

First year post-stroke healthcare costs and fall-status among those discharged to the community

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ABSTRACT

Introduction: Falls are common post-stroke events but their relationship with healthcare costs is unclear. The aim of this study was to examine the relationship between healthcare costs in the first year after stroke and falls among survivors discharged to the community.

Patients and Methods: Survivors of acute stroke with planned home-discharges from five large hospitals in Ireland were recruited. Falls and healthcare utilisation data were recorded using inpatient records, monthly calendars and post-discharge interviews. Cost of stroke was estimated for each participant from hospital admission for one year. The association of fall-status with overall cost was tested with multivariable linear regression analysis adjusting for pre-stroke function, stroke severity, age and living situation.

Results: 109 stroke survivors with complete follow-up data (mean age=68.5 years (SD=13.5 years)) were included. 53 participants (49%) fell following stroke, of whom 28 (26%) had recurrent falls. Estimated mean total healthcare cost was €20,244 (SD=€23,456). The experience of one fall and recurrent falls was independently associated with higher costs of care ($p=0.02$ and $p<0.01$, respectively).

Discussion: The observed relationship between falls and cost is likely to be underestimated as aids and adaptations, productivity losses, and nursing home care were not included.

Conclusion: This study points at differences across fall-status in several healthcare costs categories, namely the index admission, secondary/ tertiary care (including inpatient re-admissions) and allied health care. Future research could compare the cost-effectiveness of inpatient versus community-based fall-prevention after stroke. Further studies are also required to inform post-stroke bone-health management and fracture-risk reduction.

MANUSCRIPT

INTRODUCTION

Stroke is a major cause of death and acquired disability that imposes a considerable burden on society¹. Care for people with stroke accounts for approximately 3% of annual healthcare expenditure in several countries including Ireland¹⁻³. Recent European studies have estimated healthcare costs of between €12,000 and €18,000 in the first year after stroke with the majority of these costs occurring in the first few months after the event²⁻⁶. Approximately 7,000 people are admitted to hospital with a stroke annually in Ireland and based on anticipated changes in the country's population demographics cost of stroke in Ireland is estimated to increase by over 50% between 2007 and 2021^{7,8}. It is therefore important to consider options for reducing costs and increasing the efficiency of post-stroke service provision.

Falls are common adverse events after stroke and may contribute to increased costs. Stroke survivors fall at almost twice the rate and have four times the risk of hip fracture compared with healthy aged-matched adults^{9,10}. It is estimated that approximately 50% of those discharged home fall in the first year with up to 40% falling repeatedly and 5% experiencing fractures¹¹⁻¹³. In older adults, falls have been found to be associated with increased healthcare utilisation, independent of age and comorbidities¹⁴. Irish estimates for 2004 show fracture-related admissions for older adults cost an average of €8331 per inpatient stay¹⁵. To our knowledge, little is known about the relationship between post-stroke falls and costs. The aim of this study was to estimate cost of stroke care in Ireland in the first year among survivors discharged to the community, and to examine the relationship between falls and cost.

METHODOLOGY

Study Design

From a multicentre, prospective cohort study (the Falls Related EvEnts after Stroke (FREESE) Study)¹⁶, we obtained patient-level healthcare cost relating to Medical treatment, rehabilitation, regular care costs and informal care-provision.

Healthcare Context

Although Irish residents are entitled to receive care through the public healthcare system, delays and limited availability of post-discharge rehabilitation services lead some stroke survivors to pay for services in addition to those provided by the national health service^{7,17}. Unfortunately, unlike some other European countries, Ireland does not have centralised or linkable utilisation databases^{4,7}. Therefore, the current study collected patient-reported healthcare utilisation data about all services provided, independent of funding.

Participants

We recruited adults with a diagnosis of acute ischaemic or haemorrhagic stroke from five large teaching hospitals in the city of Dublin between November 2013 and August 2014. Those with a planned discharge home to the community were recruited consecutively. We excluded stroke survivors discharged to a nursing home and those unable to provide consent due to severe cognitive deficits (Mini Mental State Exam <18)¹⁸ or severe receptive language deficits (as judged by treating Speech and Language therapists). Ethical approval was received from each hospital's Research Ethics Committee and all participants provided written informed consent.

Baseline data collection

Demographic and clinical data were collected from medical records. Stroke severity on admission was rated using the National Institutes of Health Stroke Scale (NIHSS)¹⁹. If not recorded in the notes, as occurred with 50% of participants, this was conducted retrospectively using an established method²⁰ and strokes were classified as mild (NIHSS 1–4), moderate (NIHSS 5–15) or severe (NIHSS >15)²¹. The number of comorbid conditions recorded in the hospital admission notes were recorded if included in the Functional Comorbidity Index²². Participants reported their pre-stroke function based on the Nottingham Extended Activity of Daily Living (NEADL) scale and a score between 0 to 22 (low to high function) was calculated²³.

Falls data collection

In accordance with international recommendations, a fall was defined as “an unexpected event in which participants came to rest on the ground, floor, or lower level”²⁴. Inpatient fall-status was established through a post-discharge phone call with participants. Falls that occurred after discharge from hospital

were recorded both prospectively using participant-completed calendars and retrospectively through face-to-face interviews at six months and phone interviews at one year. A 'faller' was defined as a participant who experienced at least one fall over the follow-up period. Participants who experienced at least two falls were designated as 'recurrent fallers'.

Healthcare utilisation data collection

Healthcare utilisation was recorded from hospital admission to one year after discharge in all participants. Length of inpatient stay (including in a rehabilitation hospital) was recorded from medical records. Participants' self-reported post-discharge healthcare utilisation was recorded both prospectively using participant-completed calendars and retrospectively through structured interviews at six and one year after discharge. The number of visits to the following services was recorded: general practitioner (GP), outpatient services, emergency department, public health nurse, physiotherapist, occupational therapist, speech and language therapist, dietician, psychologist, optician, dentist, chiropodist, hearing services, alternative therapist, day care and respite care. Participants also reported their number of re-admissions as an inpatient and nights spent in hospital. The source and frequency of any regular help received was recorded. It was classified as informal (from friends and family) or formal care. At the final interview, participants reported their pre-stroke and current employment status.

Cost estimation

Total cost of stroke was calculated for each participant based on healthcare utilisation and unit costs. Sub-categories of cost were calculated as follows: Cost of index admission, post-discharge primary care, secondary/ tertiary care (including inpatient re-admissions), post-discharge allied health services, other post-discharge services, regular formal care and regular informal care.

Unit costs were extracted from existing Irish sources and adjusted to 2014-price levels using the national Consumer Price Index for Health^{7,25-27}. Unit costs and sources for each service are presented in Supplemental Table 1. Costs are expressed in Euro (€). The cost of informal care was estimated based on an assumption that it replaces approximately 50% of formal care. The cost of informal care is not included in the total cost of stroke but is presented separately. Total cost did not include productivity losses, but the number of individuals affected by a change in employment status was estimated. The

number of hours of formal and informal care received by participants over the first and second six-month periods post-discharge was estimated as detailed in Table 1.

Statistical analysis

Data were analysed using Stata Version 13.1 for Mac (StataCorp). Cost for non-fallers was compared with that of 'one-time fallers' and 'recurrent fallers' using univariable linear regression for each cost category. Univariable linear regression analysis was conducted to explore the association between several factors (fall-status, pre-stroke status (NEADL), stroke severity (NIHSS), age and living situation) and total cost. Explanatory variables were chosen to account for factors that may influence baseline pre-stroke healthcare utilisation and the cost of the stroke itself²⁸. Fall-status as a variable represented the stroke-recovery phase in the analysis. Age was categorised as conducted in a large prospective study of community-dwelling older adults in Ireland that has shown a relationship between healthcare utilisation and age²⁸. An a priori decision was made to dichotomise NIHSS as <5 points or 5+ points as this cut-off is used to clinically distinguish mild from moderate/severe stroke. A multivariable linear regression model was used to test the association of fall-status with overall cost with adjustment for the other factors. A significance level of $p < 0.05$ was used for all analyses.

Sensitivity analysis

Five sensitivity analyses were conducted:

- i. Participants with costs above the 95th and below the 5th percentiles of cost were excluded.
- ii. Higher unit costs for allied healthcare services were assigned by applying costs to estimated patient contact hours rather than total hours worked by therapists⁷.
- iii. A lower cost was applied to time spent in an offsite rehabilitation facility compared with the acute hospital.
- iv. Costs calculated from estimated hours of regular formal care were excluded.
- v. Cost was weighted to a 1-year time period for all participants to account for the variable follow-up time due to different lengths of acute stay in hospital.

RESULTS

In total 322 stroke survivors were referred, 270 were potentially eligible, 128 were recruited and 109 (67 men and 42 women) completed all follow-up interviews. Figure 1 shows the flow of participants through recruitment and follow-up. Participants had a mean age of 68.5 years (SD=13.5) at baseline. Their median pre-stroke NEADL score was 18 (Interquartile range =16–21), signifying good function, and the median NIHSS score was 3 (Interquartile range=2–7), indicating mild-moderate stroke. The mean total follow-up time-period was 395 days (SD=32 days). Initial median length of inpatient stay was 14 days (range 2–163 days). For 16% of participants (n=17), this included days at a rehabilitation facility. A further 13% received Early Supported Discharge (ESD). Seventeen participants (16%) had a previous stroke, and 20 (19%) had a fall in the prior year. Table 2 shows further participant characteristics at baseline by post-stroke fall-status.

Over 95% of participants visited their GP, 57% attended a physiotherapist and 59% received informal care during follow-up. The proportion of participants who used each service and their number of visits is presented in Supplemental Table 2. Table 3 shows the proportion of each fall-category that used each category of care. Notably, 100% of recurrent fallers, 72% of one-time fallers and 57% of non-fallers received community allied healthcare. At the end of the follow-up period, 18 of the 31 (58%) individuals who were employed pre-stroke had ceased working.

During the follow-up period, almost half of participants fell (n=53), 26% repeatedly (n=28). Six 'one-time' and five 'recurrent fallers' experienced falls in hospital. After at least one of their falls, 21 fallers (40% of fallers) reported seeking healthcare advice, while 10% of fallers (n=5) reported sustaining fractures.

The total mean cost of care over the first year was estimated at €20,244 (SD=€23,456). The median cost was €10,425 (IQR=€5,937–€28,429). Table 3 shows sub-categories of cost by fall-status. Recurrent fallers had a statistically higher cost of their index admission ($p<0.01$) and post-discharge allied healthcare services ($p<0.01$) than non-fallers. Recurrent fallers also had significantly higher overall cost (mean €12,730 higher, 95% CI €2,181–€23,280). As shown in Table 3, the only category of cost that was significantly higher for one-time fallers than non-fallers was the cost of secondary/ tertiary care. One-time fallers spent a mean of 13.4 nights in hospital during re-admissions (SD=35.1), in

comparison to a mean of 2.6 nights (SD=8.2) for non-fallers. The mean cost of informal care was estimated at €2,512 (SD=€4,682), €1,361 (SD=€2,213), and €3,422 (SD=€4,851), for non-fallers, one-time fallers and recurrent fallers, respectively. No significant association was found between the cost of informal care and single falls ($p=0.27$) or recurrent falls ($p=0.36$).

Table 4 shows the results of univariable and multivariable linear regression analyses. Higher cost of stroke care was associated with both the experience of one fall or recurrent falls ($p<0.01$) when compared to not falling, independent of pre-stroke reported functional status, age, stroke severity and living status. Table 5 shows the results of the sensitivity analyses. Excluding participants outside the top and bottom fifth percentile of cost had the largest effect on the overall cost of stroke care. In all analyses, the experience of recurrent falls remained statistically associated with total cost when compared with the experience of no falls, adjusting for factors outlined in Table 4.

DISCUSSION

This study examined the relationship between fall-status and the healthcare costs of community-dwelling individuals following stroke. The experience of recurrent falls during the follow-up period was found to be associated with higher costs of stroke care overall, a higher cost of the index admission and a higher cost of post-discharge allied healthcare services. Furthermore, when controlling for age, pre-stroke reported function, stroke severity and living status, the experience of both a single fall and recurrent falls were independently associated with higher costs. In this cohort, the estimated average cost of care was €20,244. This is in line with previous international studies using similar methodologies^{4,5}. It is also similar to an Irish 2007 prevalence-based estimate cost of €18,751 per stroke in the first year²⁹. In addition, the post-stroke falls incidence in this cohort is in keeping with similar prospective studies^{9,13}. Despite the majority of participants (93%) having mild-moderate strokes, half of participants still experienced a fall.

In this study, we present the categories of healthcare costs that drive the statistical association between overall cost and the experience of falls in this population, namely inpatient care initially after the stroke or due to a re-admission. Those who fall recurrently over the first year are also the individuals who received the highest level of allied healthcare after discharge. Community-based services however, as

seen in prior studies, do not contribute significantly to the overall cost of care as they are relatively inexpensive^{1,6}. This study does not claim to attribute healthcare costs purely to the fall events themselves. We do know that after at least one of their falls, 40% of fallers sought healthcare advice and 10% sustained fractures that required medical care. Falls experienced during stroke recovery have an important relationship with perceived falls-risk, fear of falling, and implementation of falls-prevention interventions³⁰ that could contribute to overall cost both before and after the fall event itself. Fallers post-stroke in this and previous studies were found to have a longer initial inpatient stay¹³. Those deemed to be at risk of falls are likely kept longer in hospital for rehabilitation¹³. Early Supported Discharge (ESD) is a service that accelerates hospital discharge by providing rehabilitation at home⁷. It is considered to be best international practice post-stroke, but only 5% of stroke survivors in Ireland currently access it³¹⁻³³. Wren and colleagues in 2014 estimated that developing ESD in Ireland could save €2–7 million⁷. As community-based interventions have not been shown to reduce falls after stroke thus far³⁴, further research should explore whether ESD could reduce healthcare costs after stroke while providing adequate falls-prevention rehabilitation.

Re-admissions to hospital are another important contributor to average costs in each fall category. Interestingly, fall-status in this study was statistically associated with the category of secondary/ tertiary care for one-time fallers only. Large standard deviations suggest that this cost was driven by a small number of individuals. Sensitivity analysis also revealed that excluding very high-cost users resulted in the experience of one-time falls no longer being independently associated with overall healthcare costs. Fractures and other injuries requiring inpatient admission are potentially expensive and can occur even with a single fall¹⁵. Bone density assessment to facilitate targeted introduction of treatments to reduce the likelihood of post-stroke fractures may have the potential to reduce overall costs of care following stroke³³, but this requires further research.

Strengths and limitations

While self-report of healthcare utilisation in the post-discharge period may have been affected by compliance and recall bias, it has been shown to be comparable to administrative databases in previous research, particularly for high cost care³⁵. Within the Irish system, the lack of a centralised utilisation database and the high rate of privately accessed care makes self-report necessary². Ideally, self-report of inpatient falls would be verified using both incident report systems and medical records

but this was not considered feasible in the current multi-site study due to limited resources³⁶, a major strength of this study is that we collected post-discharge falls and healthcare utilisation data using a combination of prospective diaries and retrospective interviews²⁴. While this resulted in collection of detailed information about falls and healthcare utilisation, it must be acknowledged that sample size is relatively small, resulting in wide 95% confidence intervals in regression analyses.

While the study had a low attrition rate in the follow-up phase (<15%) and included stroke survivors across 5 large university teaching hospitals^{9,12,31}, it must be noted that of the 270 individuals originally determined to be potentially eligible, only 41% were recruited and completed follow-up. This may affect the external validity of the study. The majority of those who were not recruited or followed-up in the current study had either short lengths of stay in hospital (i.e. <3 days) or did not participate due to perceived burden of the study. This could include both the lowest and highest users of healthcare. It is therefore unclear to what extent this could have influenced the observed association between falls and cost.

We have tested assumptions of our methodology by performing several sensitivity analyses. This has increased our confidence in the observed statistical relationship between healthcare cost and falls in this population. It is likely that the strength of this association been underestimated. Total cost of stroke care did not include the cost of aids or home adaptations, which are recommended falls prevention interventions in current stroke care guidelines³³. Informal care was not found to be associated with fall-status in the current study. Previous research has found however that carers may be reluctant to leave stroke survivors at home alone due to perceived falls-risk even in the absence of falls³⁷. We acknowledge that care provided by friends and family can reduce the burden of stroke on society but may also result in carers being unable to continue in paid employment, thus contributing to the 'indirect' financial cost of stroke². However, we opted to exclude the cost of informal care from 'total cost' in our study design to facilitate comparisons with data from the vast majority of related studies^{1,7}.

The current study focused on survivors discharged to the community who account for 66% of those who experience a stroke in Ireland³¹. This study does not purport to estimate the cost of care for all persons with stroke as it excludes those discharged to nursing homes or those who died as inpatients. Productivity losses amongst stroke survivors themselves were not accounted for in the current study

either and this may also have underestimated costs. Between 17% and 28% of participants in the current study were affected by changes in employment. In a recent Dutch study⁶, 29% of stroke survivors experienced productivity losses, accounting for 10% of overall costs.

CONCLUSION

This study points at differences across fall-status in several healthcare costs categories, namely the index admission, secondary/ tertiary care (including inpatient re-admissions) and allied health care. The relationship between increased overall cost of care and fall-status exists independently of pre-stroke factors and stroke severity. Future research could compare both the effectiveness and cost of inpatient versus community-based fall-prevention interventions. Further studies are also required to inform post-stroke bone-health management and fracture-risk reduction.

DECLARATIONS

Conflicting interests: The Authors declare that there is no conflict of interest.

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Informed consent: Written informed consent was obtained from all participants for their anonymised information to be published in this article.

Ethical approval: Four research ethics committees approved this study: Beaumont Hospital, Mater Misericordiae University Hospital, St Vincent's Healthcare Group and Tallaght/ St James's Hospitals

Guarantor: MEW

Contributorship: MEW was involved in study design, performed data collection, data analysis and drafted the manuscript. JS advised on and assisted with data analysis and assisted in drafting of manuscript. RG and NFH were involved in study design and supervised data collection and analysis. DW, JH, SM, RC, DMC and MC were involved in study design and assisted with recruitment. All authors edited drafts of manuscript and approved the final version for submission.

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Table 1. Estimation of care hours during six-month period

Description of frequency of care	Calculation*	Total hours for six-month time period
All the time	7 hours/day x 130 weekdays	910
Most of the day	4 hours/day x 130 weekdays	520
1-2 times per day	1 hour/day x 130 weekdays	130
Few times each week	2 hours/week x 26 weeks	52
Once weekly or less	1 hour/week x 26 weeks	26

*Assumption of weekday service during "office hours"⁷ and equal distribution of service use across each six-month time period

Table 2. Detailed participant characteristics at baseline by post-stroke fall-status (n=109)

Characteristic	Category	Non-fallers (n=55)		One-time fallers (n=25)		Recurrent fallers (n=28)		All participants (n=109)	
		n	(%)	n	(%)	n	(%)	n	(%)
Stroke subtype	Ischaemic	48	(87)	23	(92)	23	(82)	96	(88)
	Haemorrhagic	7	(13)	2	(8)	5	(18)	12	(11)
Initial Stroke severity	Mild (NIHSS 0-1)	11	(20)	3	(12)	3	(11)	17	(16)
	Mild (NIHSS 2-3)	20	(36)	7	(28)	7	(25)	34	(31)
	Mild (NIHSS 4-5)	9	(16)	7	(28)	7	(25)	23	(21)
	Moderate (NIHSS 6-15)	13	(24)	4	(16)	9	(32)	26	(24)
	Severe (NIHSS >15)	1	(2)	0	(0)	1	(4)	2	(2)
Number of comorbid conditions recorded	0	17	(31)	7	(28)	8	(29)	32	(29)
	1	16	(29)	4	(16)	8	(29)	28	(26)
	2	11	(20)	7	(28)	7	(25)	25	(23)
	3+	12	(22)	7	(28)	5	(18)	24	(22)
Living status	Lives alone	15	(27)	7	(28)	4	(14)	27	(25)
	Lives with spouse	31	(56)	10	(40)	20	(71)	61	(56)
	Lives with other family/ other	9	(16)	7	(28)	2	(7)	18	(17)
Pre-stroke employment status	Employed	17	(31)	4	(16)	10	(36)	31	(29)
	Not employed/ retired	39	(71)	20	(80)	17	(61)	76	(71)
Fall in year prior to stroke	Fall in year prior	12	(22)	2	(8)	6	(21)	20	(19)
	No fall in year prior	41	(75)	22	(88)	22	(79)	85	(81)

Table 3. Sub-categories of cost by fall-status (2014 costs in €)

Healthcare service category	Non-Fallers (n=56)			One-time Fallers (n=25)			Recurrent fallers (n=28)			Linear regression*	
	n (%) using service	Mean (€)	SD (€)	n (%) using service	Mean (€)	SD (€)	n (%) using service	Mean (€)	SD (€)	p-value one-time faller	p-value recurrent faller
Index Admission	56 (100%)	10,695	10,954	25 (100%)	10,290	10,109	28 (100%)	19,605	19,851	0.90	<0.01**
Primary care	55 (98%)	340	505	25 (100%)	295	176	28 (100%)	416	189	0.62	0.40
Secondary and tertiary care	14 (25%)	1,783	5,617	11 (44%)	9,193	23,980	13 (46%)	3,347	8,423	0.02**	0.60
Allied Health	32 (57%)	538	946	18 (72%)	1,019	2,002	28 (100%)	1,802	1,597	0.16	<0.01**
Other Healthcare Services	45 (80%)	161	195	18 (72%)	124	126	25 (89%)	205	212	0.42	0.30
Formal Care	17 (30%)	1,476	4,228	9 (36%)	2,708	7,251	12 (43%)	2,350	5,176	0.34	0.48
Total Cost		14,994	16,052		23,629	30,576		27,724	26,814	0.12	0.02**

*Non-faller= reference category

**Statistically significant at 95% confidence level

Table 4. Linear regression analysis with total cost as outcome

Variable	Category	Univariable analysis				Multivariable analysis*		
		Co-efficient (€)	95% CI (€)	Constant	P-value	Co-efficient (€)	95% CI (€)	P-value
Fall status (Ref=Non-faller)	One-time faller	8,635	-2,328–19,599	14,994	0.12	15,163	4,442–25,884	<0.01**
	Recurrent faller	12,730	2,181–23,280		0.02**	14,297	3,845–24,748	<0.01**
Age (Ref=<50 years)	50-59 years	-2,126	-20,796–16,544	-7,500	0.82	-7,262	-24,209–9,685	0.40
	60-69 years	3,843	-13,268–20,954		0.66	-1,569	-17,112–13,974	0.84
	70-79 years	4,369	-11,930–20,668		0.60	5,139	-10,242–20,520	0.51
	80+ years	16,818	-623–34,260		0.06	10,111	-6,455–26,676	0.23
Stroke Severity (Ref=NIHSS <5)	Moderate/Severe (NIHSS 5+ points)	14,948	5,841–24,055	15,097	<0.01**	13,301	4,351–22,252	<0.01**
Living status	Lives alone	13,988	4,019–23,958	16,585	<0.01**	15,617	5,883–25,351	<0.01**
NEADL Scale	1 point intervals	-358	-744–27	48,966	0.07	-220	-592–152	0.24

*Constant= -5812, Adjusted R²=0.27 (With all 5 variables included in model)

NIHSS= National Institutes of Health Stroke Scale, NEADL= Nottingham Extended Activities of Daily Living

Table 5. Sensitivity analyses

Analysis description	Total mean cost	% Change in cost from base analysis	p-value (One-time fallers)*	p-value (Recurrent fallers)*
Exclusion of top and bottom 5% cost users (<€2,458, >€65,379)	€17,111	19% decrease	0.08	<0.01
Assigning higher cost to allied health services	€20,702	2% increase	<0.01	<0.01
Excluding estimated hours of care from cost	€18,681	8% decrease	<0.01	<0.01
Assigning nursing home cost to offsite rehabilitation	€18,168	10% decrease	<0.01	<0.01
Indexing length of cost period to 365 days for all participants	€17,778	12% decrease	<0.01	0.01

*Multivariable linear regression, controlling for factors as in Table 4. Reference category= "Non- fallers"

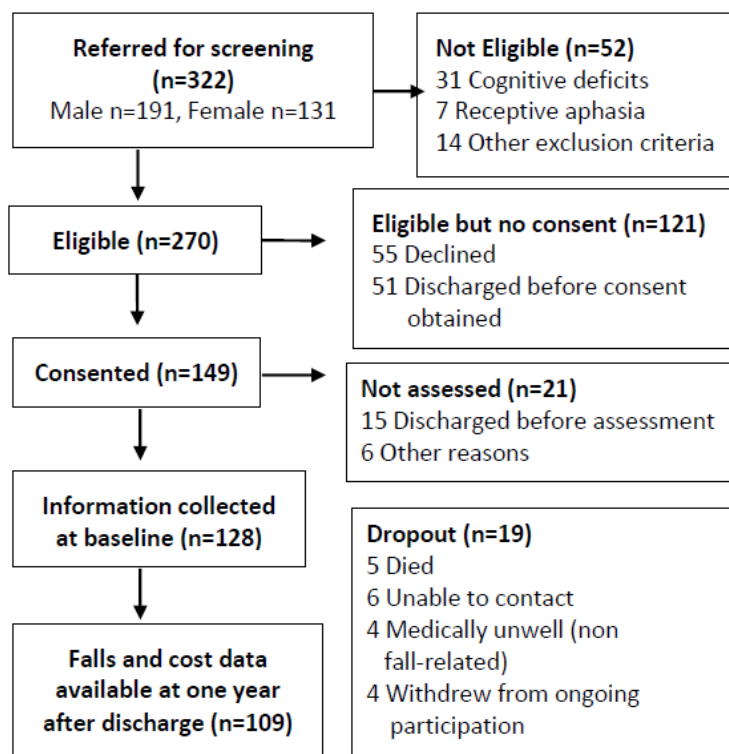


Figure 1. Flow diagram of participants through recruitment and follow-up process

First year post-stroke healthcare costs and fall-status among those discharged to the community

Walsh ME, Sorensen J, Galvin R, Williams DJP, Harbison JA, Murphy S, Collins R, McCabe DJH, Crowe M, Horgan NF

SUPPLEMENTARY MATERIAL

Supplemental Table 1. Unit costs and sources

Resource Category	Unit cost (2014)	Unit	Source of data	Comments
Index admission	€472	Night	Health Service Executive (HSE) Casemix Programme Ready Reckoner for 2013 ¹	A weighted average cost per night was calculated across inpatient severity levels of the Stroke Diagnosis Related Group based on cost and utilisation data. This was multiplied by participants' total inpatient length of stay prior to returning home. This approximates all resources used while in hospital/ inpatient rehabilitation.
Primary care				
General Practitioner	€48	Visit	Wren et al 2014 ²	Average of cost for medical card and private coverage
On-call General Practitioner	€81	Visit	Smith et al 2010 ³	Based on out-of-hours nursing home visit under medical card
Public health nurse	€33	Visit	Wren et al 2014 ²	Hourly rate applied to 20 minute average visit
Secondary and tertiary care				
Outpatient Consultant	€132	Visit	Wren et al 2014 ²	Cost per visit
Emergency Department	€271	Visit	HSE Casemix Ready Reckoner 2013 ¹	Cost per non-admission visit
Inpatient Night	€684	Night	HSE Casemix Ready Reckoner 2013 ¹ and Economic and Social Research Institute 2012 ⁴	As the reasons for inpatient re-admissions were not known, a generic cost per night was calculated by dividing the Inpatient 'Base Price' of €4,580 by the average length of stay for inpatients in acute hospitals in Ireland in 2011 of 6.7 days
Allied health services				
Physiotherapy	€80	Visit	Wren et al 2014 ²	The lower cost provided in the report was used. Wren et al calculated this cost by applying costs to total hours worked by therapists. It assumes a visit of 1 hour duration
Occupational Therapy	€78	Visit	Wren et al 2014 ²	
Speech and Language Therapy	€75	Visit	Wren et al 2014 ²	

Resource Category	Unit cost (2014)	Unit	Source of data	Comments
Dietician	€74	Visit	Brick et al 2015 ⁵	Assumes 30 minute visit
Psychology	€284	Visit	Brick et al 2015 ⁵	Assumes 1 hour visit
Other healthcare services				
Optician	€32	Visit	National Consumer Agency Survey of Opticians September 2011 ⁶	Based on average cost of standard eye exam
Dentist	€39	Visit	Brick et al 2015 ⁵	Average of medical card and private cost
Chiroprapist	€69	Visit	Brick et al 2015 ⁵	Assumes 30 minute visit
Hearing services	€32	Visit	National Consumer Agency Survey of Opticians September 2011 ⁶	Assumption made that cost of hearing test would be comparable to cost of eye exam
Alternative therapies	€64	Visit	Brick et al 2015 ⁵	Assumes 1 hour visit
Formal care				
Day Care	€36	Day	Brick et al 2015 ⁵	Based on HSE service in Midlands region
Respite Care	€139	Night	Brick et al 2015 for nursing home cost ⁵	Per night cost calculated based on weekly nursing home of €958
Personal Care Assistant	€22	Hour	Brick et al 2015 ⁵	Assumes 1 hour visit
Meals on Wheels	€11	Meal	Wren et al 2014 ²	Cost per meal
Home Help**	€22	Hour	Wren et al 2014 ²	Assumes 1 hour visit
Voluntary Organisation	€22	Hour	Brick et al 2015 ⁵	Assumes same cost of "other paid help"
Informal care	€11	Hour	Brick et al 2015 for Home Help cost ⁵	Assumes half of informal care replacing home help and half part of normal social interaction
Sensitivity analyses				
Physiotherapy	€131	Visit	Wren et al 2014 ²	Wren et al estimated higher cost of rehabilitation services by applying costs to estimated patient contact hours rather than total hours worked by therapists
Occupational therapy	€128	Visit	Wren et al 2014 ²	
Speech and Language therapy	€124	Visit	Wren et al 2014 ²	The Health Service Executive (HSE) Casemix Programme Ready Reckoner does not include separate costs for inpatient rehabilitation. Smith et al estimated the cost of post-stroke off-site inpatient rehabilitation based on the average weekly Nursing Home cost. For individuals who received all their rehabilitation onsite in the acute hospital, no reduction in cost was calculated
Inpatient rehabilitation	€206	Night	Smith et al 2010 ³	

*Many unit costs calculated by Brick et al⁵ are based on wages, salary costs, overheads and capital overheads using the Personal Social Services Research Unit methodology. **"Home help" in the Irish context refers to assistance with domestic work usually provided by non-profit organisations⁷

Supplemental Table 2. Post-discharge healthcare services utilisation (n=109)

Healthcare service	Participants using service, n (%)		n= those using each service	
			Median number of visits (IQR)	Mean number of visits (SD)
Primary care				
General Practitioner*	104	(95.4)	4 (2,7)	5.1 (3.3)
On-call General Practitioner visit	15	(13.7)	1 (1, 2)	1.6 (1.4)
Public health nurse	54	(49.5)	2 (1, 5)	6.0 (14.4)
Secondary and tertiary care				
Outpatient consultant visit	98	(89.9)	2 (1, 4)	3.1 (2.4)
Emergency department visit	37	(33.9)	1 (1, 2)	1.5 (0.7)
Inpatient re-admission	38	(34.8)	Visits: 1 (1, 2) Nights: 5.5 (1, 14)	Visits: 1.5 (1.1) Nights: 16.3 (29.8)
Post-discharge Allied Health Services**				
Physiotherapy	62	(56.8)	6 (3, 12)	9.4 (9.4)
Occupational Therapy	43	(39.4)	3 (2, 6)	5.0 (5.9)
Speech and Language therapy	26	(23.8)	3 (1, 8)	6.0 (6.4)
Dietician	25	(22.9)	1 (1, 2)	1.7 (0.9)
Psychology	16	(14.6)	4 (1, 8.5)	6.1 (6.7)
Other healthcare services				
Optician	52	(47.6)	1 (1, 2)	1.5 (1.0)
Dentist	40	(36.7)	2 (1, 3)	2.6 (2.2)
Chiropracist	38	(34.8)	3 (1, 4)	3.1 (2.1)
Hearing services	20	(18.3)	1 (1, 2.5)	1.8 (1.0)
Alternative therapies	10	(9.2)	4 (2, 6)	3.3 (2.7)
Regular formal care				
Day Care	19	(17.4)	12.5 (6, 30)	32.0 (49.7)
Respite Care	5	(4.5)	Visits: 1 (1,2) Nights: 25 (14, 42)	Visits: 1.4 (0.5) Nights: 34.2 (29.7)
Personal Care Assistant***	19	(17.5)	130 hours (104, 260)	300.4 hours (340.5)
Meals on Wheels***	5	(4.5)	130 hours (52, 130)	93.6 hours (50.7)
Home Help***	16	(14.6)	78 hours (52,130)	126.8 hours (151.9)
Voluntary Organisation***	3	(2.7)	26 hours (26,26)	26 hours (0)
Regular Informal care***	64	(58.7)	156 hours (52, 650)	384.3 hours (449.8)

*Mean and median values refer to "minimum" number of visits as participants reported ranges (i.e. 1, 2–3, 4–6, >6 visits)

**Includes visits related to Early Supported Discharge service

***Number of hours have been estimated based on frequency of service use reported within first six-month and second six-month period per Table 1

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