ESRI

Working Paper No. 469

October 2013

Deriving a Method to Estimate Incidence of Stroke in Ireland

Maev-Ann Wren[1] and Peter Kelly[2]

Abstract: This paper assesses the validity of estimating stroke incidence employing discharge data from the Hospital Inpatient Enquiry (HIPE) database, adjusted to reflect evidence from the North Dublin Population Stroke Study (NDPSS). This analysis compares contemporaneous HIPE stroke discharges among North Dublin residents to hospitalised stroke patients in the NDPSS and finds no significant difference between the datasets' measures of hospitalised stroke cases in five North Dublin hospitals. We find that in estimating incidence, HIPE discharges with principal and secondary stroke diagnoses should be included but patients admitted for rehabilitation should be excluded to avoid duplication. The HIPE-based estimate should be further adjusted to reflect the NDPSS evidence of non-hospitalised stroke incidents.

Corresponding author: Maev-Ann.Wren@esri.ie

Key words: stroke, incidence

[1] Economic and Social Research Institute, Whitaker Square, Sir John Rogerson's Quay, Dublin 2

[2] Dublin Academic Medical Centre – Mater University Hospital, Eccles Street, Phibsborough, Dublin 7/University College Dublin, Belfield, Dublin 4

Acknowledgements: We would like to gratefully acknowledge the contributions made to this paper by Aisling Mulligan and Miriam Wiley as well as participants in a seminar held at the ESRI and members of the steering group of the Stroke Rehabilitation in Ireland project.

Deriving a Method to Estimate Incidence of Stroke in Ireland

1. Introduction

To assess the adequacy of Irish stroke rehabilitation services relative to need on a regional basis, it is desirable to estimate stroke incidence by region. There is no data source for Irish regional stroke incidence per se. However, the Hospital Inpatient Enquiry (HIPE) database records discharges for patients with a diagnosis of stroke and such patients' area of residence. HIPE collects demographic, clinical and administrative data on discharges from, and deaths in, acute public hospitals nationally. From HIPE data, it has been possible to calculate stroke discharges and live discharges by region of residence, as well as by other variables such as age, gender and discharge destination (Wren et al. 2013). By matching the discharges by area of residence from HIPE, disaggregated by age and gender, to the population by HSE Region, similarly disaggregated, it is possible to estimate regional discharge rates. Discharge rates cannot be assumed, however, to represent the incidence of stroke. Furthermore, in the absence of a unique patient identifier, it is not possible to link HIPE data to other records of non-hospitalised stroke incidents such as death certificates.

In contrast to the HIPE hospital-sourced count of stroke discharges, the only comprehensive study of stroke incidence in Ireland, the North Dublin Population Stroke Study (NDPSS), identified incident and recurrent stroke events in 2005/2006 using multiple overlapping hospital and community sources, including acute and non-acute hospitals, general practitioners, nursing homes and review of death certificates and pathology or coroner's records (Kelly et al. 2012). The NDPSS found that, of patients with first ever stroke (FES) in North Dublin over the period December 2005 to November 2006, 90.5 per cent were admitted to hospital and 9.5 per cent were treated in the community (Kelly et al. 2012). This finding suggests that reliance on HIPE data alone would underestimate stroke incidence.

For this reason, in estimating the cost of stroke in Ireland, Smith et al. (2010) took the approach of applying the incidence rates by age and gender found in 2005/2006 in the NDPSS to the population as a whole in 2007, generating 7,735 estimated incident cases of stroke. Given evidence that the North Dublin population was not representative of the population as a whole (Smith et al. 2010: 84), this study also applied 95 per cent confidence limits to estimate population sensitivity parameters. The effect of this methodology was to place the potential incidence of stroke in Ireland in 2007 in a wide range of 5,290 to 11,491 cases. This compared to 5,514 discharges with a principal diagnosis of stroke recorded in HIPE 2007 (Smith et al. 2010: 83-85).

Since a specific focus of the forthcoming Stroke Rehabilitation in Ireland study[i] is to identify regional differences in rehabilitation need and services, the objective of the analysis in this paper is to assess the validity of adopting an alternative approach to estimating incidence, employing HIPE discharges as the primary source for regional incidence estimates with a correction factor to reflect the divergence between HIPE and the NDPSS. The degree of divergence between HIPE and the NDPSS is analysed by matching the NDPSS count of

hospitalised patients with stroke to contemporaneous discharges from HIPE, identified as residing in the NDPSS population area by North Dublin postcode.

The next section describes how the HIPE and NDPSS datasets differ under a number of headings. Section 3 explains how the two datasets have been reconciled, insofar as possible given these differences, and the findings from this exercise. Section 4 concludes and discusses the correction factor derived from this analysis, its application and limitations.

2. HIPE and NDPSS Datasets

2.1 Time period

The NDPSS identified individuals residing in North Dublin who had experienced a stroke over a 12-month period (December 1, 2005–November 30, 2006). The HIPE database records discharges from hospitals (including deaths) of patients with a diagnosis of stroke. It is possible to extract from HIPE the discharges occurring in the period covered by the NDPSS (December 1, 2005–November 30, 2006).

2.2 Discharges versus incident strokes

By definition, the discharges extracted from HIPE for these dates will not necessarily coincide with the patients recorded as hospitalised with occurrence of a stroke in the NDPSS. Whereas the NDPSS records a stroke event within this 12-month period; HIPE records a stroke discharge within the same period. Depending on patient length of stay, differing patients may be captured in each dataset.

2.3 Individual-patient data versus discharges

The NDPSS recorded data for individual patients. HIPE records discharges, which may include multiple discharges for the same patient. HIPE is not permitted to disclose patients' individual medical record numbers to researchers. Thus, the HIPE data extracted for the same period as the NDPSS may contain duplicate patients.

2.4 Residence basis

The boundaries of the population-based NDPSS were defined using District Electoral Divisions (DEDs). The source population was quantified from 2006 census data for North Dublin, giving a population of 294,529 individuals, 7 per cent of the Irish population (Kelly et al. 2012). HIPE records area of residence using postcodes. It is not possible to match DED and postcode boundaries exactly.

2.5 Hospital-based and multiple sources

The NDPSS used multiple data sources including acute and non-acute hospitals, general practitioners, nursing homes and review of death certificates and pathology or coroner's records (Kelly et al. 2012); HIPE data are collected within hospitals and exclude patients who present and die in the Emergency Department or in an ambulance en route to hospital; as

well as patients who experience a stroke, are treated and may have died at home, in a nursing home or other non-HIPE hospital setting.

3. Reconciling HIPE and NDPSS data

3.1 Data extract from HIPE

For this analysis, an initial extract was downloaded from the HIPE database covering all patients discharged between December 1st 2005 and November 30th 2006.

3.2 Identification of HIPE discharges from North Dublin

The DEDs included in the NDPSS population were identified from the Census 2006 Small Area Population Statistics. The HIPE Dublin postal codes were sourced from the HIPE Instruction Manual. Postcodes were mapped to the North Dublin DEDs by inspection of DED boundaries using the CSO Census 2006 SAPMAP application (http://census.cso.ie/sapmap2006/).

Table 1 Mapping of HIPE postcodes to NDPSS DEDs

Postcode	Areas within HIPE postcode which overlap with NDPSS DEDs	Areas within HIPE postcode not included in NDPSS DEDs
0101	North Wall, North Docks	
0103	Ballybough, Clonliffe, Clontarf, Dollymount, East Wall, Fairview, Marino	
0105	Artane, Coolock, Harmonstown, Raheny	
0107	Arbour Hill, Cabra, Four Courts, Phibsboro	
0109	Beaumont, Drumcondra, Elm Mount, Griffith Avenue, Santry, Whitehall	Some Santry addresses
0111	Ballygall, Cappagh, Cremore, Finglas, Jamestown, Wadelai	Dubber, Kilshane
0113	Donaghmede	Baily, Baldoyle, Bayside, Howth, Sutton
0117	Belcamp, Clonshaugh, Darndale, Priorswood, Riverside	Balgriffin

The HIPE postcode areas of residence do not exactly map to the NDPSS DEDs (Table 1). However, for most of the postcodes the mapping is reasonably close. The exception is postcode 0113, which includes populous areas of North Dublin that are not included in the NDPSS DEDs. While other postcodes encompass some non-NDPSS areas, these areas are either small or relatively unpopulated. In identifying HIPE discharges from the NDPSS population area, discharges were included for patients whose areas of residence fell within the postcodes shown in Table 1 with the exception of postcode 0113. The HIPE extract

described under 3.1 above was accordingly reduced to only these discharges. Excluding postcode 0113 had the consequence of excluding discharges from Donaghmede, an area in which stroke incidents would have been included in the NDPSS.

3.3 Identification of HIPE stroke discharges from North Dublin

The HIPE extract was further reduced to include only those inpatient discharges with a principal or secondary diagnosis of stroke.[3] In 2005 and 2006, HIPE collected a principal diagnosis for each discharge, together with up to nineteen additional diagnosis codes. Diagnoses and procedures were coded using the 10th Revision of the International Classification of Diseases, Australian Modification, 4th Edition (ICD-10-AM) incorporating the Australian Classification for Health Interventions (ACHI)(National Centre for Classification in Health (NCCH) 2004).The HIPE codes for the extracted discharges were: subarachnoid haemorrhage (I60); intracerebral haemorrhage (I61); cerebral infarction (I63); or stroke, not specified as haemorrhage or infarction (I64).

3.4 Selection of hospital categories for comparison of datasets

In comparing the two datasets, HIPE discharges were further restricted to those from five North Dublin hospitals that were included in the NDPSS. Discharges from hospitals that specialise in rehabilitation which were included in the NDPSS were excluded in this comparison because, within HIPE, they were more likely to duplicate cases already recorded as discharges from acute hospitals.

3.5 Selection of patient/discharge categories for comparison of datasets

The HIPE stroke discharges were further reviewed to exclude discharges with a secondary diagnosis of stroke and a principal diagnosis of rehabilitation[4], which were also likely to duplicate cases recorded as discharges from acute hospitals. Following the restriction of the HIPE discharges to non-rehabilitation hospitals, all such discharges were found to have been removed already.

To ensure the greatest degree of comparability between the two datasets, day cases and discharges that were followed by transfer to another hospital or home after a stay of less than one day were excluded from the HIPE dataset. These categories of discharge were judged more likely to include duplicates. The HIPE dataset for comparison was therefore restricted to patients who had an inpatient length of stay of at least one day or whose

[3] In HIPE, a principal diagnosis is defined as the "diagnosis established after study to be chiefly responsible for occasioning the episode of admitted patient care". A secondary diagnosis is defined as "a condition or complaint either coexisting with the principal diagnosis or arising during the episode of admitted patient care. Interpreted as conditions that affect patient management." (ESRI 2009)

[4] The relevant discharge codes are Z48.8, which is assigned to patients with a diagnosis of 'postoperative convalescence', who transfer from one hospital to another and who are still receiving active treatment; Z50, which is assigned to patients who are admitted specifically for rehabilitation; and Z54, which is assigned to patients with a principal diagnosis of convalescence. Extracted from NCCH eBook(National Centre for Classification in Health (NCCH) 2004) .

treatment was not as a day case or succeeded by transfer to another hospital or home. The NDPSS dataset for comparison was limited to patients who were described as hospitalised.

3.6 Comparison of HIPE stroke discharges and NDPSS stroke incidence

There is a close correspondence between HIPE's record of stroke discharges for residents of North Dublin as defined above and the NDPSS count of hospitalised patients with stroke from the same five North Dublin hospitals over the same 12-month period (Table 2). HIPE records 499 discharges with a principal and/or secondary diagnosis of stroke and the NDPSS records 507 patients who were hospitalised with first-ever or recurrent stroke. Notwithstanding the imprecise reconciliation of areas of residence and the other differences in methodology between the two datasets, the difference between the two datasets' alternative measures of stroke incidence giving rise to hospitalisation in these hospitals in the North Dublin population in 2005/2006 is statistically insignificant.[5] This exercise in comparison gives some comfort to the use of HIPE as a basis for estimating hospitalised stroke cases, provided both principal and secondary diagnoses of stroke are included.

Table 2 HIPE discharges and NDPSS stroke incidents, 5 North Dublin hospitals, December 1st 2005 to November 30th 2006

	HIPE 5 North Dublin hospitals	NDPSS 5 North Dublin hospitals
Principal diagnosis stroke	416	
Secondary diagnosis stroke	101	
Overlap of principal and secondary diagnosis stroke	18	
Total stroke discharges (excluding overlaps)	499	
First-ever or recurrent stroke cases identified from hospitals		516
Stroke patients hospitalised		507

Source: HIPE (2005/2006) and NDPSS. Note HIPE discharges may include duplicates. Due to differences in methodology, it cannot be assumed that these counts represent the same patients (see 2.2 above).

3.7 NDPSS evidence on non-hospitalised stroke cases

The evidence from the NDPSS of stroke cases that were not admitted to acute hospitals is the basis for the proposed correction factor to be applied to estimate regional stroke incidence and rehabilitation need using HIPE data. The NDPSS identified 61 stroke incidents, representing 11 per cent of total incident strokes, which did not give rise to acute hospital inpatient treatment in the five hospitals included in this comparison. Such cases included: patients whose treatment was entirely in the hospital Emergency Department; patients who died at home and were identified from coroners' records; and patients who were identified within the community or in long-term care settings. (In comparison, HIPE records a further

[5] Using McNemar's test (Pocock 2006)

12 stroke discharges among residents in the included North Dublin postcode areas, who were admitted to acute hospitals other than the 5 North Dublin hospitals surveyed by the NDPSS.)

3.8 HIPE live discharges and NDPSS evidence of time to death

Since the focus of the SRI study is stroke rehabilitation, it is necessary to identify patients who would benefit from rehabilitation i.e. those for whom the stroke does not lead to early death. HIPE records patients who were discharged from or died in hospital. The NDPSS offers much greater detail about disability and death for up to two years after stroke, recording deaths at time after stroke. NDPSS recorded that of the 507 hospitalised patients in the 5 North Dublin hospitals above, 90 had died at 28 days after stroke and 119 at 90 days after stroke.

Of the 499 discharges recorded by HIPE for the same 5 North Dublin hospitals in 2005/2006, 131 or 26 per cent of all stroke discharges were in-hospital deaths. HIPE records that at 28 days length of stay, there were 85 in-hospital deaths; and at 90 days length of stay, there were 114 in-hospital deaths, statistically insignificant differences to the post-stroke deaths recorded by the NDPSS (Table 3). This finding suggests that HIPE corresponds reasonably closely to the NDPSS in the count of hospitalised patients' who die post-stroke.

Table 3 HIPE in-patient deaths and NDPSS deaths post-stroke, 5 North Dublin hospitals, Dec 1st 2005-Nov 30th 2006

	HIPE 5 North Dublin hospitals	NDPSS 5 North Dublin hospitals
In-hospital post-stroke deaths at 28 days length of stay	85	
Deaths at 28 days post-stroke		90
In-hospital post-stroke deaths at 90 days length of stay	114	
Deaths at 90 days post-stroke		119

Source: HIPE (2005/2006) and NDPSS

A correction factor for stroke patients, who are not admitted to an acute hospital (and are not therefore captured by HIPE) but who may require rehabilitation services, can be derived by examining the early fatalities recorded for the non-hospitalised stroke incidents in the NDPSS. Of the 61 stroke incidents recorded in the NDPSS, which did not lead to acute hospital admission within these five hospitals, 31 per cent resulted in death within 72 hours, 34 per cent within seven days, 41 per cent within 28 days and 46 per cent within 90 days. This high rate of early deaths in stroke patients who are not admitted to hospital is unsurprising, since many of these stroke incidents were recorded in coroners' records and/or could have occurred in a hospital Emergency Department. For the purpose of deriving regional stroke incidence of patients who require rehabilitation services, the

correction factor for non-hospitalised patients should reflect their high rate of early death from stroke. In the NDPSS, while non-hospitalised patients represent 11 per cent of incident strokes overall, they represent 8.8 per cent of survivors at 72 hours post-stroke and 8.5 per cent of survivors at 90 days.

4. Conclusion

Contemporaneous stroke inpatient discharges recorded in HIPE accord sufficiently closely with the North Dublin Population Stroke Study's evidence of hospitalised incidents of stroke to support the use of HIPE data to estimate regional incidence of stroke. Such use of HIPE data to estimate incidence is subject to some provisos:

- This accordance arises only when both principal and secondary diagnoses of stroke in HIPE are included in the estimate of incidence;
- To reduce potential double-counting in HIPE discharges, it is advisable to exclude: discharges from rehabilitation hospitals; discharges from other hospitals with a principal diagnosis of rehabilitation; and discharges with a length of stay of less than one day that were followed by transfer to another hospital or home;
- The estimate derived from HIPE should be adjusted to take into account stroke incidents which do not give rise to acute hospitalisation.

The foregoing analysis of the NDPSS suggests an upwards adjustment of 9 per cent of stroke survivors at discharge is indicated, when estimating stroke survivors requiring rehabilitation services. If it is intended to estimate stroke incidences, including early deaths from stroke, the NDPSS evidence would suggest a higher 11 per cent adjustment factor. It is acknowledged that the factors which determine hospitalisation or non-hospitalisation may differ across regions so that these adjustments are approximations. Furthermore, given the ability of HIPE to identify discharges of residents of an area from acute hospitals outside that area, it could be the case that the NDPSS-derived adjustment factors, suggested here, would give rise to an over-estimate of incidence when applied to all HIPE discharges for residents of an area. The potential for duplicate cases to arise in HIPE may also lead to an over-statement of incidence. While cognisant of the limitations of this approach to estimating stroke incidence, in the absence of a unique patient identifier and/or national stroke register, this comparative exercise supports the use of HIPE data to estimate stroke incidence.

5. References

ESRI, 2009. Hospital In-patient Enquiry Scheme (HIPE) Data Dictionary 2009 Version 1.0, Economic and Social Research Institute.

Kelly, P. J., G. Crispino, O. Sheehan, L. Kelly, M. Marnane, A. Merwick, N. Hannon, D. Ni Chroinin, E. Callaly, D. Harris, G. Horgan, E. B. Williams, J. Duggan, L. Kyne, P. McCormack, E. Dolan, D. Williams, J. Moroney, C. Kelleher and L. Daly, 2012. "Incidence, event rates, and early outcome of stroke in Dublin, Ireland: the North Dublin population stroke study." *Stroke* **43**(8): 2042-2047.

National Centre for Classification in Health (NCCH), 2004. "The International Statistical Classification of Diseases and Related Health ProblemsTenth Revision, Australian Modification (4th Edition)". e book. Sydney, NCCH, Faculty of Health Sciences, The University of Sydney.

Pocock, S. J., 2006. "The simplest statistical test: how to check for a difference between treatments." *British Medical Journal* **332**(May): 1256-1258.

Smith, S., F. Horgan, E. Sexton, M. Wiley, S. Cowman, A. Hickey, P. Kelly, H. McGee, S. Murphy, D. O'Neill, M. Royston and E. Shelley, 2010. Cost of Stroke in Ireland. Estimating the annual economic cost of stroke and transient ischaemic attack (TIA) in Ireland. Dublin, Irish Heart Foundation.

Wren, M.-A., S. Smith, F. Horgan, A. Hickey and K. Kearns, 2013. "Stroke Rehabilitation in the Irish Health-Care System Interim Report: Overview of current rehabilitation services and pathways of care for stroke patients in Ireland". Unpublished, Economic and Social Research Institute (ESRI) and the Royal College of Surgeons in Ireland (RCSI).

[1] The Stroke Rehabilitation in Ireland project aims to examine rehabilitation services for stroke patients in the Irish health-care system, identifying patterns of use and assessing implications (economic, health outcomes) of existing and new models of care. Rehabilitation, which focuses on recovering lost function, reducing the risk of a recurrent event, and optimising quality of life can have an important impact on the overall clinical and economic burden of stroke not just for the stroke survivor but also for the family/caregiver, the health-care system and the economy. The project is led by researchers from the ESRI and the Royal College of Surgeons in Ireland and is funded by the Irish Heart Foundation. The project is ongoing and is due to report in 2013.

Year	Number	Title/Author(s) ESRI Authors/Co-authors *Italicised*
2013		
	468	The Impact of Parental Income and Education on the Schooling of Children Arnaud Chevalier, Colm Harmon, Vincent O'Sullivan, Ian Walker
	467	SME Credit Constraints and Macroeconomic Effects *Petra Gerlach-Kristen, Brian O'Connell* and *Conor O'Toole*
	466	Transitions In and Out of Unemployment Among Young People in the Irish Recession *Elish Kelly, Seamus McGuinness, Philip O'Connell,* David Haugh and Alberto González Pandiella
	465	The Impact of the Recession on the Structure and Labour Market Success of Young NEET Individuals in Ireland *Elish Kelly* and *Seamus McGuinness*
	464	How do banking crises affect aggregate consumption? Evidence from international crisis episodes *Petra Gerlach-Kristen*, *Brian O'Connell* and *Conor O'Toole*
	463	Negative Equity in the Irish Housing Market: Estimates using loan level data *David Duffy*, ESRI and Niall O'Hanlon, CSO
	462	Decomposing patterns of emission intensity in the EU and China: how much does trade matter? *Valeria Di Cosmo* and *Marie Hyland*
	461	When to invest in carbon capture and storage technology in the presence of uncertainty: a mathematical model *D.M. Walsh,* K. O'Sullivan, W.T. Lee, and M. Devine
	460	The HERMES-13 macroeconomic model of the Irish economy *Adele Bergin, Thomas Conefrey, John FitzGerald, Ide Kearney* and *Nuša Žnuderl*
	459	Smoking Outside: The Effect of the Irish Workplace Smoking Ban on Smoking Prevalence Among the Employed *Michael Savage*
	458	Climate policy, interconnection and carbon leakage: the effect of unilateral UK policy on electricity and GHG emissions in Ireland *John Curtis, Valeria Di Cosmo,* Paul Deane

For earlier *Working Papers* see

http://www.esri.ie/publications/search_for_a_working_pape/search_results/index.xml