimates based on the casemix methodology are lower than those based on the cost per bed day methodology. The cost per bed day methodology attaches the same unit cost to each in-patient day. This does not control for the fact that the cost of treating a patient in the post-acute phase of care is lower than in the acute phase. The casemix method attaches a cost to the overall complexity of the case over the whole episode of care, taking into account average length of stay for that specific DRG (and adjusts for above/below average length of stay). The older age profile of stroke/TIA patients, and associated problems in securing long-term care at the point of discharge for older patients in

many areas, is also consistent with the observed long lengths of stay[56] and higher costs based on a cost per bed day methodology. The use of the top-down, cost per bed day methodology in cost of stroke estimation is not observed in the international literature, while the casemix methodology is used in a number of studies (e.g., Dewey et al., 2001; Ghatnekar et al., 2004; Navarrete-Navarro et al., 2007). However, in the Irish application, the casemix method is based on estimates about the resources used by different categories of stroke patients. Other cost of stroke studies adopt a micro-costing approach, in which they directly observe, and attach costs to, the resources used by each stroke patient over their hospital stay (e.g., Grieve et al., 2001; Epstein et al., 2008). One Irish study that used this detailed bottom-up approach to estimating the acute hospital costs of stroke is available. McGowan et al. (2003) estimated that the mean acute hospital cost per stroke patient was €10,740 (estimated in 2007 prices[57]), which was higher than the casemix cost per case of €7,160 (estimated in 2007 prices) identified for that year. These estimates are consistent with the estimated mean hospital cost per incident stroke case based on the casemix method in this study (€9,113 or €11,194 including in-patient rehabilitation). Measures are currently being taken to introduce direct bottom-up patient level costing in Irish hospitals and this will generate more accurate and more detailed data for future cost of illness studies in the Irish context.

The costs of in-patient rehabilitation have been separated in this study, although it is important to note that the rehabilitation phase of care for stroke and TIA patients starts almost immediately at admission. A proportion of the cost of in-patient rehabilitation is therefore included with the acute hospital costs. The provision of in-patient rehabilitation in hospitals/rehabilitation units outside of the HIPE scheme requires further analysis. This study relied on survey estimates of the proportion of patients receiving rehabilitation, and the amount of rehabilitation received (number of weeks) as there are no national data in this area.

The estimated nursing home costs are based on available data on the number of stroke patients living in nursing homes. This is a conservative estimate of the number of stroke patients. Diagnosing stroke in nursing home patients is difficult due to the complexity of multiple morbidities in this older age, and dependent, cohort. As noted above, some studies have deducted the cost of living expenses from nursing home costs, on the basis that these costs would have been incurred anyway (Dewey et al., 2001). However, this is a complex issue and assumes a straightforward distinction between maintenance (e.g., food, electricity,

[56] The mean length of stay for stroke in-patient discharges in 2007 was 22.5 days and the median length of stay was 12 days compared with the total average over all in-patient discharges of 6.7 days.

[57] Cost estimates in 1999 are inflated to 2007 prices using annual health inflation (available from Central Statistics Office, http://www.cso.ie/statistics/consumpriceindex.htm Accessed 14/12/09).

accommodation) and nursing, and requires further analysis. The new procedures for paying for nursing home care (i.e., A Fair Deal, DOHC, 2006) will have implications for the distribution of nursing home costs and these will need to be examined.

The costs of GP and OPD care are based on an estimated ratio of two GP visits for every OPD visit. Available literature indicates that one stroke-specific specialist OPD visit per stroke patient is a reasonable estimate.

Drug costs account for 2–3 per cent of direct and total stroke costs. Drug costs are estimated for patients taking stroke-related medications for the first time post-stroke/TIA. The level of prescribing of preventative cardiovascular medications has implications for the costs that can be directly attributed to stroke/TIA. Where a higher number of patients are prescribed cardiovascular medication prior to stroke/TIA, the proportion of patients taking the medication post-stroke/TIA falls and the cost of drugs attributed to stroke falls. Ultimately, a higher level of preventative prescribing would be expected to reduce the number of cardiovascular events, including stroke, TIA and acute coronary events (Bandolier, 1997[58]). Increases in prescribing of cardiovascular medication have wider implications for reducing the costs of stroke/TIA by reducing the number of cases. Medications commonly used for vascular prevention following stroke and TIA may also have benefits for prevention of other complications related to cerebrovascular disease, such as dementia, falls and seizures.

The uncertainty around the estimated cost of community rehabilitation due to data limitations in this area of service has been outlined. The INASC report highlights 'major gaps' in the provision of multi-disciplinary services for people with stroke in the community (Irish Heart Foundation, 2008: 52). The cost of providing the Irish Heart Foundation's recommended level of staffing for community rehabilitation has been estimated at €37 million (staff cost plus overheads, see Appendix 3). This would bring the cost of community rehabilitation up from 1 per cent to between 4–7 per cent of total annual stroke costs in 2007.[59] This is a partial cost estimate. A change in community rehabilitation, and the projected costs, cannot be assessed in isolation from the rest of the system. Further analysis would be required to determine the knock-on implications for other levels of stroke care, and the associated cost implications. More detailed and nationally representative data on community health care services in Ireland are required to determine how resources are being allocated to identify and address the gaps in service provision.

[58] A review of studies on the numbers needed to treat (NNT) with cardiac interventions to prevent stroke.

[59] It is noted that, as the focus in this study is on the cost of the projected service, further consideration of supply side feasibility, operational and other implementation issues are not discussed.

The complexities in estimating the indirect costs of stroke or other illness were outlined in the methodology. The human capital approach is likely to overestimate the value of productivity foregone due to stroke morbidity and mortality because it doesn't take into account the possibility of replacing the worker. This study controls for overestimation by focusing on the value of productivity foregone within one year. This differs from the approach adopted in other cost of illness studies where, if an individual in paid work dies prematurely, the total cost of productivity foregone is calculated as: the value of the total amount of work foregone between the age of death and the average age of retirement (i.e., 65 minus age at death). By focusing only on productivity foregone in one year, the study avoids overestimating productivity foregone in future years, and estimates the frictional period is a maximum of one year.

Consistent with other cost of stroke studies (e.g., Navarrete-Navarro et al., 2007), there is no value attached to leisure time lost due to stroke morbidity or mortality. This has implications for comparing the indirect costs of stroke with those of other illnesses. The proportion of people in paid work declines in older age groups (i.e., 65+) and stroke affects a relatively high proportion of older age groups (more than 65 per cent are estimated to be aged 65+ in Ireland in 2007). Using a method that attaches a value to time lost from paid work and domestic work, the value of productivity lost due to stroke morbidity and mortality will be lower than for an illness that affects a younger (and more economically active) age cohort. Thus, caution is required when comparing indirect costs across different illnesses in the absence of data that allows a willingness to pay approach (i.e., attaches value to all time foregone due to illness/mortality).

However, in the estimation of informal care costs, a value is attached to the amount of time lost from both leisure and paid work due to informal caregiving by the caregiver. This is consistent with the approach adopted in the literature but highlights an inconsistency in how the time of caregivers and stroke patients are valued. A value is attached to leisure time lost by caregivers,[60] but no value is attached to leisure time lost due to illness/mortality for the stroke patient. This is consistent with the observation that, in the absence of informal caregiving, some degree of formal care would be needed as a replacement (regardless of whether that informal care was provided at a cost of paid work or leisure time), with a cost attached.

Despite uncertainties around the methodology, inclusion of indirect costs is important given the chronic nature of the disease. For informal care, this study used two estimates of the average number of hours of informal care provided per week to stroke patients in Ireland. The amount of informal care provided has

[60] It is further noted that domestic work is not identified separately from economically inactive time in this study.

been found to vary with the functional status of the patient and other factors (Tooth et al., 2005). The results from this study underline the importance of further data collection in this area to identify an accurate picture of the burden of stroke care taken up by informal carers in the Irish context.

The costs included in this study do not cover all the services used by stroke patients. Transport costs have not been included and yet they are an important cost for stroke patients and their carers. Many other cost of stroke studies have also omitted transport costs and, where they have been included, they are estimated to account for approximately 1 per cent of total stroke costs (e.g., Rossnagel et al., 2005). Their inclusion would not be expected to affect the cost estimates for Ireland by a large amount (although they may have important distribution implications).

The breakdown of stroke/TIA costs by age and sex is available for some of the individual cost elements but not for all. Further analysis of the differential costs by age is needed, particularly in light of the findings from the recent national stroke audit regarding unavailability of rehabilitation services for stroke patients under the age of 65 years (Irish Heart Foundation, 2008). The breakdown of stroke costs by type of stroke (i.e., intracerebral haemorrhage, cerebral infarction, etc.) is also important. This has not been undertaken in this study but there is evidence that the long-term costs of ischaemic stroke are higher than those of intracerebral haemorrhage (although costs in the first year after stroke are higher for intracerebral haemorrhage, Cadilhac et al., 2009).

Sensitivity analysis

This study examines the sensitivity of stroke costs to changes in stroke prevalence, incidence, and individual cost parameters. Changes in parameters for acute hospital, in-patient rehabilitation and indirect costs can have relatively large impacts on the individual cost elements, and increase total costs by more than 20 per cent. Shifts in incidence (12–13 per cent above and below baseline rates) have less than 5 per cent impact on total stroke costs. Total stroke costs are most sensitive to estimated prevalence (increase in 65 per cent from low to high prevalence), although this is partly explained by the larger gap between the lower and higher estimates of stroke prevalence than between the lower and upper estimates of incidence. While more accurate data on stroke prevalence will refine this sensitivity analysis, the relatively large impact of a change in stroke prevalence on total stroke costs is consistent with findings in the literature. Saka et al. (2009a) observed that this reflects the fact that stroke is a chronic disease (i.e., requiring ongoing care beyond the acute phase).

Future cost estimates

The implication of an increase in the number of older age people for stroke costs is noted in a number of studies (e.g., Dewey et al., 2001; Rossnagel et al., 2005; Saka et al., 2009a). In Ireland in 2007, 11 per cent of the population were aged 65 and older and this cohort accounts for 67–68 per cent of total stroke prevalence. By 2021, the proportion of the population aged 65 and older is projected to increase to 15 per cent (Layte et al., 2009).

Even without any change in stroke incidence, the total number of stroke cases is projected to rise by 58 per cent from 2007 to 2021, compared with an overall increase in the population of less than 20 per cent. The estimates presented in this study indicate that the number of stroke cases could increase by 89–90 per cent if changes in stroke epidemiology are taken into account. Data on projected changes in stroke incidence and prevalence are preliminary and these results are to be treated with caution. Further investigation of changes in stroke prevalence are reported by Balanda et al. (2010). The magnitude of the increase in total stroke costs between 2007 and 2021 (more than 50 per cent increase due to demographic change, more than 80 per cent increase due to demographic plus epidemiological change) almost fully reflects the size of the estimated increase in total stroke prevalence.

However, it is important to note that these future cost estimates do not take into account any changes in stroke service provision. The need for reform of stroke services in Ireland has been well documented (O'Neill, 1999; O'Neill et al., 2000; McCormack et al., 2000; Irish Heart Foundation, 2008, 2009). Recommendations for reform include: 24-hour availability of specialists trained in thrombolysis, development of stroke units, processes for early supported discharge from hospital, and ongoing support and rehabilitation from community teams (Irish Heart Foundation, 2008). Measures to ensure better detection and management of primary and secondary risk factors for stroke in primary care are also required, in particular the proactive management of atrial fibrillation (Irish Heart Foundation, 2008) and hypertension.

There are both outcome and cost implications of changing the way in which stroke services are provided. Additional analysis in Appendix 3 focuses on the impacts of four key stroke care interventions, namely, better management of atrial fibrillation, improved access to thrombolytic therapy, increased availability of organised stroke unit care, and improved community rehabilitation. Atrial fibrillation involves disordered electrical activity in the atria and leads to irregular and rapid contraction of the ventricles (Abcede and Obviagele, 2010). Treatment of atrial fibrillation with anticoagulation (e.g., warfarin) has important benefits in terms of reduced incidence of strokes in these patients. For patients who have suffered acute ischaemic stroke, where an artery in the brain is blocked by a

blood clot, thrombolytic therapy can restore blood flow to the brain before major brain damage occurs. Stroke units are services where 'the acute and rehabilitation care of the patient with stroke is under the direct care of a specialist with training and expertise in stroke management, in conjunction with a dedicated interdisciplinary team' (O'Neill et al., 2000: 8).

A review of international evidence highlights the benefits of these stroke service interventions in terms of improved outcomes (e.g., reduced disability, deaths averted). The interventions also have cost implications and these have been examined in a number of international studies, usually with the primary objective of identifying their cost-effectiveness. It is recognised that while cost-effectiveness is an important goal in health care, it is not the only driver in the development of a societal response to the care needs of those with illness. The drive for, and major investment in, improved cancer services in Ireland has not been driven by cost-effectiveness, but rather by a recognition that better care was both possible and an important societal and individual benefit. The need for better preventive, assessment, management and support services for stroke should not be constrained within the confines of discussions of cost and cost-effectiveness, but can also be driven by the same principles that have underpinned developments in cancer and heart disease.

Drawing on available international evidence, and on the data compiled for this study, analysis in Appendix 3 examines the potential benefits and costs of implementing these key stroke care interventions in the Irish health care system. The interventions are analysed separately, although in practice they may be rolled out concurrently and the total impact is not a linear sum of the positive outcomes from each intervention.

In terms of benefits, it is estimated that 70 first-ever strokes in Ireland could be avoided in one year where 10 per cent of patients with atrial fibrillation are adequately treated with warfarin. This estimate could increase to 350 where warfarin treatment is available to 50 per cent of patients with atrial fibrillation. For thrombolysis, analysis indicates the potential to avert between 38 and 102 deaths/dependent outcomes in Ireland in one year with a thrombolysis rate of 20 per cent (based on 2007 stroke incidence data). It is important to note that these are underestimates as the potential number of deaths/dependent cases averted is greater the earlier thrombolysis is administered following the onset of stroke symptoms. For stroke unit care, an estimated 175–655 deaths/institutionalised cases could be avoided in Ireland in one year if 95 per cent of incident stroke patients were treated in a stroke unit (based on 2007 incidence data). Analysis in Appendix 3 also examines the potential number deaths/dependent cases averted if patients who had their stroke prior to 2007 (i.e., net prevalent stroke cases) had

been given access to thrombolytic therapy (where clinically appropriate) and stroke unit care during their acute phase of care (see Appendix 3).

In terms of costs, the key staff costs required to deliver a network based stroke service (in line with the recommendations of the new Cardiovascular Health Policy, DOHC, 2010) are estimated, drawing on international guidelines for staff and non-staff inputs into a best practice stroke service. Using Irish data, staff costs per network are estimated for specialist consultant services, thrombolysis, acute stroke units, and community rehabilitation (see Appendix 3 for further details). The focus is on total, rather than additional, staffing requirements and it is important to note that the incremental cost would need to take into account the potential for redeployment of existing staff.

Apart from the costs of implementation, at the aggregate level, changes to stroke service provision have a number of implications for the total economic burden of stroke, some of which increase the burden and others which reduce it. For example, an increase in the number of stroke patients who survive has conflicting impacts on the overall costs of stroke. A greater number of people living with the consequences of stroke (and requiring rehabilitation, GP visits, medication, etc.), will have an upward influence on aggregate direct costs. A reduction in the number of stroke patients requiring long-term nursing home care puts downward pressure on the total cost of stroke. Examining possible sources of short- and long-term cost savings that accrue from changing the way in which stroke services are delivered can help to put the implementation costs (e.g., staff costs) into perspective. The potential for long-term cost savings in connection with these changes in stroke services provision in the Irish context are also assessed in Appendix 3. While the analysis is hypothetical and partial there are indications that, at the aggregate level, there are potential cost savings that accrue from there being a higher number of stroke patients residing at home following their stroke rather than in a nursing home. Moreover, these cost savings may offset, or potentially more than offset, the costs associated with introducing the stroke service interventions, and this is before a ‘value’ is attached to the positive outcomes of fewer deaths and better quality of life for stroke survivors.

5 CONCLUSIONS

This study has estimated the total economic cost of stroke and TIA in Ireland in the year 2007. Conservative estimates indicate that total direct and indirect stroke costs in 2007 were between €489 and €805 million (i.e., at baseline incidence rates and low estimates of hospital, rehabilitation, and indirect costs). Total estimated direct expenditure on stroke accounted for between 2–4 per cent of total health expenditure and 0.2–0.3 per cent of GNP in Ireland in 2007. This is in line with international estimates of the cost of stroke. The mean direct cost per stroke patient for incident cases in the first year of stroke was approximately €18,751 at baseline incidence rates, equivalent to 50 per cent of GNP per capita. The total cost of TIA in Ireland in 2007 is estimated to be €11 million, the majority of which is accounted for by hospital costs. The mean TIA cost per case of €4,925 is less than 30 per cent of the mean total per patient stroke cost, consistent with international evidence.

Public resources account for the majority of direct expenditure on stroke and TIA services. However, out-of-pocket payments are required for approximately 25 per cent of the costs of stroke-related drugs, nursing home and GP care, with implications for equity and efficiency in stroke service resource allocation.

There are a number of data limitations that need to be addressed and these have been outlined. In particular, data gaps on the provision of services for stroke patients outside of the hospital setting (e.g. community rehabilitation) are highlighted.

Sensitivity analysis examines the implications for total stroke costs of adjustments in stroke incidence and prevalence, costing methods, and cost parameters. Under these alternative scenarios, the full range of total stroke costs in Ireland in 2007 was €470–€1,008 million.

This study has also examined future cost implications. Demographic change alone could lead to an increase in total stroke costs of more than 50 per cent by 2021 and changes in stroke epidemiology could increase this cost further. Introducing changes to stroke service provision will have important implications for costs. A review of available literature indicates that there are potential cost savings, particularly in long-term care, from a number of interventions. Further data are required in the Irish context to examine supply side and cost implications in more detail.

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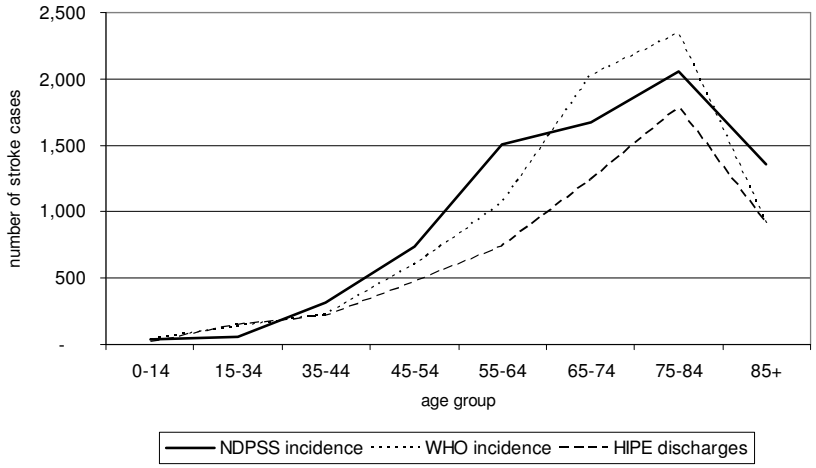
APPENDIX 1 EPIDEMIOLOGICAL DATA

A1.1 STROKE INCIDENCE

Detailed estimates of stroke incidence disaggregated by age and sex are available from the World Health Organization (WHO), the North Dublin Population Stroke Study (NDPSS) and the Hospital In-patient Enquiry (HIPE).

Figure A.1 outlines the estimated incidence from these three data sources. Age and sex specific incidence rates estimated by WHO and NDPSS are applied to the 2007 population. HIPE discharges include all in-patient discharges with a principal diagnosis of I60/I61/I63/I64 (ICD-10-AM classification) in 2007 (excluding duplicates[61]). Discrepancies between the different sources of incidence rates are more apparent at older age groups. The total number of stroke cases estimated using these three sources varies from 5,514 (HIPE excluding duplicates) to 7,340 (WHO) to 7,735 (NDPSS including recurrent stroke cases).

FIGURE A.1
Estimated number of incident stroke cases using NDPSS, WHO and HIPE data, 2007



This study adopts the NDPSS rates to estimate stroke incidence in Ireland in 2007. The NDPSS followed internationally recommended methods for measuring incidence and provides the most recent and Irish specific estimates of incidence. WHO estimates of acute stroke incidence are generated for the Global Burden of Disease project (Truelsen et al., 2005, Truelsen et al., 2006). The estimates are

[61] As far as possible, patient level data are identified by excluding duplicate cases but it is emphasised that this method is not 100 per cent accurate without a unique health identifier (duplicates are identified on patient record number, date of birth and sex).

based on mortality data and assume an equal 28 day case fatality rate (20 per cent) across most European countries, including Ireland.

Analysis of available census-based data indicates that the demographic and socioeconomic profile of North Dublin City is different to the national profile (e.g., higher level of deprivation, higher proportion of 20–29 and 65–84 age groups[62]). These data suggest the need for some adjustment of NDPSS incidence rates. As noted in the literature, caution is required when extrapolating local incidence rates to wider populations (Dewey et al., 2001, Truelsen et al., 2006). Sensitivity analysis adopts incidence rates at the upper and lower bounds of the 95 per cent confidence interval around the baseline.

The divergence between HIPE records of stroke cases and estimates of stroke incidence using NDPSS or WHO rates needs explanation. HIPE records are an underestimate of stroke incidence for a number of reasons:

- A proportion of stroke patients are treated at home without attending hospital. Others attend a hospital emergency department (ED) without being admitted (e.g., die in the ED) and others attend hospitals not included in the HIPE scheme.
- Where a patient has multiple morbidities, the principal diagnosis can be one of a number of conditions and stroke may be listed as a secondary diagnosis. Figure A.1 is based on discharges where stroke is recorded as the principal diagnosis.
- There are also difficulties in diagnosing stroke and there is anecdotal evidence of both undercounting and overcounting the number of stroke cases due to problems of misdiagnosis.

A1.2 TIA INCIDENCE

Estimates of TIA incidence are available from the NDPSS and from HIPE records. Applying the age and sex specific NDPSS TIA incidence rates to the 2007 population gives a total number of 1,799 cases. This is lower than the number of discharges with a principal diagnosis of G45.0/G45.2/G45.3/G45.9 recorded in HIPE in 2007 (excluding duplicates). This study estimates the hospital and drug costs for the number of TIA patients identified in HIPE recorded data.

Tables A.1 and A.2 present the estimated incidence of stroke (including recurrent stroke) and TIA in Ireland in 2007, disaggregated by age and sex.

[62] Analysis based on the national deprivation index (Kelly and Teljeur, 2007) and census data (Central Statistics Office, 2009b).

TABLE A.1[63]

Estimated incidence of stroke, Ireland, 2007 (Number)

Age group	NDPSS Lower CI (95%)			NDPSS Baseline			NDPSS Upper CI (95%)		
	No.			No.			No.		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
0–14	0	9	9	5	30	35	32	66	97
15–34	0	15	15	7	48	55	82	138	220
35–44	109	34	143	207	107	314	434	288	722
45–54	222	226	448	359	376	735	610	636	1,247
55–64	636	426	1,062	868	642	1,511	1,207	954	2,161
65–74	737	463	1,200	1,001	669	1,669	1,345	942	2,287
75–84	687	832	1,519	956	1,104	2,060	1,302	1,445	2,748
85+	377	517	894	609	746	1,355	946	1,063	2,009
Total	2,768	2,522	5,290	4,012	3,723	7,735	5,959	5,533	11,491

TABLE A.2

Estimated incidence of TIA, Ireland, 2007 (Number)

Age group	TIA incidence		
	No.		
	Male	Female	Total
0–14	-	1	1
15–34	15	14	29
35–44	36	30	66
45–54	98	74	172
55–64	208	163	371
65–74	307	269	576
75–84	343	408	751
85+	80	201	281
Total	1,087	1,160	2,247

A1.3 PREVALENCE

This study draws on available data to generate up-to-date and Irish specific estimates of stroke prevalence. A number of surveys include questions on stroke. To estimate acute stroke prevalence for Ireland, it is important for available data to meet as many of the following criteria as possible:

- disaggregated by age and sex
- all age groups
- individual-based survey (i.e., not household level)
- ever had a stroke (not just stroke in last year)
- Irish-based.

Table A.3 outlines the adherence of a range of surveys to the above criteria. The QNHS meets all but one (age 18+ only) of the criteria.

[63] Figures and percentages are subject to rounding in the appendices tables.

TABLE A.3
Description of available survey data on stroke prevalence

Survey	Year of data available	Age/sex breakdown	All age groups	Individual-based survey	Irish sample	Lifetime diagnosis (i.e., no time period restriction)
SLAN[a]	2007	yes	no (18+)	yes	yes	no (Have you had […] in the last 12 months ...)
QNHS Health Module[b]	2001 & 2007	yes	no (18+)	yes	yes	yes (Has your doctor ever diagnosed you …)
HARP[c]	2004	yes	no (65+)	yes	yes	yes (Have you had a stroke …)
HESSOP[d]	2000	yes	no (65+)	yes	Restricted sample (West and East)	
England Health Survey	2006	yes	yes	yes	no	yes (Have you ever had …)

Notes: [a] Survey of Lifestyle, Attitudes and Nutrition
[b] Quarterly National Household Survey
[c] Healthy Ageing Research Programme
[d] Health and Social Services for Older People

Table A.4 presents a range of available estimates of stroke prevalence in Ireland, based on prevalence rates applied to the 2007 population. Partial estimates of stroke prevalence are available in health-focused surveys, including the Survey of Lifestyle, Attitudes and Nutrition (SLAN), and the Health Module of the Quarterly National Household Survey (QNHS). These surveys exclude individuals living in institutions (e.g., nursing homes) and thus provide underestimates of stroke prevalence. The WHO estimated stroke prevalence rates for Ireland as part of the Global Burden of Disease project as for the incidence rates above. Prevalence estimates based on the rates from the Auckland Stroke Studies[64] and from the recent work published by the Institute of Public Health are also included.[65]

TABLE A.4
Estimates of stroke prevalence in Ireland, 2007[a]

	QNHS 2007	QNHS 2001	SLAN 2007	Auckland Stroke Study	WHO	Institute of Public Health (England Health Survey)[c]
Total acute stroke prevalence	22,581[b]	24,747	27,029	37,899	46,873	58,778

Notes: [a] Prevalence rates are applied to 2007 population numbers and aggregated to give estimated total prevalence. Where available, the prevalence rates are separated for males and females and stratified by age group.
[b] Microdata were not available for the 2007 QNHS health module at the time of analysis.
[c] Age 16 and older

[64] The INASC reported 30,000 survivors of stroke in Ireland (Irish Heart Foundation, 2008). This estimate is based on prevalence rates from the Auckland Stroke Studies (Bonita et al., 1997) applied to the Irish population in the late 1990s.

[65] As part of a project on the prevalence of hypertension, ischaemic heart disease and stroke prevalence in Ireland published by the Institute of Public Health, risk factors for stroke have been identified based on the England Health Survey and applied to risk factor data in the Republic of Ireland (see Balanda et al., 2010).

The QNHS Health Module asks if the respondent has ever had/been diagnosed with stroke, while the SLAN survey only focuses on the occurrence of a stroke in the past 12 months. However, total prevalence estimated using the SLAN data is higher than that using either of the QNHS modules. The 2001 QNHS estimate (which is based on age and sex specific rates) is selected as a mid-range estimate between that based on the 2007 SLAN survey and the 2007 QNHS survey.

To take into account the prevalence of stroke in long-term institutions, adjustment of the QNHS estimates is required. Discharge status of patients in the NDPSS at 90 days post-stroke is used to estimate the proportion of acute stroke cases living at home and in a nursing home. Approximately 12–13 per cent (varies by age and sex) of total stroke cases are estimated to reside in a nursing home. Estimates of prevalence based on the 2001 QNHS survey are factored up by 12–13 per cent to take into account stroke cases living in long-term institutions.

This gives an estimated prevalence of acute stroke in Ireland in 2007 of 28,330. Of this total, the estimated nursing home stroke population is 3,477. This is consistent with an alternative method for estimating the number of stroke patients living in nursing homes based on the INASC nursing home survey (3,613).[66]

For sensitivity analysis, a higher estimate of prevalence is also adopted. The case fatality rates assumed for the WHO estimates is consistent with acute stroke death rates recorded in HIPE and in the NDPSS.[67] The WHO prevalence rates give an estimated prevalence of acute stroke in Ireland in 2007 of 46,873 (of which 6,004 are estimated to live in nursing homes). This also provides a mid-range estimate amongst the three higher prevalence estimates outlined in Table A.4 (i.e., rates based on the Auckland Stroke Study, the WHO, and the Institute of Public Health).

Table A.5 presents the low and high estimates of stroke prevalence in Ireland, based on the 2007 population, disaggregated by age and sex.

[66] The INASC nursing home survey identified the proportion of stroke patients in public (22 per cent) and private (12 per cent) nursing homes. These proportions are applied to recent estimates of the nursing home population from the Dept. of Health and Children, giving a total of 3,613 stroke patients living in nursing homes.

[67] INASC clinical audit: 17 per cent of cases dead at 30 days. NDPSS: 16 per cent dead at 28 days. HIPE discharges 2007: 17 per cent of stroke discharges dead.

TABLE A.5
Estimated prevalence of stroke, Ireland, 2007 (Number)

Age group	Low prevalence (QNHS/NDPSS)			High prevalence (WHO prevalence)		
	No.			No.		
	Male	Female	Total	Male	Female	Total
0–14	12	12	24	12	12	24
15–34	82	92	174	329	496	825
35–44	228	316	544	520	793	1,313
45–54	1,988	1,111	3,099	2,543	2,765	5,308
55–64	3,543	1,689	5,232	4,530	3,537	8,067
65–74	4,843	4,779	9,622	6,802	6,439	13,241
75–84	2,591	4,331	6,922	5,590	7,516	13,106
85+	797	1,917	2,714	1,620	3,369	4,989
Total	14,084	14,247	28,330	21,947	24,927	46,873

APPENDIX 2 SENSITIVITY ANALYSIS AROUND INCIDENCE RATES AND COST PARAMETERS

A2.1 LOW AND HIGH PREVALENCE

The cost estimates outlined in section 3 (Results) are presented for low and high rates of stroke prevalence, holding stroke incidence constant at the baseline level. Total costs of stroke based on the high level of stroke prevalence are 65 per cent larger than those based on the low level of stroke prevalence (at baseline incidence).

A2.2 INCIDENCE SCENARIOS (LOWER, BASELINE, UPPER)

Table A.6 presents total direct and indirect costs for incident stroke cases for each of the three incidence scenarios (i.e., baseline, upper and lower boundaries of the 95 per cent confidence interval). Total direct costs for incident cases range from €130 million at the lower boundary to €147 million at the baseline to €171 million at the upper boundary. Total indirect costs for incident cases range from €18 to €32 million from the lower to the upper boundary of the 95 confidence interval.

Total stroke incidence increases by 49 per cent from the baseline to the upper boundary of the 95 per cent confidence interval, and falls by 32 per cent from the baseline to the lower boundary of the confidence interval. The costs of nursing home and ambulatory care, drugs, aids, appliances, home modifications, and informal care change by similar magnitudes from the baseline to the upper and lower incidence boundaries. The shift in total incidence costs across the scenarios is smaller. Total incidence costs at the upper bound of the 95 per cent confidence interval are 17 per cent higher than those at the baseline. At the lower bound of the confidence interval the total incidence costs are 15 per cent lower than at the baseline.

TABLE A.6
Variation in total incident costs, stroke patients, 2007 (€000 and %)

Cost element	Incidence at lower CI		Incidence at baseline		Incidence at upper CI	
	€000	Proportion of baseline	€000	Proportion of baseline	€000	Proportion of baseline
Direct costs						
Acute hospital care[a]	70,170	1.0	70,798	1.0	71,782	1.0
In-patient rehabilitation	16,167	1.0	16,167	1.0	16,167	1.0
Nursing home care	31,690	0.7	43,957	1.0	62,887	1.4
GP care	669	0.7	977	1.0	1,468	1.5
OPD care	718	0.7	1,086	1.0	1,663	1.5
Drugs	815	0.6	1,259	1.0	1,917	1.5
Community rehabilitation[b]	6,355	1.0	6,355	1.0	6,355	1.0
Aids, appliances, home modifications	3,837	0.6	5,919	1.0	9,192	1.6
Voluntary agency services	-		-		-	
Total direct costs	130,421	0.9	146,519	1.0	171,430	1.2
Indirect costs						
Informal care[c]	3,588	0.6	5,549	1.0	8,390	1.5
Productivity loss from morbidity and mortality[d]	14,779	0.7	22,041	1.0	23,261	1.1
Total indirect costs	18,367	0.7	27,590	1.0	31,651	1.1
Total incident cost of stroke care	**148,788**	**0.85**	**174,108**	**1.0**	**203,081**	**1.17**

Notes:
[a] Costs based on the casemix methodology.
[b] Cost based on adjusted occupational therapy provision.
[c] Cost based on the low estimate of number of informal care hours.
[d] Cost based on the low estimate of number of patients stopping work due to illness.

For a given estimate of stroke prevalence in Ireland, changes in the number of incident cases will give rise to changes in the number of net prevalent cases. Thus, net prevalent costs and total costs will also change across the different incidence scenarios. These variations are presented in Table A.7, for both low and high prevalence. For a given level of stroke prevalence, total stroke costs change by between 2 per cent and 4 per cent from baseline incidence to incidence at the upper or lower boundary of the 95 per cent confidence interval.

A2.3 CHANGING COST PARAMETERS

Sensitivity to changes in parameters for three individual cost elements is also examined:

- Acute hospital and in-patient rehabilitation costs for stroke and TIA patients have been presented for two methodologies (i.e., cost per bed day and casemix). Total acute hospital costs for stroke patients based on the cost per bed day methodology are 35 per cent higher than those based on the casemix method.
- The cost of informal care for stroke patients depends on the number of hours of informal care provided to stroke patients. Increasing the average number of

informal care hours from 9 hours per week to 20 hours per week leads to a 122 per cent rise in total informal care costs.

- Increasing the percentage of stroke patients giving up paid work due to ill health from 47 per cent to 65 per cent leads to a 29–31 per cent rise in productivity foregone due to stroke morbidity.

Table A.7 presents total stroke costs incorporating the low and high estimates of these hospital, rehabilitation and indirect cost elements. Incorporating the higher cost estimates for acute hospital and in-patient rehabilitation care, informal care, and productivity foregone due to morbidity, leads to an overall increase of 22–24 per cent in total stroke costs (for all prevalence and incidence scenarios).

A2.4 FULL VARIATION IN TOTAL STROKE COSTS

As outlined in Table A.7, at low prevalence, the full range[68] of stroke costs in 2007 across the different incidence scenarios, and across the low and high estimates for acute hospital, in-patient rehabilitation, and indirect costs, is between €470 and €625 million (a percentage difference of 33 per cent). At high prevalence, the full range of total stroke costs in 2007 is between €783 and €1,008 million (a percentage difference of 29 per cent). The percentage difference between the lowest cost estimate at the low prevalence scenario and the highest cost estimate at the high prevalence scenario is 115 per cent.

TABLE A.7
Variation in total costs, stroke patients, 2007 (€000 and %)[69]

Cost element	Low prevalence			High prevalence		
	Incidence at lower CI	Incidence at baseline	Incidence at upper CI	Incidence at lower CI	Incidence at baseline	Incidence at upper CI
	€000	€000	€000	€000	€000	€000
Low hospital, rehabilitation and indirect estimates						
Incident costs	150,217	174,374	204,092	148,788	174,108	203,081
Net prevalent costs	355,499	314,349	265,589	674,553	631,106	580,250
Total cost of stroke care	505,717	488,723	469,681	823,341	805,214	783,331
High hospital, rehabilitation and indirect estimates						
Incident costs	187,852	215,739	250,519	186,532	215,732	248,158
Net prevalent costs	437,209	387,538	327,256	821,780	769,492	711,463
Total cost of stroke care	625,061	603,276	577,775	1,008,312	985,224	959,621

[68] A range of other cost scenarios could be presented (e.g., low estimate of acute hospital and in-patient rehabilitation costs combined with high estimate of informal care costs, etc.). Future analysis of available data (e.g., informal care for stroke patients in Ireland) can help to identify the most appropriate parameters for these cost elements.

[69] Variations in incidence costs between the low and high prevalence scenarios are due to rounding issues (e.g., total incidence costs at baseline incidence rates should be the same under the low and high prevalence scenarios).

APPENDIX 3 CHANGES TO STROKE SERVICES: IMPLICATIONS FOR OUTCOMES AND COSTS

A3.1 INTRODUCTION

The need for reform of stroke services in Ireland has been well documented (O'Neill, 1999; O'Neill et al., 2000; McCormack et al., 2000; Irish Heart Foundation, 2008, 2009). Recommendations for reform include 24-hour availability of specialists trained in thrombolysis, development of stroke units, processes for early supported discharge from hospital, ongoing support and rehabilitation from community teams (Irish Heart Foundation, 2008). Measures to ensure better detection and management of primary and secondary risk factors for stroke in primary care are also required, in particular the proactive management of atrial fibrillation (Irish Heart Foundation, 2008) and hypertension.

There are both outcome and cost implications of changing the way in which stroke services are provided. Drawing on available international evidence, and on the data compiled for this study, the objectives of this analysis are to examine what are the potential benefits, and what are the potential costs, if some of these changes were implemented in the Irish health care system. The potential for cost savings in the Irish context are also assessed. The analysis focuses on the following key interventions: improvement of stroke prevention via management of atrial fibrillation, improved access to thrombolytic therapy, increased availability of organised stroke unit care, and improvement in community rehabilitation services.

Section A3.2 summarises international evidence on the benefits and costs of selected interventions. Section A3.3 shifts the focus to Ireland, examining the potential for improved outcomes if three key changes to stroke service provision were implemented. The potential staff costs associated with comprehensive stroke services in the Irish setting are presented in section A3.4, the potential for long-term cost savings is discussed in section A3.5, and section A3.6 concludes.

A3.2 BENEFITS AND COSTS OF SELECTED INTERVENTIONS

A3.2.1 Improved outcomes – international evidence

A number of studies have demonstrated the benefits of selected stroke service interventions in terms of improved outcomes (e.g., reduced disability, deaths averted). This section focuses on three interventions: one stroke preventive measure (anticoagulation treatment for patients with atrial fibrillation), and two treatment interventions aimed at mitigating the impact of stroke (thrombolytic therapy for ischaemic stroke cases and stroke units for all stroke cases).

Atrial fibrillation involves disordered electrical activity in the atria and leads to irregular and rapid contraction of the ventricles (Abcede and Obviagele, 2010). The prevalence of atrial fibrillation has been estimated to be about 1 per cent of the population (Miller et al., 2005) although this increases in older age groups, affecting over 5 per cent of persons aged 65 and older (Teng et al., 2000; Miller et al., 2005). Treatment of atrial fibrillation has important benefits in terms of reduced incidence of strokes in these patients. Controlling for other risk factors, atrial fibrillation alone is associated with a 300–400 per cent increased risk of stroke and has also been found to result in more severe strokes (Abcede and Obviagele, 2010). A review of a number of studies found that stroke in patients with atrial fibrillation is associated with more severe or fatal outcomes, longer in-patient hospital stays, greater dependency, and a higher level of institutionalisation following stroke (Miller et al., 2005). Anticoagulation treatment for patients with atrial fibrillation has been found to yield a 67–80 per cent reduction in the risk of stroke (Miller et al., 2005). Warfarin is an oral anticoagulation treatment that has been observed to reduce the risk of stroke by more than 60 per cent in patients with atrial fibrillation from 12 per cent to 4 per cent per year in secondary prevention and from 4 per cent to 1.5 per cent per year in primary prevention (Sulch, 1997). Similarly, Teng et al. (2000) report analysis showing warfarin is associated with an absolute risk reduction of stroke of 8.4 per cent for secondary prevention and 2.7 per cent for primary prevention.

For patients who have suffered acute ischaemic stroke, where an artery in the brain is blocked by a blood clot, thrombolytic therapy can restore blood flow to the brain before major brain damage occurs. However, there are risks attached to thrombolytic drugs that can cause serious bleeding in the brain, which can be fatal. A Cochrane systematic review identified that thrombolytic treatment can reduce the risk of disability, despite the bleeding risks (Wardlaw et al., 2009). In a comparison of the impact of any thrombolytic agent versus a control group, available randomised controlled trials indicate that the probability of death/dependent cases is 50.9 per cent in the 'thrombolysis' group compared with 55.8 per cent of the control group ($p<0.0001$) (Wardlaw et al., 2009), a difference of 4.9 per cent (i.e., number needed to treat to avoid death/dependency: 20). Lees et al. (2010) examined the impact of time to treatment on the effectiveness of treatment with intravenous recombinant tissue plasmogen activator (rt-PA). Results indicate the number needed to treat (NNT) to achieve an excellent outcome (i.e., modified Rankin score 0–1 versus 2–6)[70] ranges from 5 when treatment is within 0–90 minutes of symptom onset, to 15 within the 181–270 minute window (Lees et al., 2010). Stroke causes a wide range of functional impairment and disability and stroke outcomes are often measured using ordinal scales (e.g., modified Rankin Scale). Lansberg et al. (2009)

[70] The modified Rankin scale ranges from 0 (no symptoms) to 6 (dead).

adopted a method to determine the NNT for one patient to experience a benefit across the entire range of ordinal outcome scales used in six major randomised acute stroke trials of intravenous tissue plasmogen activator (tPA). Results indicate that, up to 4.5 hours after symptom onset, the number of patients that benefit from thrombolytic treatment outweighs the number harmed. For patients treated within the 181–270 minute window, one patient benefits for every 7.4 patients treated with tPA (Lansberg et al., 2009).

For all stroke patients, acute care in stroke units can lead to improved outcomes. Stroke units are services where 'the acute and rehabilitation care of the patient with stroke is under the direct care of a specialist with training and expertise in stroke management, in conjunction with a dedicated interdisciplinary team' (O'Neill et al., 2000: 8). A Cochrane systematic review of randomised controlled trials found that patients in receipt of organised in-patient stroke unit care are more likely to survive their stroke, return home, and become independent in looking after themselves (Stroke Unit Trialists' Collaboration, 2009). Estimates of the NNT to avoid death or dependency range from 10 to 25, and the NNT to avoid death or institutionalisation ranges from 8 to 30 (Stroke Unit Trialists' Collaboration, 1997).

A3.2.2 Cost implications – international evidence

There are also cost implications of these interventions and these have been examined in a number of international studies, usually with the primary objective of identifying their cost-effectiveness.

Management of warfarin treatment is complex and there are risks when patients are not adequately monitored (Walker and Bennett 2008). For warfarin to be effective, patients must be maintained within a specific therapeutic range which requires frequent monitoring and dose adjustment. While the medication cost may be relatively low, the costs of monitoring could be quite expensive (Bjorholt et al., 2007). Thus, despite the benefits of warfarin in reducing the risk of stroke in patients with atrial fibrillation, it has been found to be underutilised in real-world settings (Walker and Bennett, 2008). Reviews of cost-effectiveness studies indicate that warfarin has been found to be cost-effective and in some cases cost saving (Teng et al., 2000, Miller et al., 2005). Teng et al. (2000) raise some concerns that the benefits of warfarin observed in a clinical trial setting are not replicable in a real-world setting. However, Miller et al. (2005) suggest that the cost-effectiveness of anticoagulation therapy might be greater than currently estimated. As discussed above, stroke in patients with atrial fibrillation (AF) is associated with worse outcomes than with non-AF related strokes (i.e., greater severity, higher recurrence, higher dependency, etc.). As this could give rise to higher costs in AF related strokes, the potential cost saving from avoiding these AF related strokes may be greater than currently estimated.

Treatment with thrombolysis has the potential to reduce costs on a per patient basis. As identified by Moodie et al. (2004), thrombolytic therapy can raise the costs of stroke care in the first year post-stroke due to increased acute in-patient costs, although these can be partly offset by reductions in in-patient rehabilitation and nursing home costs. Yip and Demaerschalk (2007) found that health care costs for stroke patients who have been treated with thrombolysis were lower relative to those who were untreated, mainly because of a reduced need for long-term care and rehabilitation following thrombolysis. One study in Canada estimated that CAN$678 in medical care is saved per patient in their first year after receiving thrombolysis. Yip and Demaerschalk (2007) use this estimate to calculate aggregated national cost savings in one year, at varying rates of thrombolysis cover. Results indicate that if 20 per cent of all incident ischaemic stroke patients in the country received thrombolytic therapy, more than CAN$7.5 million could be saved in the first year. Using data from the UK, Sandercock et al. (2004) found that thrombolysis could cost £13,581 (€21,520)[71] per quality-adjusted life year (QALY) gained in the first year post-stroke (acceptably below the threshold for cost-effectiveness in the UK of £30,000/<€44,000), while over the patient's lifetime it could save £96,565 (€155,349) (due to lower levels of long-term care associated with reduced disability) per QALY gained relative to a standard treatment scenario. However, the authors emphasise the imprecision of these estimates and note the need for large scale randomised trials in this area.

A consensus remains to be established relating to the potential aggregated savings which may accrue from thrombolysis. Some authors have suggested that savings may be limited because of the small number of patients for whom thrombolysis is clinically suitable (Moodie et al., 2004). However, extension of the therapeutic window for stroke thrombolysis, combined with public education programmes and wider availability of emergency stroke teams, is likely to increase the proportion of patients treated, with consequent effect on cost savings. In a more recent study, Ehlers et al. (2007) find that the additional per patient costs of thrombolysis during hospitalisation are approximately twice as expensive as conventional treatment but that large-scale cost savings may be achieved in the long-term (and the acute costs attributed to thrombolysis may have been over-stated in this study). There are also important cost distribution considerations in a health system characterised by separate funding streams (e.g., higher acute in-patient costs are borne by hospitals while cost savings are reaped elsewhere in the system). In the Irish context, the potential for reduction in disability and long-term care needs is important given that long-term care accounts for a relatively high proportion of total stroke costs.

[71] Converted from Sterling to Euro using exchange rate at 31 December 1999 (original study based on costs at 1999-2000).

It is difficult to identify a consistent pattern of the cost implications of stroke units. In one comparison across a number of countries, stroke units were found to have no impact on the variation in acute care costs for a sample of stroke patients across different countries (Epstein et al., 2008). In other studies, stroke units have been observed to be more expensive than alternative conventional wards. Kalra et al. (2005) estimated the costs per stroke patient during the first year of stroke using UK data. The average direct cost per patient in the first year of stroke was 20 per cent higher for patients who had been treated in a stroke unit relative to those treated in a general medical ward with a mobile specialist stroke team. However, the authors also point out that when the differences in mortality are taken into account, the average direct cost per day alive was lower for patients who were treated in a stroke unit. Stroke unit patients were more likely to receive higher informal caregiver inputs (i.e., number of hours of care per patient day alive) relative to patients treated in a general medical ward which could possibly be related to increased expectations of support from patients treated in a stroke unit (Kalra et al., 2005). In a more recent UK study, Saka et al. (2009b) used Markov modelling methods to estimate variations in the average direct and indirect cost per stroke patient over a period of 10 years. The average cost per stroke patient was 12 per cent higher for stroke patients treated in a stroke unit relative to those treated on a general medical ward. Moodie et al., (2006) found that the average direct costs of hospital and post-hospital care for stroke patients in the first 28 weeks of a stroke were 26 per cent higher for patients treated in a stroke unit relative to conventional care, but this difference was not statistically significant (although the acute care component was significantly higher for stroke unit care, p=0.003). In France, the average direct cost per stroke patient over a 5 year period was 12 per cent higher for patients treated in a stroke unit relative to conventional care (Launois et al., 2004). However, these studies have also demonstrated the cost-effectiveness of stroke units relative to general ward care for stroke patients (Launois et al., 2004; Moodie et al., 2006; Saka et al., 2009b) and thus the higher cost of stroke unit care can be justified in terms of greater health benefits (e.g., avoiding severe complications) (Moodie et al., 2006).

A3.3 POTENTIAL FOR IMPROVED OUTCOMES IN IRELAND

In this section, a range of potential benefits associated with changes to stroke service provision in Ireland are estimated, based on 2007 population and stroke epidemiological data. The potential benefits are measured in terms of strokes avoided, or the number of deaths averted, or the number of dependent or institutionalised cases averted. To examine sensitivity, the size of the potential benefit is varied for each intervention. To reflect possible capacity and resource constraints, the impact of the interventions is assessed at different phases in implementation (e.g., 5 per cent coverage, 15 per cent coverage, etc.). The interventions are analysed separately although in practice they may be rolled out

concurrently and the total impact is not a linear sum of the positive outcomes from each intervention.

A3.3.1 Anticoagulation treatment for patients with atrial fibrillation

Sulch (1997) noted that the risk of a first-ever stroke in patients with atrial fibrillation can be reduced to 1.5 per cent if treated with warfarin (i.e., primary prevention). For atrial fibrillation patients who have already had a stroke, warfarin treatment can reduce the risk of another stroke to 4 per cent per year (i.e., secondary prevention). This section estimates the potential number of strokes that could be avoided if a greater number of patients with atrial fibrillation in Ireland were treated with warfarin.

The prevalence of atrial fibrillation has been estimated to be 2.3 per cent for those aged between 40 and 64, and 5.9 per cent for those aged 65 and older, although these rates are not specific to Ireland. Applying these rates to Irish population data gives an estimated prevalence of AF of 56,654 in 2007. To identify the potential for primary and secondary prevention of stroke in these patients, the number of patients with AF who have already had a stroke is estimated. Approximately 22 per cent of stroke cases analysed in the INASC report (Irish Heart Foundation, 2008) had been diagnosed with AF and this proportion is used to estimate the total number of stroke cases with AF in 2007. These latter cases are deducted from the total number of AF cases.

A low level of anticoagulation pre-stroke (6 per cent) was identified in the INASC report (Irish Heart Foundation, 2008). One study of primary care in Ireland identified almost one third of a sample of patients with atrial fibrillation who could have been anticoagulated but were not (and just over half were treated with the alternative of aspirin) (White et al., 2004). Low levels of anticoagulation have also been discussed in other studies (Miller et al., 2005, Walker and Bennett, 2008). This analysis estimates the potential number of strokes averted where warfarin treatment is available (where appropriate) to 10 per cent, 30 per cent and 50 per cent of patients with atrial fibrillation.

As outlined in Table A.8 an estimated 70 first-ever strokes in Ireland could be avoided in one year if 10 per cent of patients with atrial fibrillation were adequately treated with warfarin (based on 2007 data). This increases to 350 where warfarin treatment is available to 50 per cent of patients with atrial fibrillation. An estimated 40 to 200 secondary strokes could be averted in Ireland where treatment with warfarin covers 10 to 50 per cent of AF patients who have already had a stroke.

TABLE A.8
Estimated number of strokes averted due to warfarin treatment for patients with atrial fibrillation

Number of strokes averted:	Primary strokes averted	Secondary strokes averted[a]
Warfarin cover at 10%	70	40
Warfarin cover at 30%	210	120
Warfarin cover at 50%	350	200

Notes: [a] Based on high prevalence.

A3.3.2 Thrombolytic therapy for ischaemic stroke patients

There is a limited time period within which thrombolysis for ischaemic stroke is effective. Lansberg et al. (2009) note that beyond 4.5 hours after symptom onset, thrombolysis does not appear to have a net benefit (i.e., where the number of patients that benefit from the treatment outweigh those who are harmed). Drawing on available evidence, the number needed to treat with thrombolysis to achieve a positive outcome ranges from 20, to 15, to 7.4 where treatment is administered 181–270 minutes after symptom onset (Wardlaw et al., 2009, Lees et al., 2010, Lansberg et al., 2009).

In 2005, thrombolysis was administered to 1 per cent of acute stroke cases in Ireland (Irish Heart Foundation, 2008) while in other settings higher rates have been reported (e.g., a range of 6–21 per cent in one study from the Netherlands, van Wijngaarden et al., 2009). This analysis estimates the potential number of positive outcomes in Ireland where the thrombolysis rate varies from 5 per cent, to 10 per cent, to 15 per cent, to 20 per cent.

Table A.9 presents the estimated number of incident stroke deaths/dependent cases that could have been averted in Ireland in 2007 were thrombolysis administered within the first 4.5 hours of stroke symptom onset. The estimates are presented for varying estimates of the effectiveness of thrombolysis (i.e., NNTs of 20, 15, 7.4), and at varying rates of thrombolysis cover (5–20 per cent). A total of 3,761 (ICD 10-AM code I63) cases of ischaemic stroke were recorded in HIPE in 2007.[72] With a thrombolysis rate of 5 per cent, a potential 188 stroke patients could have been treated with thrombolysis, increasing to 752 stroke patients where the rate of thrombolysis is 20 per cent. Table A.9 identifies the potential to avert between 38 and 102 deaths/dependent outcomes in Ireland in one year with a thrombolysis rate of 20 per cent, based on 2007 stroke incidence data. It is important to note that these are underestimates as the potential number of deaths/dependent cases averted is greater the earlier thrombolysis is administered following the onset of stroke symptoms.

[72] Excluding duplicate cases (see Appendix 1)

TABLE A.9
Potential number of stroke deaths/dependent cases averted with thrombolysis

Number of improved outcomes (deaths/dependent cases averted)	Incident cases			Net prevalent cases					
				Low prevalence			High prevalence		
	NNT			NNT			NNT		
	20	15	7.4	20	15	7.4	20	15	7.4
Thrombolysis cover at 5%	9	13	25	35	47	95	67	89	180
Thrombolysis cover at 10%	19	25	51	70	94	190	133	178	361
Thrombolysis cover at 15%	28	38	76	105	140	285	200	267	541
Thrombolysis cover at 20%	38	50	102	140	187	380	267	356	722

Table A.9 also outlines the potential number deaths/dependent cases averted if patients who had their stroke prior to 2007 (i.e., net prevalent stroke cases) had been given access to thrombolytic therapy (where clinically appropriate) during their acute phase of care.[73] At low prevalence rates, it is estimated that between 140 and 380 deaths/dependent cases could have been averted with a thrombolysis rate of 20 per cent. At high prevalence rates, an estimated 267 to 722 deaths/dependent cases could have been averted with a thrombolysis rate of 20 per cent. However, as noted below, these are hypothetical estimates and should be interpreted with caution.

A3.3.3 Stroke unit care for stroke patients

The estimated NNT for organised stroke unit care to avert death/institutionalisation ranges from 8 to 30 in available studies (Stroke Unit Trialists' Collaboration, 1997). To test for sensitivity, this section estimates the number of deaths/institutionalised cases avoided where the NNT for stroke unit care is 30, 19 (the midpoint in the range), and 8.

As outlined in the INASC report, there was only one stroke unit in operation in the Irish acute hospital sector in 2005 (Irish Heart Foundation, 2008). It is recognised that changes to stroke service provision may be phased in over time. To take this into account, the impact of stroke unit care on the number of deaths/institutionalised cases averted is estimated at different rates of stroke unit coverage (25 per cent, 50 per cent, 95 per cent). The upper boundary of 95 per cent coverage is consistent with other studies that have modelled changes in stroke service provision (e.g., Saka et al., 2005).

Table A.10 presents the estimated number of incident stroke deaths/institutionalised cases that could have been averted in Ireland in 2007 were stroke patients treated in a stroke unit during their acute in-patient phase

[73] This is necessarily an underestimate. The proportion of positive outcomes is calculated on the basis of the number of net prevalent cases counted in 2007 (i.e., deaths in previous years are not included).

of care. The estimates are presented for varying estimates of the effectiveness of stroke unit care (i.e., NNTs of 30, 19, 8), and at varying rates of stroke unit cover (25–95 per cent). A total of 5,514 cases of stroke (defined as ICD 10-AM I60/I61/I63/I64) were recorded in HIPE in 2007.[74] As indicated in Table A.10, it is estimated that between 175 and 655 deaths or institutionalised cases could be avoided in Ireland in one year if 95 per cent of incident stroke patients were treated in a stroke unit (based on 2007 incidence data).

TABLE A.10
Potential number of stroke deaths/institutionalised cases averted with stroke unit care

Number of improved outcomes (deaths/institutionalised cases averted)	Incident cases			Net prevalent cases					
				Low prevalence			High prevalence		
	NNT			NNT			NNT		
	30	19	8	30	19	8	30	19	8
Stroke unit cover at 25%	46	73	172	172	271	644	326	515	1,223
Stroke unit cover at 50%	92	145	345	343	542	1,287	652	1,030	2,446
Stroke unit cover at 95%	175	276	655	652	1,030	2,446	1,239	1,957	4,648

Table A.10 also outlines the potential number deaths/institutionalised cases averted if patients who had their stroke prior to 2007 (i.e., net prevalent stroke cases) had been treated in a stroke unit during their acute phase of care. It is estimated that 652–2,446 deaths/institutionalised cases could have been averted at 95 per cent stroke unit coverage at low prevalence rates (1,239–4,648 at high prevalence rates). It is important to emphasise the hypothetical nature of the net prevalent estimates in Tables A.9 and A.10. More accurate estimates would require complex dynamic modelling techniques that are beyond the scope of this study. Thus, the purpose here is to provide some insight into the long-term benefits (beyond one year) of the possible scale of numbers of lives saved and institutionalised cases avoided that come about because of changes to stroke service provision.

A3.4 COST OF CHANGES TO STROKE SERVICES IN IRELAND

A3.4.1 Stroke networks

As outlined earlier, there are costs attached to changing the way in which stroke services are delivered. To identify these costs in the Irish setting would require detailed analysis of the additional staffing requirements, skill mix, infrastructural requirements, and the potential for reconfiguration of existing staff and services. The new Cardiovascular Health Policy recommends that hospital stroke services in Ireland are organised around stroke networks, each catering for populations of

[74] See Appendix 1 for a more detailed description of the estimated incidence of stroke in Ireland in 2007. The number of stroke cases recorded under the specified ICD-10-AM codes in HIPE is lower than the estimated total incidence of stroke based on NDPSS incidence rates.

approximately 500,000, depending on geography and population density (DOHC, 2010). To give some idea of the resources involved in delivering a comprehensive stroke service, this section draws on international guidelines for staff and non-staff inputs to a best practice stroke service. These benchmarks are used to make preliminary estimates of some of the key staff costs required to deliver a network-based stroke service in the Irish health care system (focusing on the costs per stroke network covering approximately 500,000 people).

International guidelines recommend the organisation of stroke care in integrated stroke networks covering all steps in the care pathway, including specialist acute care, emergency thrombolysis, rehabilitation, and secondary prevention for each network serving between 500,000 and 1 million people (Department of Health, 2007). In the Irish context, the proposed stroke network would be made up of a number of hospitals working together to provide a range of services required for optimal stroke care and integrating with community services. In each network there will be at least one hospital meeting international criteria for a comprehensive stroke centre (i.e., providing both appropriate diagnosis and treatment for most stroke patients, as well as high technology medical and surgical care). Other hospitals in the network will meet the criteria for a primary stroke centre (i.e., capacity to provide appropriate diagnosis and treatment for most stroke patients). Each network is to be configured to allow at least 80 per cent of the population to access a consultant-delivered 24-hour, 7-day thrombolysis service by ground ambulance within 90 minutes of the onset of stroke (DOHC, 2010). In this analysis, five key service components of a stroke network are examined, namely, specialist stroke consultants, anticoagulation for stroke prevention, thrombolysis, acute stroke units, and specialist community rehabilitation. Key staff costs per network based on Irish data are estimated for each element (with the exception of anticoagulation services where clear guidelines are not available). The focus is on total, rather than additional, staffing requirements and it is important to note that the incremental cost would need to take into account the potential for redeployment of existing staff.

A3.4.2 Stroke networks – staffing requirements and costs

A3.4.2.1 Stroke consultant physicians

At the network level, there is a need for specialist stroke consultants to provide input across the care pathway. The British Association of Stroke Physicians (BASP) has examined the consultant workforce requirements for acute, rehabilitation and out-patient stroke care. Acute care consultant duties include acute stroke unit ward rounds, multidisciplinary meetings, emergency assessment and thrombolysis, and neuroradiology meetings. Rehabilitation consultant services include multidisciplinary meetings and meetings with families, rehabilitation ward rounds, and assessment of patients for rehabilitation. Out-patient/community

services include a neurovascular clinic for early management of TIA, a stroke review clinic, and reviewing patients for the community stroke team (British Association of Stroke Physicians, 2007).

It is estimated that a hospital with 300 acute stroke admissions per year, covering a population of 180,000 people, will require approximately 2 Whole Time Equivalent (WTE) consultant posts, while a larger hospital with 400 acute stroke admissions, covering a population of 240,000, would require approximately 3 consultant posts (British Association of Stroke Physicians, 2007). These estimates assume a certain level of commitment to non-stroke work related to a parent speciality, such as neurology or geriatric medicine. A lower number of posts may be required where less non-stroke work is needed.

A stroke network covering a population of 500,000 would therefore require approximately 5 consultant posts, depending on the configuration of acute hospitals in the network. Consultant posts would be distributed across one comprehensive stroke centre and smaller primary stroke centres within each network.

The BASP (2007) acknowledge that these staffing estimates do not account for a 24/7 consultant-delivered thrombolysis service. In the Cardiovascular Health Policy it is estimated that, in order to deliver the additional service requirements of atrial fibrillation management, rapid access TIA clinics, and other services, an additional 2–3 consultants per network would be required in the Irish context.

To capture the consultant costs pertaining to stroke care only, it is estimated that 70 per cent of each consultant's time is spent on stroke care (British Association of Stroke Physicians, 2007).

TABLE A.11
Estimated consultant requirements and costs per stroke network

	No. of consultant stroke specialist posts	No. of consultant WTE for stroke	Salary costs[a] (€000)	
			Lower bound	Upper bound
Stroke network per 500,000 population	7–8	4.9–5.6	892	1,019

Note: [a] Based on payscale for Category I geriatric consultant, 01/06/07, available at: http://www.hseea.ie/subNav.aspx?pid=payConditions

A3.4.2.2 Anticoagulation services in primary care for stroke prevention

Stroke prevention requires service inputs including the management of atrial fibrillation. This section focuses on the use of warfarin to manage patients with atrial fibrillation. The cost of managing atrial fibrillation with warfarin includes the cost of medical and nursing staff inputs, IT services, drugs, and the costs of

complications associated with anticoagulation. Treatment can be primarily based in primary care, with additional support and input from specialised hospital staff. IT infrastructure may be necessary to ensure a quality service based in primary care.

There is limited up-to-date evidence on the costs of anticoagulation services. A recent report by the UK National Health Service (National Institute for Health and Clinical Excellence, 2006) estimated that an annual course of anticoagulant therapy for patients with atrial fibrillation requires 20 clinic appointments, with the cost varying according to the setting (primary/acute). The weighted average cost of anticoagulation per patient was estimated at approximately €569 in 2006/2007.[75] The cost of anticoagulation also includes costs associated with complications such as haemorrhaging. NICE (2006) assumes that 2.4 per cent of patients have major bleeds annually and 15.8 per cent have minor bleeds. In 2007, acute in-patient admissions due to 'Haemorrhagic disorder due to circulating anticoagulants' (major bleeds) cost €4,964 per case (Health Service Executive, 2009). It is assumed that minor bleeds require an emergency department attendance (National Institute for Health and Clinical Excellence, 2006).

A3.4.2.3 Thrombolysis

Consultant inputs for thrombolysis are discussed above. A number of non-consultant inputs are also required to deliver a quality, 24/7 thrombolysis service. A specialist nurse is required to assess each potentially eligible patient and to monitor each patient receiving the therapy. Other potential non-staff costs include emergency transport, tele-medicine infrastructure, drug costs, and CT scans.

NHS Quality Improvement Scotland (2009) estimated that one WTE specialist nurse is required to assess/treat 450 potentially eligible patients. In the Irish context, anecdotal evidence indicates that for every 3–4 stroke patients, one is treated with thrombolysis. As outlined earlier, in Ireland, at a thrombolysis rate of 20 per cent a total of 752 incident cases could have been treated (based on 2007 data), indicating a potentially eligible group of 2,256–3,008. On this basis, an estimated 5.0–6.7 WTE specialist nurses would be required in Ireland for a national thrombolysis service. Assuming approximately nine stroke networks (i.e., stroke network per 500,000 persons), this suggests a need for 0.6–0.7 WTE nurses per network. It is important to note that these specialist nursing

[75] Weighted average cost per patient of STG£382.90 is converted to euro at 01/01/2007 exchange rates.

requirements are specific to the delivery of thrombolysis and would be additional to the nursing requirements for stroke units and other stroke services.[76]

TABLE A.12
Estimated specialist stroke nurse requirements and cost per stroke network for thrombolysis service

	No. of clinical nurse specialist posts	Salary cost (€000)[a]
Stroke network per 500,000 population	0.6–0.7	31–36

Note: [a] Based on estimated mean salary for Clinical Nurse Specialist (General) in 2007, calculated from Payscale available at: http://www.hseea.ie/subNav.aspx?pid=payConditions

A3.4.2.4 Stroke units

Each comprehensive and primary stroke centre in a network will require either separate acute and rehabilitation stroke units or a combined acute/rehabilitation stroke unit. The number of beds in each unit, and the number of units in each network, will depend on the population served, the number of stroke admissions, and local configuration of hospital services.

As part of the Irish National Audit of Stroke Care, a survey of the 37 acute public hospitals providing services for stroke in Ireland recorded a total of 411 beds occupied by acute stroke in-patients (Irish Heart Foundation, 2008). This suggests that 100 per cent stroke unit cover would require at least 410 stroke unit beds nationally, or approximately 47 per stroke network covering 500,000 people.[77] Lower levels of stroke unit coverage would require fewer beds (see Table A.13).

TABLE A.13
Estimated number of stroke unit beds per network, by level of coverage

	Number of Stroke Unit Beds
Stroke network per 500,000 population	
Stroke unit cover at 25%	12
Stroke unit cover at 50%	24
Stroke unit cover at 95%	45
Stroke unit cover at 100%	47

The staffing levels reported for stroke units evaluated in the Cochrane Systematic Review of organised in-patient care for stroke (Langhorne et al., 2002) have been cited as a model for stroke unit staffing (e.g., Scottish Intercollegiate Guidelines Networks, 2010). Estimated stroke unit staffing requirements and costs (based on a combined acute/rehabilitation stroke unit) for a network covering 500,000

[76] There is increasing recognition of the role of specialist nursing in stroke care (e.g., Clinical Nurse specialist, Advanced Nurse Practitioner) and it is important not to underestimate the staffing requirements for all areas in which stroke nursing care is involved, including health promotion, rehabilitation, discharge planning, etc.

[77] Adjusting for the size of the population in Ireland (i.e., 410 stroke unit beds per 4.3 million people)

population in the Irish context are displayed in Table A.14. The estimated costs are based on 100 per cent stroke unit cover.

TABLE A.14
Estimated stroke unit staffing requirements and cost per stroke network

	WTE staff per 10 bed unit	WTE staff per stroke network (47 beds per 500,000 population)	Salary cost per network (€000)[a]	
			Lower bound	Upper bound
Nursing[b]	7–12	33–56	1,225	2,100
Non-consultant hospital doctor[c]	0.5–1.5	2–7	121	363
Physiotherapy[d]	1.2–1.7	6–8	241	341
Occupational therapy[d]	0.6–1.7	3–8	121	341
Speech and language therapy	0.2–0.7	1–3	52	181
Social work	0.6	3	121	121
Clinical psychologist[e]	0.9	4	356	356
Total stroke unit cost per network			2,235	3,803

Notes:
[a] Based on estimated mean salaries for 2007, calculated from Payscales available at: http://www.hseea.ie/subNav.aspx?pid=payConditions
[b] Nursing levels for a daytime shift only are reported in Langhorne et al. (2002). An estimate for total nursing staff required is obtained from a Staffing Levels Grid available as part of the Online NHS Workforce Planning Resource for Stroke. http://www.dh.gov.uk/prod_consum_dh/groups/dh_digitalassets/documents/digitalasset/dh_081411.pdf
[c] Consultant input is included in estimates of specialist stroke physician requirements. Non-consultant hospital doctor input is divided equally between house officer and registrar grades.
[d] Divided equally between senior and assistant grades.
[e] Clinical psychology input is not reported in Langhorne et al. (2002). The estimate reported here is obtained from a Staffing Levels Grid available as part of the Online NHS Workforce Planning Resource for Stroke. http://www.dh.gov.uk/prod_consum_dh/groups/dh_digitalassets/documents/digitalasset/dh_081411.pdf

A3.4.2.5 Community Rehabilitation Costs

The Irish Heart Foundation (2008) recommends a model of specialised community rehabilitation stroke teams, with the capacity to provide a prompt, needs-led service with equitable access for all stroke patients. This model would also have the capacity to provide an early supported discharge service, which could have implications for acute service utilisation. The estimated staffing costs of these community stroke teams per stroke network are presented in Table A.15.[78]

[78] The estimated total cost of the Irish Heart Foundation's recommended level of staffing for community rehabilitation is estimated to be €37 million to cover the whole country (staff cost including provision for overheads of 15 per cent).

TABLE A.15
Estimated specialist community rehabilitation requirements and cost per stroke network

Discipline	WTE staff per 100,000 population	WTE staff per stroke network (500,000 population)	Salary cost per network (€000)[a]
Physiotherapy (senior grade)	2	10	550
Occupational therapy (senior grade)	2	10	550
Speech and language therapy (senior grade)	2	10	550
Clinical nutrition and dietetics (senior grade)	0.4	2	110
Nursing	3	15	750
Clinical psychology	1.5	8	631
Psychology assistant	1	5	188
Social work	1	5	214
Therapy assistants	2	10	305
Total community stroke rehabilitation cost per network			3,849

Note: [a] Based on estimated mean salaries for 2007, calculated from Payscales available at: http://www.hseea.ie/subNav.aspx?pid=payConditions

A3.4.2.6 Aggregate staff costs per stroke network

Table A.16 aggregates the estimated staffing costs associated with specialist stroke consultants, specialist nurse input for thrombolysis, acute stroke units, and community stroke teams for the Irish health care system. The costs are presented on the basis of a stroke network covering 500,000 people. However, it is important to note that these cost estimates do not include the additional support staff and non-staff inputs required for a best practice stroke service (e.g., diagnostics, etc.).

TABLE A.16
Total estimated salary costs per stroke network serving 500,000 population

	Salary costs (€000)	
	Lower bound	Upper bound
Specialist stroke consultants	892	1,019
Specialist thrombolysis nurse	31	36
Stroke units	2,235	3,803
Community stroke team	3,849	3,849
Total stroke network per 500,000 population	7,007	8,707

A3.5 POTENTIAL FOR COST SAVINGS IN IRELAND

A3.5.1 Source of cost savings

The analysis in section A3.3 indicates the potential for changes in how stroke services are provided in Ireland to yield improved outcomes for stroke patients, in terms of preventing strokes, reducing fatalities, and reducing the need for

long-term care post-stroke. Section A3.4 outlined some of the key cost drivers of improving stroke services, although the precise costs are difficult to estimate without assessment of the potential for reconfiguration of existing services.

Apart from the costs of implementation, at the aggregate level, changes to stroke service provision have a number of implications for the total economic burden of stroke, some of which increase the burden and others which reduce it:

- A reduction in the number of strokes due to prevention measures (i.e., primary and secondary prevention) has a downward influence on the overall cost of stroke.
- An increase in the number of stroke patients who survive has conflicting impacts on the overall costs of stroke. A greater number of people living with the consequences of stroke (and requiring rehabilitation, GP visits, medication, etc.) will have an upward influence on aggregate direct costs. The impact on total productivity foregone is uncertain: fewer deaths reduces the total amount of productivity foregone due to mortality, but a greater number of people living with the consequences of stroke might increase the amount of productivity foregone due to illness.
- A reduction in the number of stroke patients requiring long-term nursing home care puts downward pressure on the total cost of stroke.

Clearly the above implications for total costs have to be balanced against the cost of implementing the interventions. While the costs of the implementations have been discussed earlier, this section estimates the possible sources of short- and long-term cost savings that accrue from changing the way in which stroke services are delivered, and these can help to put the costs into perspective.

A3.5.2 Aggregate cost savings – incidence costs

This section examines the cost implications of increasing the proportion of incident stroke cases that have access to thrombolytic therapy (where clinically appropriate) and stroke unit care during their acute hospital phase of care in Ireland. Total costs of stroke for incident cases in Ireland in 2007 are recalculated on the basis of the revised numbers of incident stroke patients who survive stroke and reside at home in the context of expanded access to stroke unit care and thrombolytic therapy.

A3.5.2.1 Rollout of Thrombolysis

The estimated number of incident deaths/dependent cases averted where access to thrombolysis is improved is taken from Table A.9. For the purposes of this analysis, these positive outcomes are interpreted as the number of nursing home

cases avoided.[79] Table A.17 shows the impact on total incident costs in Ireland in 2007 (i.e., the total costs relating to all stroke patients in their first year of stroke) where access to thrombolysis for eligible patients was increased to 5 per cent, 10 per cent, 15 per cent or 20 per cent. For sensitivity, the results are presented at varying rates of effectiveness of thrombolysis (i.e., NNT ranges from 20 to 7.4).

The baseline cost of stroke for all incident cases in their first year of stroke in Ireland was estimated to be €174 million in 2007. Where access to thrombolysis covers 10 per cent of eligible ischaemic stroke patients, and at an NNT of 15, the total annual cost of all incident cases falls to €173 million, or 0.5 per cent lower than the baseline estimate. Table A.18 presents a more detailed breakdown of the incident costs for this scenario (i.e., 10 per cent thrombolysis cover at NNT of 15). With a reduced number of incident stroke cases requiring long-term nursing home care, the aggregate nursing home costs are lower than in the baseline by 2 per cent. These savings are offset to some extent by an increase in total indirect costs, and some increase in the costs of aids, appliances and home modifications. The estimated costs of expanding access to thrombolysis are not included here. The analysis indicates that there are potential savings that accrue from allowing a greater number of stroke patients to live at home rather than in a nursing home, and these can at least partially offset some of the implementation costs of increasing thrombolysis. The extent to which the implementation costs can be offset requires more detailed analysis.

[79] The focus here is on the number needed to treat with thrombolysis to avert dependent cases, given some uncertainty in the literature about the potential for reducing deaths (see Wardlaw et al., 2009).

TABLE A.17

Estimated impact of thrombolysis rollout on aggregate stroke incidence costs (2007, €000 and %)

	Baseline	NNT 20		NNT 15		NNT 7.4	
		Increased thrombolysis service	Change from baseline	Increased thrombolysis service	Change from baseline	Increased thrombolysis service	Change from baseline
	€000	€000	%	€000	%	€000	%
5% Thrombolysis cover							
Direct costs for incident cases[a,b]	146,519	146,189	-0.2	146,080	-0.3	145,629	-0.6
Indirect costs for incident cases[c]	27,590	27,616	0.1	27,624	0.1	27,660	0.3
Total incident costs[d]	174,108	173,805	-0.2	173,704	-0.2	173,289	-0.5
10% Thrombolysis cover							
Direct costs for incident cases[a,b]	146,519	145,860	-0.4	145,641	-0.6	144,740	-1.2
Indirect costs for incident cases[c]	27,590	27,642	0.2	27,659	0.3	27,730	0.5
Total incident costs[d]	174,108	173,502	-0.3	173,300	-0.5	172,469	-0.9
15% Thrombolysis cover							
Direct costs for incident cases[a,b]	146,519	145,531	-0.7	145,202	-0.9	143,850	-1.8
Indirect costs for incident cases[c]	27,590	27,668	0.3	27,693	0.4	27,800	0.8
Total incident costs[d]	174,108	173,199	-0.5	172,896	-0.7	171,650	-1.4
20% Thrombolysis cover							
Direct costs for incident cases[a,b]	146,519	145,202	-0.9	144,763	-1.2	142,961	-2.4
Indirect costs for incident cases[c]	27,590	27,693	0.4	27,728	0.5	27,870	1.0
Total incident costs[d]	174,108	172,896	-0.7	172,491	-0.9	170,831	-1.9

Notes:

[a] Hospital costs based on the casemix methodology.

[b] Community rehabilitation costs based on adjusted occupational therapy provision.

[c] Indirect cost based on low estimate of number of informal care hours and low estimate of number of patients stopping work due to illness.

[d] Incidence at baseline

TABLE A.18
Estimated impact of thrombolysis rollout on aggregate stroke incidence costs with 10 per cent thrombolysis cover (NNT 15) in 2007 (€000 and %)

	NNT 15		
	Baseline	10% Thrombolysis cover	Change from baseline
	€000	€000	%
Direct costs			
Acute hospital care[a]	70,798	70,798	-
In-patient rehabilitation	16,167	16,167	-
Nursing home care	43,957	43,056	-2.0
GP care	977	974	-0.3
OPD care	1,086	1,086	-
Drugs	1,259	1,259	-
Community rehabilitation[b]	6,355	6,355	-
Aids, appliances, home modifications	5,919	5,946	0.5
Voluntary agency services	-	-	
Total direct costs	146,519	145,641	-0.6
Indirect costs			
Informal care[c]	5,549	5,586	0.7
Productivity loss from morbidity and mortality[d]	22,041	22,073	0.1
Total indirect costs	27,590	27,659	0.3
Total incident cost of stroke care[e]	**174,108**	**173,300**	**-0.5**

Notes:
[a] Costs based on the casemix methodology.
[b] Cost based on adjusted occupational therapy provision.
[c] Cost based on the low estimate of number of informal care hours.
[d] Cost based on the low estimate of number of patients stopping work due to illness.
[e] Incidence at baseline

A3.5.2.2 Rollout of stroke units

The estimated number of deaths/institutionalised cases averted with the rollout of stroke units in Ireland is presented in Table A.10, at varying levels of stroke unit cover and varying rates of stroke unit effectiveness. To identify cost implications, it is important to separate out the estimated number of deaths averted from the number of institutionalised cases averted. A reduction in the number of deaths leads to an increase in the number of stroke survivors and associated costs. Conversely, a reduction in the number of institutionalised cases leads to a reduction in aggregate nursing home costs. In the absence of further evidence, the total number of adverse outcomes averted is split evenly between deaths averted and institutionalised cases, although this proportional split could be varied in further analysis.

Table A.19 shows the impact on total incident costs in Ireland in 2007 where stroke units are rolled out to cover 25 per cent, 50 per cent and 95 per cent of stroke patients during their acute in-patient stay. For sensitivity, results are

presented at varying rates of stroke unit effectiveness (i.e., NNT ranges from 30 to 8).

As indicated above, the baseline cost of stroke for all incident cases in their first year of stroke in Ireland was estimated to be €174 million in 2007. Where stroke units cover 50 per cent of stroke patients and at an NNT of 19, the total annual cost of all incident cases is estimated to fall to €172 million (1.3 per cent lower than the baseline). A more detailed breakdown of the incident costs for this scenario (i.e., 50 per cent stroke unit cover at NNT of 19) is outlined in Table A.20. At higher rates of stroke unit cover and at a lower NNT, the total incident costs could fall to almost 6 per cent below the baseline.

While the estimated costs of expanding access to stroke units are not included here, the results highlight the potential cost savings due to the reduced numbers of deaths and institutionalised cases. These can in turn offset at least some of the costs of rolling out stroke unit care, although the extent to which the implementation costs are offset requires further analysis.

TABLE A.19
Estimated impact of stroke unit rollout on aggregate stroke incidence costs (2007, €000 and %)

	Baseline	NNT 30		NNT 19		NNT 8	
		Increased stroke unit service	Change from baseline	Increased stroke unit service	Change from baseline	Increased stroke unit service	Change from baseline
	€000	€000	%	€000	%	€000	%
25% stroke unit cover							
Direct costs for incident cases[a,b]	146,519	145,750	-0.5	145,305	-0.8	143,636	-2.0
Indirect costs for incident cases[c]	27,590	27,639	0.2	27,667	0.3	27,773	0.7
Total incident costs[d]	174,108	173,389	-0.4	172,972	-0.7	171,409	-1.6
50% stroke unit cover							
Direct costs for incident cases[a,b]	146,519	144,981	-1.0	144,091	-1.7	140,753	-3.9
Indirect costs for incident cases[c]	27,590	27,688	0.4	27,744	0.6	27,956	1.3
Total incident costs[d]	174,108	172,669	-0.8	171,835	-1.3	168,709	-3.1
95% stroke unit cover							
Direct costs for incident cases[a,b]	146,519	143,597	-2.0	141,906	-3.1	135,565	-7.5
Indirect costs for incident cases[c]	27,590	27,775	0.7	27,883	1.1	28,286	2.5
Total incident costs[d]	174,108	171,373	-1.6	169,789	-2.5	163,850	-5.9

Notes:
[a] Hospital costs based on the casemix methodology.
[b] Community rehabilitation costs based on adjusted occupational therapy provision.
[c] Indirect cost based on low estimate of number of informal care hours and low estimate of number of patients stopping work due to illness.
[d] Incidence at baseline

TABLE A.20
Estimated impact of stroke unit rollout on aggregate stroke incidence costs at 50 per cent stroke unit cover (NNT 19) in 2007 (€000 and %)

	NNT 19		
	Baseline	50% stroke unit cover	Change from baseline
	€000	€000	%
Direct costs			
Acute hospital care[a]	70,798	70,798	0.0
In-patient rehabilitation	16,167	16,167	0.0
Nursing home care	43,957	41,351	-5.9
GP care	977	978	0.1
OPD care	1,086	1,098	1.1
Drugs	1,259	1,272	1.0
Community rehabilitation[b]	6,355	6,355	0.0
Aids, appliances, home modifications	5,919	6,073	2.6
Voluntary agency services	-	-	
Total direct costs	146,519	144,091	-1.7
Indirect costs			
Informal care[c]	5,549	5,748	3.6
Productivity loss from morbidity and mortality[d]	22,041	21,996	-0.2
Total indirect costs	27,590	27,744	0.6
Total incident cost of stroke care[e]	**174,108**	**171,835**	**-1.3**

Notes:
[a] Costs based on the casemix methodology.
[b] Cost based on adjusted occupational therapy provision.
[c] Cost based on the low estimate of number of informal care hours.
[d] Cost based on the low estimate of number of patients stopping work due to illness.
[e] Incidence at baseline

A3.5.3 Aggregate cost savings – net prevalent costs

A3.5.3.1 Rollout of Thrombolysis – net prevalent costs

This section examines the implications for net prevalent costs of changes in stroke service provision. The effectiveness of stroke unit and thrombolytic care in terms of averting deaths and reducing the need for long-term care amongst incident cases is expected to change the total economic burden of stroke in future years. By averting stroke deaths in the current year, a higher number of stroke patients surviving into future years could increase net prevalent costs in the future vis-à-vis the current year. Conversely, by reducing the number of stroke patients who require institutionalisation, this could have a downward impact on net prevalent costs in future years relative to the current year. Projecting forward to estimate the net impact of these different cost drivers on future net prevalent costs would require complex dynamic analysis and is outside the scope of the prevalence-based cost of illness methodology. The analysis here adopts a partially dynamic approach to provide some insight into this issue, but it is emphasised that these results are to be interpreted with caution.

The estimated number of deaths/dependent cases averted if patients who had their stroke prior to 2007 had been given access to thrombolytic therapy (where appropriate) has been presented in Table A.9. Total costs of stroke for all net prevalent cases in Ireland in 2007 are recalculated on the basis of these potential reductions in the number of net prevalent patients requiring long-term care.

Table A.21 shows the potential impact on aggregate net prevalent costs in the context of a higher number of stroke cases living at home rather than in a nursing home as a result of better access to thrombolysis in previous years. Results are presented for varying rates of thrombolysis effectiveness and access. In the baseline analysis, the total annual cost of stroke for all stroke patients who had a stroke prior to 2007 (i.e., net prevalent cases) was estimated to be €631 million (at high prevalence rates). In the hypothetical scenario whereby thrombolysis was available to cover 10 per cent of eligible cases in the year in which the stroke occurred, at an NNT of 15, the aggregate annual stroke cost is estimated to be €618 million, or 2.1 per cent lower than the baseline. Reduced aggregated nursing home costs are the main source of this cost saving. At higher rates of thrombolysis cover, and at a lower NNT, the aggregate annual stroke cost for net prevalent cases can fall to 8 per cent below the baseline.

TABLE A.21
Estimated impact of thrombolysis rollout on aggregate net prevalent stroke costs (€000 and %)

	Baseline	NNT 20		NNT 15		NNT 7.4	
		Increased thrombolysis service	Change from baseline	Increased thrombolysis service	Change from baseline	Increased thrombolysis service	Change from baseline
	€000	€000	%	€000	%	€000	%
5% Thrombolysis cover							
Direct costs for net prevalent cases[a,b]	410,868	405,671	-1.3	403,938	-1.7	396,821	-3.4
Indirect costs for net prevalent cases[c]	220,237	220,548	0.1	220,652	0.2	221,079	0.4
Total net prevalent costs[d]	631,106	626,219	-0.8	624,590	-1.0	617,899	-2.1
10% Thrombolysis cover							
Direct costs for net prevalent cases[a,b]	410,868	400,473	-2.5	397,008	-3.4	382,773	-6.8
Indirect costs for net prevalent cases[c]	220,237	220,860	0.3	221,067	0.4	221,920	0.8
Total net prevalent costs[d]	631,106	621,333	-1.5	618,075	-2.1	604,693	-4.2
15% Thrombolysis cover							
Direct costs for net prevalent cases[a,b]	410,868	395,275	-3.8	390,078	-5.1	368,725	-10.3
Indirect costs for net prevalent cases[c]	220,237	221,171	0.4	221,482	0.6	222,761	1.1
Total net prevalent costs[d]	631,106	616,447	-2.3	611,560	-3.1	591,487	-6.3
20% Thrombolysis cover							
Direct costs for net prevalent cases[a,b]	410,868	390,078	-5.1	383,148	-6.7	354,678	-13.7
Indirect costs for net prevalent cases[c]	220,237	221,482	0.6	221,898	0.8	223,603	1.5
Total net prevalent costs[d]	631,106	611,560	-3.1	605,045	-4.1	578,280	-8.4

Notes:
[a] Hospital costs based on the casemix methodology.
[b] Community rehabilitation costs based on adjusted occupational therapy provision.
[c] Indirect cost based on low estimates of number of informal care hours and of number of patients stopping work due to illness.
[d] At high prevalence rates

A3.5.3.2 Rollout of stroke units – net prevalent costs

Table A.22 shows the potential impact on aggregate net prevalent stroke costs in 2007 in the context of a higher number of stroke cases alive or living at home rather than in a nursing home as a result of better access to stroke units in previous years.

Results are presented for varying rates of stroke unit effectiveness and access. In the hypothetical scenario whereby stroke units covered 50 per cent of eligible cases in the year in which the stroke occurred, at an NNT of 19, the aggregate annual stroke cost is estimated to be €597 million (at high prevalence rates), or 5.4 per cent lower than the baseline. Reduced aggregated nursing home costs are the main source of this cost saving. At higher rates of stroke unit cover, and at a lower NNT, the aggregate stroke cost for net prevalent cases can fall to 24 per cent below the baseline.

TABLE A.22
Estimated impact of stroke unit rollout on aggregate net prevalent stroke costs (€000 and %)

	Baseline	NNT 30		NNT 19		NNT 8	
		Increased stroke unit service	Change from baseline	Increased stroke unit service	Change from baseline	Increased stroke unit service	Change from baseline
	€000	€000	%	€000	%	€000	%
25% stroke unit cover							
Direct costs for net prevalent cases[a,b]	410,868	398,297	-3.1	391,019	-4.8	363,727	-11.5
Indirect costs for net prevalent cases[c]	220,237	221,984	0.8	222,996	1.3	226,789	3.0
Total net prevalent costs[d]	631,106	620,282	-1.7	614,015	-2.7	590,516	-6.4
50% stroke unit cover							
Direct costs for net prevalent cases[a,b]	410,868	385,726	-6.1	371,170	-9.7	316,585	-22.9
Indirect costs for net prevalent cases[c]	220,237	223,732	1.6	225,755	2.5	233,341	6.0
Total net prevalent costs[d]	631,106	609,458	-3.4	596,925	-5.4	549,927	-12.9
95% stroke unit cover							
Direct costs for net prevalent cases[a,b]	410,868	363,098	-11.6	335,442	-18.4	231,731	-43.6
Indirect costs for net prevalent cases[c]	220,237	226,877	3.0	230,721	4.8	245,135	11.3
Total net prevalent costs[d]	631,106	589,975	-6.5	566,163	-10.3	476,866	-24.4

Notes:
[a] Hospital costs based on the casemix methodology.
[b] Community rehabilitation costs based on adjusted occupational therapy provision.
[c] Indirect cost based on low estimates of number of informal care hours and of number of patients stopping work due to illness.
[d] At high prevalence rates

A3.6 SUMMARY AND CONCLUSIONS

International literature confirms the positive impacts of a number of changes to stroke service provision in terms of prevention of strokes and improved outcomes following stroke. In the above analysis, international evidence on the effectiveness of a range of interventions has been used to estimate the potential number of strokes/deaths/dependent cases averted in the Irish context with regard to improvements to stroke services. The costs of implementing these changes have also been examined, with specific focus on the staffing requirements for stroke networks within the Irish health care system. Finally, at the aggregate level, there are potential savings that accrue from there being a higher proportion of stroke patients residing at home following their stroke, and these can be balanced against the cost implications of a greater number of people surviving their stroke.

There are strong caveats attached to the hypothetical nature of the estimates of cost savings, and the partial approach does not allow for assessment of the total impact were the interventions to be implemented concurrently. It is also noted that, in the context of a fragmented health care system, it is more difficult to re-allocate savings from one area of the health care system to another. However, the estimated impact at the aggregate level of a greater number of stroke patients alive and/or living at home rather than in a nursing home following stroke shows the potential for cost savings that may offset, or potentially more than offset, the costs associated with changing the stroke services, and this is without even attaching a 'value' to the positive outcomes of fewer deaths and better quality of life for stroke survivors.

APPENDIX 4 GLOSSARY OF KEY TERMS

AR-DRG	Australian Refined Diagnosis Related Group
Bottom-up approach	Utilisation is multiplied by unit costs and aggregated to yield total costs.
Casemix unit (CMU)	A casemix unit measures the complexity, in terms of resource use, of a Diagnosis Related Group (DRG) relative to all other DRGs.
Cost of illness study	Evaluation of the economic burden of a specific illness on society in terms of consumption of resources and production losses
Demographic change	Change in population (size, age profile, geographical distribution) given fertility, mortality and migration patterns
Diagnosis-related group (DRG)	Groups together cases which share common clinical attributes and similar patterns of use.
Direct costs	Costs of services that are directly related to the provision of health care (e.g., hospital costs, medication)
Early supported discharge	Services (e.g., pre-discharge home visit, recovery goal setting) that aim to allow stroke patients to return home from hospital earlier than usual and receive more rehabilitation at home
Epidemiological change	Change in morbidity patterns in the population
Hospital In-Patient Enquiry (HIPE)	Records demographic, clinical and administrative data on discharges and deaths from all public acute hospitals in Ireland, reporting on over 1.3 million records annually.
Incidence	Number of newly diagnosed cases of a disease during a specific time period
Incidence-based cost of illness	Estimates lifetime costs of a disease for the new cases in a specific year.
Indirect costs	Value of productivity foregone due to an illness (e.g., absenteeism from work because of illness, or because of

	providing informal care for a person with the illness)
Informal care	Unpaid care (e.g., by friend or relative)
Intangible costs	Cost/value of items that have no physical substance (e.g., suffering, loss of quality of life)
Non-HIPE hospitals	Hospitals not included in the Hospital In-Patient Enquiry system
Off-site in-patient stroke rehabilitation	In-patient rehabilitation for stroke patients in hospitals that are not included in the HIPE system (e.g., St. Mary's Hospital, Phoenix Park; St. Finbarr's Hospital, Cork; Thomastown, Kilkenny)
Prevalence	Total number of cases of a disease that is present in a particular population at a given time
Prevalence-based cost of illness	Aggregates the total costs of a disease in a given time period, including the costs associated with those who already have the disease and those who develop the disease during the period.
Societal perspective	A focus on costs that affect all institutions/individuals in the economy (e.g., public health care providers, private health care providers, patients, patient carers, etc.)
Stroke unit	Service where the acute and rehabilitation care of a stroke patient is under the direct care of a specialist with training and expertise in stroke management in conjunction with a dedicated interdisciplinary team
Thrombolysis	Medication to restore blood flow to the brain before major brain damage occurs in the case of acute ischaemic stroke where an artery in the brain is blocked by a blood clot
Top-down method	Total resources attributed across individuals/services (e.g., total hospital resources allocated across individuals on the basis of length of stay)

APPENDIX 5 COMMUNITY REHABILITATION DATASHEET

Separate datasheets were sent to the professional bodies of each of the following disciplines: Public Health Nursing, Physiotherapy, Speech and Language Therapy, Dietetics and Occupational Therapy. The example included here refers to Physiotherapy.

Cost of Stroke in Ireland (COSI) Project

The Irish Heart Foundation and Economic and Social Research Institute are conducting a project to estimate the costs of stroke care in Ireland. The aim is to estimate the costs of community rehabilitation for stroke patients and we would be very grateful if you would complete this questionnaire.

Questionnaire completed by:
Name _____
Email _____ Phone number _____

Please specify your LHO area (please tick)

HSE Dublin North and The North East		**HSE West and North West**	
North West Dublin Local Health Office	☐	Donegal Local Health Office	☐
North Central Dublin Local Health Office	☐	Sligo/Leitrim/West Cavan Local Health Office	☐
North Dublin Local Health Office	☐	Roscommon Local Health Office	☐
Cavan	☐	Mayo Local Health Office	☐
Monaghan	☐	Galway Local Health Office	☐
Louth Local Health Office	☐	Clare Local Health Office	☐
Meath Local Health Office	☐	North Tipperary/East Limerick Local Health Office	☐
		Limerick Local Health Office	☐
HSE Dublin South and Mid-Leinster		**HSE South**	
Dun Laoghaire Local Health Office	☐	Cork - South Lee Local Health Office	☐
Dublin South East Local Health Office	☐	Cork - North Lee Local Health Office	☐
Dublin South City Local Health Office	☐	West Cork Local Health Office	☐
Dublin South West Local Health Office	☐	North Cork Local Health Office	☐
Dublin West Local Health Office	☐	Carlow/Kilkenny Local Health Office	☐
Kildare/West Wicklow Local Health Office	☐	Kilkenny Community Care Headquarters	☐
Wicklow Local Health Office	☐	South Tipperary Local Health Office	☐
Laois/Offaly Local Health Office	☐	Waterford Local Health Office	☐
Longford/Westmeath Local Health Office	☐	Wexford Local Health Office	☐
		Kerry Local Health Office	☐

1. STAFF PROFILE AND STROKE CASE-LOAD

a	b	c	d
GRADE	Number of staff	For each member of staff, please indicate proportion of week for which they work i.e., full time or number of sessions per week (insert additional lines if needed)*	For each member of staff, please indicate approx. number of hours per week spent caring for patients with stroke
Physiotherapist, Senior			
Physiotherapist, Clinical Specialist			
Physiotherapist, Manager			
Others (please specify)			

* If work term time, please indicate number of paid weeks per year.

NOTES

Irish Heart Foundation

4 Clyde Road, Ballsbridge, Dublin 4

Tel: 01 668 5001

Email: info@irishheart.ie

Web: www.stroke.ie

www.irishheart.ie

Heart and Stroke Helpline:

1890 432 787

Charity Number: CHY 5507