27. Schaap LA, Pluijm SM, Deeg DJ, Penninx BW, Nicklas BJ, Lips P *et al*. Low testosterone levels and decline in physical performance and muscle strength in older men: findings from two prospective cohort studies. Clin Endocrinol 2008; 68: 42–50.
28. Forrest KY, Zmuda JM, Cauley JA. Patterns and determinants of muscle strength change with aging in older men. Aging Male 2005; 8: 151–6.
29. Newman AB, Haggerty CL, Goodpaster B, Harris T, Kritchevsky S, Nevitt M *et al*. Strength and muscle quality in a well-functioning cohort of older adults: the Health, Aging and Body Composition Study. J Am Geriatr Soc 2003; 51: 323–30.
30. Duvigneaud N, Matton L, Wijndaele K, Deriemaeker P, Lefevre J, Philippaerts R *et al*. Relationship of obesity with physical activity, aerobic fitness and muscle strength in Flemish adults. J Sports Med Phys Fitness 2008; 48: 201–10.
31. Stenholm S, Alley D, Bandinelli S, Griswold ME, Koskinen S, , Rantanen T *et al*. The effect of obesity combined with low muscle strength on decline in mobility in older persons: results from the InCHIANTI study. Int J Obes (Lond) 2009; 33: 635–44.
32. Bunout D, Barrera G, De La Maza T, Avendaño M, Gattas V, , Petermann M *et al*. Lean and fat mass as determinants of muscle strength and insulin sensitivity in Chilean elderly subjects. J Nutr Health Aging 2004; 8: 374–8.
33. Goodpaster BH, Park SW, Harris TB, Kritchevsky SB, Nevitt M, Schwartz AV *et al*. The loss of skeletal muscle strength, mass, and quality in older adults: The Health, Aging and Body Composition Study. J Gerontol A Biol Sci Med Sci 2006; 61: 1059–64.
34. Rantanen T, Masaki K, Foley D, Lzmirlian G, White L, Guralnik JM. Grip strength changes over 27 yr in Japanese-American men. J Appl Physiol 1998; 85: 2047–53.
35. Galvão DA, Taaffe DR, Spry N, Joseph D, Turner D, Newton RU. Reduced muscle strength and functional performance in men with prostate cancer undergoing androgen suppression: a comprehensive cross-sectional investigation. Prostate Cancer Prostatic Dis 2009; 12: 198–203.
36. Basaria S, Lieb J II, Tang AM, DeWeese T, Carducci M, Eisenberger M *et al*. Long-term effects of androgen deprivation therapy in prostate cancer patients. Clin Endocrinol (Oxf) 2002; 56: 779–86.

Received 20 June 2011; accepted in revised form 30 November 2011

Age and Ageing 2012; **41:** 332–338
doi: 10.1093/ageing/afr141
Published electronically 1 December 2011

The cost of stroke and transient ischaemic attack in Ireland: a prevalence-based estimate

Samantha Smith[1], Frances Horgan[2], Eithne Sexton[2], Seamus Cowman[2], Anne Hickey[2], Peter Kelly[3], Hannah McGee[2], Sean Murphy[4], Desmond O'Neill[5], Maeve Royston[2], Emer Shelley[2], Miriam Wiley[1]

[1]Economic and Social Research Institute, Whitaker Square, Sir John Rogerson's Quay, Dublin 2, Ireland
[2]Royal College of Surgeons in Ireland (RCSI), 123 St Stephens Green, Dublin 2, Ireland
[3]Mater Misericordiae University Hospital/University College Dublin, Dublin Academic Medical Centre, Dublin 4, Ireland
[4]Mater Misericordiae University Hospital/RCSI (formerly of Midland Regional Hospital Mullingar/RCSI)
[5]Trinity College Dublin/The Adelaide and Meath Hospital, Dublin, Ireland

Address correspondence to: S. Smith. Email: samantha.smith@esri.ie

Abstract

Background: stroke is a leading cause of death and disability globally. The economic costs of stroke are high but not often fully quantified. This paper estimates the economic burden of stroke and transient ischaemic attack (TIA) in Ireland in 2007.
Methods: a prevalence-based approach using a societal perspective is adopted. Both direct and indirect costs are estimated.
Results: total stroke costs are estimated to have been €489–€805 million in 2007, comprising €345–€557 million in direct costs and €143–€248 million in indirect costs. Nursing home care and indirect costs together account for the largest proportion of total stroke costs (74–82%). The total cost of TIA was approximately €11.1 million in 2007, with acute hospital care accounting for 90% of the total.

Conclusions: the chronic phase of the disease accounts for the largest proportion of the total annual economic burden of stroke. This highlights the need to maximise functional outcomes to lessen the longer term economic and personal impacts of stroke.

Keywords: *stroke, transient ischaemic attack, cost of illness, elderly*

Introduction

Available studies estimate that, in Western countries, 2–5% of total health-care costs are due to cerebrovascular diseases [1, 2]. 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 [2–4]. This paper adds to available evidence on the economic burden of stroke, drawing on the Irish experience. The costs of transient ischaemic attack (TIA) in Ireland are also estimated.

The Irish context is of particular interest, giving an example of a health-care system where stroke services remain relatively underdeveloped [5] and where there is a complex mix of public and private provision, with implications for the composition of the cost burden. Until recently, stroke and TIA received relatively little attention in the Irish health system and there has been limited investigation of costs [6, 7]. The first Irish National Audit of Stroke Care (INASC) highlighted substantial deficits in primary and secondary prevention, hospital treatment, rehabilitation and other services [5]. Many of the Audit's recommendations for service improvements (e.g. 24-h availability of thrombolysis therapy, development of stroke units) have cost implications. In addition, increasing age is a key risk factor for stroke. In European terms, Ireland has a relatively young population. However, as the population is increasing and the proportion aged 65 years and older in Ireland is projected to rise from 11 to 15% by 2021, the health and economic impact of stroke is set to increase [8, 9]. Understanding the current resource use and costs of stroke and TIA is important to inform priority setting and health service planning.

Methods

Overview of methodology

This is a prevalence-based study, examining the total costs of stroke and TIA in Ireland in 2007, aggregating the costs for those living with the consequences of stroke and those experiencing a stroke in 2007. This contrasts with an incidence-based study which estimates the lifetime costs of a disease for a specific cohort of new cases. A societal perspective is adopted which includes costs incurred by the national government and by private organisations and individuals. Direct costs of health care for stroke patients and indirect costs (productivity losses) are included. For TIA, direct costs of acute hospital care and medications are estimated. In line with other studies, intangible costs such as the cost of suffering and the loss of quality of life are excluded. Stroke is defined according to the International Classification of Diseases (10th revision) including subarachnoid haemorrhage, intracerebral haemorrhage, cerebral infarction and stroke not specified as haemorrhage or infarction (i.e. ICD-10 codes I60, I61, I63 and I64). TIA is defined according to the ICD-10 codes: G45.0, G45.2, G45.3 and G45.9.

Epidemiological data

The North Dublin Population Stroke Study (NDPSS) is a prospective cohort study of stroke and TIA conducted in North Dublin (population of 294,592) using internationally recommended methods for measuring incidence (recruitment December 2005–November 2006) [10]. Age- and sex-specific stroke incidence rates are adopted from the NDPSS and applied to the 2007 Irish population (n = 7,735). Sensitivity analysis adopts incidence rates at the upper and lower bounds of the 95% confidence interval (5,290–11,491). Incidence includes first-ever and recurrent strokes. Treatment costs of a recurrent stroke are estimated to be the same as those for a first stroke [11].

Upper and lower estimates of total stroke prevalence in Ireland are used to estimate the costs of continuing care after acute stroke. The lower estimate (n = 28,330) combines data from the 2001 Health Module of the Quarterly National Household Survey [12] with an estimate of the number of stroke patients residing in nursing homes. The upper estimate is adopted from the World Health Organization Global Burden of Disease project (n = 46,873) [13]. For TIA, costs are estimated for the total number of TIA cases recorded in the national hospital database of in-patient care (Hospital In-Patient Enquiry, HIPE).

Direct costs for stroke

Acute hospital and in-patient rehabilitation costs are estimated for all incident cases. The costs of care for stroke discharges recorded in HIPE are calculated using two alternative methodologies for sensitivity: casemix-based costs and cost per bed-day. These are top-down methods, allocating total hospital costs across all hospital discharges on the basis of casemix units (measure of complexity of the

diagnostic-related group to which the case is assigned, incorporating the length of stay), and on the basis of the length of stay. A proportion of incident stroke cases are not captured in HIPE (e.g. those who die before receiving emergency care and those treated at home or at an emergency department (ED) without being admitted). To correct for under-counting, the national mean cost per ED attendance is applied to all incident cases not recorded in HIPE. An estimated 19% of incident cases discharged from hospital were referred for in-patient rehabilitation (non-acute hospital), for an average of 6 weeks, at the cost equivalent to that of a public nursing home bed per week.

Long-term nursing home care costs are estimated for all stroke cases residing in nursing homes (i.e. incident cases in the first year of stroke, and other 'net prevalent' cases who experienced a stroke in previous years), calculated by multiplying the unit cost of a nursing home bed per week by the relevant number of stroke patients (and by the number of weeks in 1 year). Unit costs are stratified by the type of nursing home (public/private) and by the functional dependency level of the patient. Unit costs range from €666 (private, low dependency) to €2,141 (public, maximum dependency) per week. Variations in dependency (as measured by the Barthel index) amongst stroke patients are estimated using evidence from the INASC where the majority are assigned to the most severe disability category [5].

Ambulatory care costs are estimated for all incident and net prevalent stroke cases living at home and in nursing homes. Each stroke patient is assumed to make one stroke-related specialist out-patient department (OPD) visit per year. While this is likely to underestimate the number of specialist OPD visits in the first year following stroke, this is balanced to some degree by the number of specialist OPD visits estimated for subsequent years [14]. The average cost per OPD attendance in public hospitals was approximately €160 in 2007. It is estimated that patients require two stroke-related general practitioner (GP) visits for every stroke-related OPD visit. The cost of a GP visit is proxied by the average capitation payment per visit received by GPs in respect of publicly funded patients (ranging from €13 to €78 per visit by age group) and by the average private fee charged per GP visit for private patients (€50 at GP clinic) [15].

Stroke-related medications include antithrombotic, lipid-lowering and anti-hypertensive medicines [5]. Data from the NDPSS and INASC are used to determine the proportions of stroke patients (both incident and net prevalent stroke cases living at home and in nursing homes) taking selected medications. Analysis focuses on patients taking the selected medications for the first time since stroke to increase the likelihood of capturing stroke-specific medication utilisation. For each stroke-related medication, the most commonly used medication code/s and the mean monthly costs are identified from national prescriptions data.

Community rehabilitation costs are estimated for public health nursing, dietetics, physiotherapy, occupational therapy and speech and language therapy. The average number of hours per week provided for stroke care by community-based rehabilitation staff (estimated from datasheets circulated to allied health professionals) is multiplied by the average weekly salary. These costs are increased by 15% to factor in overhead costs.

Data on stroke patient (incident and net prevalent cases living at home) utilisation of selected aids, appliances and home modifications are drawn from the Survey of Health, Ageing and Retirement in Europe (SHARE; 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)) [16]. Unit costs are obtained from available suppliers and other Irish sources. Data are collected from relevant voluntary agencies on their stroke-related expenditure.

Direct costs for TIA

The cost of acute hospital care for TIA discharges recorded in HIPE and the cost of stroke-related medications for TIA patients are calculated in the same way as for stroke.

Indirect costs of stroke

Indirect costs of stroke are estimated using the human capital method. The work and leisure time lost due to informal care-giving for stroke patients living at home (incident and net prevalent) in 2007 is multiplied by the estimated earnings of care-givers (proxied by the median wage of €16.3 per hour in 2007 [17]) or by the value of leisure time (proxied by one-third of the median wage in 2007 [18]). Data on principal economic status of informal care-givers and of the amount of informal care provided to stroke patients are drawn from national and international survey data (Census of Population [19], INASC [5], SHARE [16]) and available studies on informal care-giving for stroke patients. A range of 9–20 h of informal care per week gives a lower and upper estimate of informal care for stroke patients [18, 20, 21].

The work time lost in 2007 due to stroke, for incident and net prevalent cases living at home and in nursing homes, is multiplied by the estimated earnings of the patients (proxied by median wage in 2007 for those giving up paid work, and by minimum wage of €8.65 per hour in 2007 for those giving up unpaid domestic work). Irish estimates of the proportion of stroke patients giving up paid work due to ill health following stroke (47% [5] and 65% [22]) are consistent with international estimates [23, 24]. Low and high estimates are applied in this study to allow sensitivity analysis. The proportion of stroke patients giving

up domestic work due to ill health is estimated to be 18% [22]. For stroke patients not giving up paid/unpaid work following stroke, the production costs foregone during the time spent in hospital are estimated. For every day spent in hospital, it is estimated that two additional days are required for recovery before return to work [9].

Full details on prevalence data and on the unit costs and utilisation patterns for the cost items are presented in Supplementary data available in *Age and Ageing* online, Appendices 1 and 2.

Results

Total cost of stroke

Total direct costs of stroke are estimated as €345–€557 million in 2007, at baseline incidence rates (Table 1). Indirect costs were €143–€248 million in 2007 (at baseline incidence rates). Total estimated direct and indirect costs were €489–€805 million in 2007. These are lower bound estimates as they are based on the low estimates for acute hospital (using the casemix methodology) and indirect costs. Nursing home care accounts for more than 44% of the total costs. Productivity losses from stroke morbidity/mortality are the next largest category (>20%), followed by hospital care (>10% including in-patient rehabilitation) and informal care (>9%).

The majority of total direct stroke expenditure is publicly funded (79%) with out-of-pocket payments accounting for 19% of the total, and some private health insurance funding (3%).

Total cost of TIA

The total cost of acute hospital care (€9.9 million) and medications (€1.1 million) for TIA patients was estimated to be €11.1 million in 2007 (with hospital costs based on the casemix methodology).

Sensitivity analysis

Total stroke costs based on the upper estimate of stroke prevalence are 66% higher than those based on low prevalence (at baseline incidence). Shifts in incidence to the lower and upper boundaries of the 95% confidence interval around the baseline have <5% impact on the total stroke costs. Sensitivity to changes in parameters for individual cost elements is also examined. Changes in parameters for acute hospital, in-patient rehabilitation and indirect costs (i.e. cost per bed-day methodology for acute hospital care, increase in average number of informal care hours from 9 to 20 h per week, increase in percentage of stroke patients giving up paid work due to ill health from 47 to 65%) increase the total costs by 22–24%. The full range of total

Table 1. Total stroke costs in Ireland, 2007 (€000 and %)

Cost element	Low prevalence[a]				High prevalence[a]			
	n	€000	%	% of total	*n*	€000	%	% of total
Direct costs								
Acute hospital care[b]	7,735	70,798	20.5	14.5	7,735	70,798	12.7	8.8
In-patient rehabilitation	1,573	16,167	4.7	3.3	1,573	16,167	2.9	2.0
Nursing home care	3,477	216,591	62.7	44.3	6,004	414,216	74.3	51.4
GP care	27,306	3,737	1.1	0.8	45,849	6,342	1.1	0.8
OPD care	27,306	4,369	1.3	0.9	45,849	7,336	1.3	0.9
Medications	[e]	9,393	2.7	1.9	[e]	16,419	2.9	2.0
Community rehabilitation	[f]	6,355	1.8	1.3	[f]	6,355	1.1	0.8
Aids, appliances, home modifications	[g]	7,872	2.3	1.6	[g]	9,811	1.8	1.2
Voluntary agency services	[f]	9,945	2.9	2.0	[f]	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[c]	9,427	44,314	30.9	9.1	15,788	78,524	31.7	9.8
Productivity loss from morbidity and mortality[d]	[h]	99,182	69.1	20.3	[h]	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	28,330	488,723		100.0	46,873	805,214		100.0
Incident cases – total cost	7,735	174,374		35.7	7,735	174,108		21.6
Net prevalent cases – total cost	20,595	314,349		64.3	39,138	631,106		78.4
Total cost of stroke care	28,330	488,723		100.0	46,873	805,214		100.0

[a]Incidence at baseline.
[b]Costs based on the casemix methodology.
[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]Number of patients varies by type of medication.
[f]Number of patients not available—costs based on aggregate expenditure (i.e. total staff costs for community rehabilitation, total voluntary expenditure on stroke services).
[g]Number of patients varies by aid/appliance/modification.
[h]Number of patients giving up work varies by type of work (paid, domestic).

Table 2. Variation in total stroke costs in Ireland, 2007 (€000)

Cost element	Low prevalence[a]			High prevalence[a]		
	Incidence at lower CI[b]	Incidence at baseline[c]	Incidence at upper CI[d]	Incidence at lower CI	Incidence at baseline	Incidence at upper CI
Low hospital, rehabilitation and indirect estimates						
Incident cases – total cost	150,217	174,374	204,092	148,788	174,108	203,081
Net prevalent cases – total cost	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 cases – total cost	187,852	215,739	250,519	186,532	215,732	248,158
Net prevalent cases – total cost	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

[a]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).
[b]Incidence at lower confidence interval $n = 5,290$.
[c]Incidence at baseline $n = 7,735$.
[d]Incidence at upper confidence interval $n = 11,491$.

Table 3. Total incident stroke costs in Ireland, Australia, France and Germany (%)

	Ireland[a] % of direct/indirect costs	Australia % of direct/indirect costs	France % of direct/indirect costs	Germany % of direct/indirect costs
Direct costs				
Acute hospital care	48.3	48.0	46.5	63.4
In-patient rehabilitation	11.0	31.2	26.3	15.4
Nursing home care	30.0	11.5	9.6	2.3
GP care	0.7	0.7	[b]	3.4
OPD care	0.7	0.8	[b]	1.2
Medications	0.9	1.9	4.7	9.1
Community rehabilitation	4.3	3.4	11.4	1.5
Aids, appliances, home modifications	4.0	2.4	1.5	3.6
Voluntary agency services	–	na	na	na
Total direct costs	100.0	100.0	100.0	100.0
Indirect costs				
Informal care	20.1	100.0	na	na
Productivity loss from morbidity and mortality	79.9	na	na	100.0
Total indirect costs	100.0	100.0	na	100.0

Sources: Australia, France, Germany [2, 11, 25].
na = not available.
[a]High prevalence and incidence at baseline.
[b]GP and OPD costs included with community rehabilitation costs.

stroke costs in Ireland in 2007 was €470–€1,008 million (Table 2).

Table 3 compares the breakdown of total stroke expenditure for incident cases in Ireland with studies from Australia [25], France [11] and Germany [2].

Discussion

International comparisons

The total economic burden of stroke in Ireland in 2007 was estimated to be €489–€805 million in the baseline scenario. Direct expenditure on stroke accounted for 2–4% of total health expenditure and 0.2–0.3% of GNP in Ireland in 2007. This is in line with estimates in other countries although international comparisons are complicated by variations in methodologies, data sources and the range of costs included.

There is consistency across countries in the distribution of stroke costs, as illustrated with the international comparison of incidence-based costs. In both Irish and international studies, the main cost items for stroke include direct costs for acute hospital care and in-patient rehabilitation, nursing home care and indirect costs [26]. Nursing home care and indirect costs account for >70% of total stroke costs in Ireland, highlighting the chronic phase of stroke care as the most important factor in total stroke costs. Nursing home care accounts for a higher proportion of direct stroke costs in Ireland relative to other studies and this warrants further analysis. Relatively high levels of

disability amongst stroke survivors in Ireland have been observed in United Kingdom–Ireland comparisons [5]. This may partly reflect the fact that while effective treatments are available to reduce acute stroke morbidity and mortality (e.g. stroke unit care, thrombolysis and rehabilitation), these services are not universally provided in Ireland and this may be contributing to a greater need for long-term care. The national audit of patients receiving acute care in 2005 found that <2% of stroke cases were treated in a stroke unit and 1% received thrombolysis [5].

Medications account for a smaller proportion of direct costs in Ireland relative to other countries. This could be due to the focus in this study on stroke-related medications taken for the first time post-stroke, but could also be associated with low rates of secondary prevention strategies as reported in INASC [5].

This study has included expenditure by voluntary agencies on stroke services, estimated to account for 2–3% of total direct expenditure for prevalent cases. Data on this area are limited, but these estimates suggest the need for further analysis of the role of voluntary agencies in the provision of stroke services.

Data and methodological issues

Caution is required when extrapolating local incidence rates to wider populations [9, 13], although a number of cost of stroke studies have adopted this method [9, 27]. The use of age- and sex-specific stroke incidence rates in this study adjusts for differences in the demographic structure between the north Dublin and national populations. Estimated national stroke incidence is in line with the number of discharges with a principal diagnosis of stroke recorded in HIPE, allowing for additional cases that are treated in the community or in the ED, and secondary diagnoses of stroke. The study also undertakes sensitivity analysis around the baseline incidence rates as a further precaution against under- or overstating incidence-related costs.

Estimating total stroke prevalence in Ireland is also complicated. The most recent estimate indicates that total stroke prevalence could be as high as 58,778 [28], suggesting that total stroke costs in Ireland are closer to the higher end of the range presented in this study.

With TIA, a large number of cases may go undetected or unreported (e.g. older people attended to by their GP). By focusing only on TIA cases recorded in the acute hospital system, the costs of TIA in this paper are therefore likely to be underestimated. There are currently no estimates of the numbers of TIA patients who are managed in the community.

Given the range of data sources used in the analysis, it is important to assess the estimated costs individually. In particular, data limitations are concentrated in specific areas of stroke care in Ireland, and most notably in community rehabilitation. In addition, large gaps in the provision of multi-disciplinary rehabilitative services for stroke patients in the community and in long-term care have been highlighted by the INASC [5, 29].

For indirect costs, the human capital approach is criticised for overestimating the costs of foregone productivity. An alternative frictional cost approach focuses on the loss of productivity experienced during the period of time required to replace a sick worker [30], but this would require a large amount of detailed information. By focusing only on productivity foregone in 1 year, this study avoids overestimating productivity foregone related to future years and estimates the frictional period as a maximum of 1 year.

Conclusions

This study provides the first detailed analysis of total direct and indirect annual stroke and TIA costs using Irish-specific data. As in other countries, nursing home and indirect costs account for the largest proportion of total stroke costs, emphasising the importance of improving outcomes after acute stroke [31] to improve patients' quality of life and to reduce the economic burden of the chronic phase of the disease. The Irish perspective highlights the complexity in interpreting the economic burden of disease. There is a tension between estimating the costs of health care that exist, and those that should exist. In the Irish case, there are indications that current nursing home costs are higher than they might otherwise be if more timely acute care reduced the level of disability in stroke survivors and associated need for long-term care. Conversely, given the deficiencies in nursing home and community rehabilitation services, it is likely that the current expenditure levels are lower than they should be if adequate levels of rehabilitation were made available. These examples emphasise the need for further analysis to unpick the reasons behind the estimated cost of a specific disease in order to inform policy appropriately.

Key points

- Total cost of stroke and TIA in Ireland is estimated to have been €500–€816 million in 2007.
- The total cost of stroke comprised €345–€557 million in direct costs and €143–€248 million in indirect costs.
- The chronic phase of the disease (e.g. nursing home care and indirect costs) accounts for the largest proportion of the total annual economic burden of stroke.
- The total cost of TIA in Ireland was approximately €11.1 million in 2007.

Acknowledgements

Sincere thanks to the Irish Heart Foundation (IHF), the IHF Council on Stroke and to colleagues from the North Dublin Population Stroke Study, the Department of

Pharmacology and Therapeutics, Trinity Centre, St James's Hospital, to Professor David Whitford (RCSI-MUB Bahrain) and Professor Ronan Conroy (RCSI) and to many other health service personnel for their support and contribution to this study.

Conflicts of interest

None declared.

Funding

This work was supported by the Irish Heart Foundation.

Supplementary data

Supplementary data mentioned in the text is available to subscribers in *Age and Ageing* online.

References

1. Evers SM, Struijs JN, Ament AJ *et al*. International comparison of stroke cost studies. Stroke 2004; 35: 1209–15.
2. Rossnagel K, Nolte C, Muller-Nordhorn J *et al*. Medical resource use and costs of health care after acute stroke in Germany. Eur J Neurol 2005; 12: 862–8.
3. Finkelstein E, Corso P. Cost-of-illness analysis for policy making: a cautionary tale of use and misuse. Expert Rev Pharmacoecon Outcomes Res 2003; 3: 367–9.
4. Saka O, McGuire A, Wolfe C. Cost of stroke in the United Kingdom. Age Ageing 2009; 38: 27–32.
5. Irish Heart Foundation. Irish Heart Foundation National Audit of Stroke Care. Dublin: Irish Heart Foundation, 2008.
6. McGowan B, Heerey A, Tilson L, Ryan M, Barry M. Cost of treating stroke in an Irish teaching hospital. Irish Med J 2003; 96: 234–6.
7. McHugh JC, Murph RP, Sobocki P. Cost of disorders of the brain in Ireland. Irish Med J 2007; 100: 518–21.
8. Layte R, Barry M, Bennett K *et al*. Projecting the Impact of Demographic Change on the Demand for and Delivery of Healthcare in Ireland. ESRI Research Series 132009. Dublin: Economic and Social Research Institute.
9. Dewey HM, Thrift AG, Mihalopoulos C *et al*. Cost of stroke in Australia from a societal perspective. Results from the North East Melbourne stroke incidence study (NEMESIS). Stroke 2001; 32: 2409–16.
10. Feigin VL, Vander Hoorn S. How to study stroke incidence. Lancet 2004; 363: 1920–1.
11. Spieler J, de Pouvourville G, Amarenco P. Cost of a recurrent vs. cost of first-ever stroke over an 18-month period. Eur J Neurol 2003; 10: 621–4.
12. Central Statistics Office. QNHS Microdata File2001: © Government of Ireland.
13. Truelsen T, Piechowski-Józwiak B, Bonita R *et al*. Stroke incidence and prevalence in Europe: a review of available data. Eur J Neurol 2006; 13: 581–98.
14. Brown D, Boden-Albala B, Langa K *et al*. Projected costs of ischemic stroke in the United States. Neurology 2006; 67: 1390–5.
15. The Competition Authority, Competition in Professional Services. General Medical Practitioners. Dublin: The Competition Authority, 2009.
16. SHARE, Survey of Health, Ageing and Retirement in Europe, 2008.
17. Central Statistics Office. National Employment Survey 2007–2009. Dublin: Stationery Office. © Government of Ireland.
18. Dewey HM, Thrift AG, Mihalopoulos C *et al*. Informal care for stroke survivors: results from the North East Melbourne Stroke Incidence Study (NEMESIS). Stroke 2002; 33: 1028–33.
19. Central Statistics Office. 2006 Census of Population – Volume 7 – Principal Economic Status and Industries, 2007, Stationery Office. Dublin: Government of Ireland.
20. van Exel NJ, Brouwer WB, van den Berg B, Koopmanschap MA, van den Bos GA. What really matters: an inquiry into the relative importance of dimensions of informal caregiver burden. Clin Rehabil 2004; 18: 683–93.
21. Patel A, Knapp M, Evans A, Perez I, Kalra L. Training care givers of stroke patients: economic evaluation. Br Med J 2004; 328: 1102.
22. Tan KM, O'Driscoll A, O'Neill D. Factors affecting return to work post-stroke. J Nutr Health Ageing 2004; 8: 313.
23. Teasdale TW, Engberg AW. Psychosocial consequences of stroke: a long-term population-based follow-up. Brain Inj 2005; 19: 1049–58.
24. Glozier N, Hackett ML, Parag V, Anderson CS. The influence of psychiatric morbidity on return to paid work after stroke in younger adults: the Auckland Regional Community Stroke (ARCOS) Study, 2002 to 2003. Stroke 2008; 39: 1526–32.
25. Cadilhac DA, Carter R, Thrift AG, Dewey HM. Estimating the long-term costs of ischemic and hemorrhagic stroke for Australia. New evidence derived from the North East Melbourne Stroke Incidence Study (NEMESIS). Stroke 2009; 40: 915–21.
26. Ekman M. Economic evidence in stroke: a review. Eur J Health Econ, 2004; 5(Suppl 1): S74–83.
27. Saka O, Serra V, Samyshkin Y, McGuire A, Wolfe C. Cost-effectiveness of stroke unit care followed by early supported discharge. Stroke, 2009; 40: 24–9.
28. Balanda KP, Barron S, Fahy L, McLaughlin A. Making Chronic Conditions Count: Hypertension, Stroke, Coronary Heart Disease, Diabetes. A Systematic Approach to Estimating and Forecasting Population Prevalence on the Island of Ireland. Dublin: Institute of Public Health in Ireland, 2010.
29. Cowman S, Royston M, Hickey A *et al*. Stroke and nursing home care: a national survey of nursing homes. BMC Geriatr, 2010; 10: 4.
30. Tarricone R. Cost-of-illness analysis. What room in health economics? Health Policy 2006; 77: 51–63.
31. Navarrete-Navarro P, Hart W, Lopez-Bastida J, Christensen M. The societal costs of intracerebral hemorrhage in Spain. Eur J Neurol, 2007; 14: 556–62.

Received 8 April 2011; accepted in revised form 25 August 2011