

# Should there be an age split for stroke DRGs? Analysing a large clinical data set of a principal teaching hospital over a five-year period

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## Abstract

The aim of this study was to analyse the inpatient statistics collection relating to stroke patients admitted to a major teaching hospital, with particular reference to length of stay, and to assess the adequacy of the diagnosis related group (DRG) as a predictor of length of stay. The study subjects were selected by DRG to identify all stroke inpatients admitted and discharged between 1 July 1995 and 30 June 2000. There were 1365 stroke discharges (half of whom were over 75 years of age at discharge) over the period of the study. The median length of stay was 8 days, and 67% of the subjects experienced complications and/or comorbidities. Age was significantly associated with increased length of stay of stroke patients, independent of complications or comorbidities.

These findings raise the question of whether casemix-based funding should be based solely on DRGs for complicated conditions such as stroke, or whether additional measures such as age should be used for funding allocation. This study provides a model that health information managers and other researchers could use to analyse inpatient statistics collections at state, territory or national levels.

**Keywords:** *Cerebrovascular accident; diagnosis related groups; DRGs; reimbursement mechanisms; health statistics; health information*

## Background

State and territory inpatient statistics collections contain a wealth of demographic and clinical data regarding all patients admitted to public and private hospitals in Australia. These collections provide valuable information to assist in the planning and funding of health services. They also provide an important basis for epidemiological and medical research. This study was undertaken to ascertain whether the age and/or associated health conditions of stroke patients influenced their length of stay in hospital. A number of research studies relating to various diagnosis related groups (DRGs) have identified that age and complications and/or comorbidities are key predictors of resource use (Gillett, 1992; Basser et al, 1994). If casemix-based funding for stroke patients is to be based on average length of stay for DRGs and there is no provision for age of patients in the current stroke DRG, hospitals may not be reimbursed adequately for treating older stroke patients who stay longer than the state average length of stay.

The method used to investigate whether age or other health conditions affected the length of stay of stroke patients was an analysis of the data contained in a hospital inpatient statistics collection database. This study provides a model which health information managers and others can use to analyse the inpatient statistics collection at state, territory or national levels.

## Aim of the study

The study had three aims:

- i. To analyse the inpatient statistics collection of stroke patients of a major teaching hospital to identify age, gender, and number and type of complications and comorbidities for a 5-year period;
- ii. To analyse the adequacy of the stroke DRG without age splits as a predictor of length of stay; and

- iii. To provide a protocol which can be used by researchers in the analysis of a hospital's inpatient statistics collection database.

## Literature review

'Stroke' is also known as a cerebrovascular accident, disease or infarction and is classified as ischaemic, haemorrhagic, embolic or thrombotic. All types of stroke can damage a part of the brain and lead to death or disability (Barnett et al, 1998). Some 40,000 people in Australia are affected each year, half of whom are over the age of 75 years (Anderson, 1993). Stroke represents a substantial burden to western countries and is the third leading cause of death in Australia after cardiovascular disease and malignancy. The incidence of stroke rises with age, and elderly patients tend to have a longer length of stay because they have more complications and comorbidities. Furthermore, severity of illness and casemix complexity of patients tend to increase with age. The use of acute and rehabilitation facilities is likely to increase with the rise in the size of the elderly population, as well as the decrease in mortality and increase in morbidity of stroke (Australian Institute of Health and Welfare, 2001; Jamrozik et al, 1999).

It is acknowledged that stroke patients have a longer length of stay compared with patients admitted for other acute conditions (Beech et al, 1999), as do elderly patients (Flamer et al, 1996; Nakayama et al, 1994). Henderson and colleagues (1990) found that the proportion of admissions in the final year of life significantly increased over time in all age groups ( $P < 0.01$ ), although their study population was limited to National Health Service (NHS) patients in Oxford, England. The results of a study in male Wistar rats by Sutherland and colleagues stress the importance of age in models of cerebral ischaemia (Sutherland et al, 1996). It has been shown that treatment of patients in

a stroke unit compared with treatment in a conventional hospital ward resulted in a shorter length of stay in stroke patients (Jorgensen et al, 1995; Wentworth et al, 1996).

The literature supports the view that complications following hospitalisation for acute conditions contribute substantially to longer periods in hospital (Stineman et al, 1998). The association between increasing age and both length of stay and complication rates has been reported (Cullen et al, 1994; Kim et al, 1993). Various researchers have found different factors related to increased length of stay, for example: the significance of cognitive impairment for rehabilitation (Galski et al, 1993); motor task impairment (Brock et al, 1995); and delayed discharge (Van Straten et al, 1997).

Casemix refers to the number and type of patients treated in a health care service. It describes the degree of treatment required, the use of resources and the cost of treating patients. Casemix complexity refers to the characteristics of patient admissions, including degree of condition, prognosis, level of difficulty to treat, intervention required, and use of resources. Diagnosis related groups (DRGs) are used

to relate the casemix of a hospital to resources required; they were developed at Yale University, USA, in 1978 (3M Health Information Systems and Commonwealth Department of Human Services and Health, 1993). Australian National Diagnosis Related Group (AN-DRG) version 1 was developed in Australia based on the American grouper AP-DRGs version 8. Older patients are likely to have longer hospital admissions and more complications and comorbidities. Version 1.0 of the AN-DRGs definitions manual only partially accounted for older age (Basser et al, 1994). Therefore, hospitals that treat a large elderly population may be disadvantaged if funding is based on DRGs (Gillett, 1992). Whilst there have been changes to subsequent versions of the grouper, it is yet to account for the elderly and more complex stroke patient.

**Method**

The study was undertaken at The Prince of Wales/Prince Henry Hospital, a principal teaching hospital of the University of New South Wales. The researchers investigated all adult stroke inpatient

**1: Number of separations in each DRG of all adult stroke separations from the Prince Henry/Prince of Wales Hospital between 1 July 1995 and 30 June 2000**

Diagnosis related group*	Gender		Number
	Male	Female	Total
DRG 37 – Cerebrovascular disorders except transient ischaemic attack with complication or comorbidity	444 (49%)	471 (51%)	915 (67%)
DRG 38 – Cerebrovascular disorders except transient ischaemic attack without complication or comorbidity	231 (51%)	219 (49%)	450 (33%)
<b>Total</b>	<b>675 (100%)</b>	<b>690 (100%)</b>	<b>1365 (100%)</b>

\*Diagnosis Related Group, Australian National Diagnosis Related Groups, version 3.0

**2: Frequency of each ICD-9-CM principal diagnosis code which grouped to DRGs 37 and 38, of all adult stroke separations from the Prince Henry/Prince of Wales Hospital from 1 July 1995 to 30 June 2000**

ICD-9-CM*	Description	Frequency	Total
434.91	Cerebral artery occlusion with mention of cerebral infarction	511	(37.4%)
436	Acute, but ill-defined, cerebrovascular disease	384	(28.0%)
431	Intracerebral haemorrhage	245	(17.9%)
430	Subarachnoid haemorrhage	45	(3.3%)
434.01	Cerebral thrombosis with mention of cerebral infarction	41	(3.0%)
434.11	Cerebral embolism with mention of cerebral infarction	35	(2.6%)
437.1	Other generalized ischaemic cerebrovascular disease	22	(1.6%)
434.9	Cerebral artery occlusion without mention of cerebral infarct	19	(1.4%)
437.7	Transient global amnesia	17	(1.2%)
432.1	Subdural haemorrhage	13	(1.0%)
437.3	Cerebral aneurysm, nonruptured	12	(0.9%)
432.9	Unspecified intracranial haemorrhage	10	(0.7%)
434.1	Cerebral embolism without mention of cerebral infarction	6	(0.4%)
437.9	Unspecified cerebrovascular disease	3	(0.2%)
432	Non-traumatic extradural haemorrhage	2	(0.1%)
<b>Total</b>		<b>1365</b>	<b>(100%)*</b>

\*Inpatient separations coded to International Classification of Disease version 10 Australian Modification (ICD-10-AM) were mapped to the International Classification of Diseases version 9 Clinical Modification (ICD-9-CM) codes for the purposes of analysis. Percentage rounded.

**3: Frequency of principal diagnosis of adult stroke patient separations categorised by age under or over 40 years, from the Prince Henry/Prince of Wales Hospitals from 1 July 1995 to 30 June 2000**

ICD-9-CM code*	Description	Number			
		< 40 years		≥ 40 years	
430	Subarachnoid haemorrhage	10	(40%)	35	(2.6%)
434.01	Cerebral thrombosis with cerebral infarction	4	(16%)	37	(2.8%)
434.11	Cerebral embolism with cerebral infarction	4	(16%)	31	(2.3%)
434.91	Cerebral artery occlusion with cerebral infarction	3	(12%)	508	(37.9%)
431	Intracerebral haemorrhage	2	(8%)	243	(18.1%)
436	Acute, but ill-defined, cerebrovascular disease	2	(8%)	382	(28.5%)
437.1	Other generalized ischaemic cerebrovascular disease	-	-	22	(1.6%)
434.9	Cerebral artery occlusion without mention of cerebral infarct	-	-	19	(1.4%)
437.7	Transient global amnesia	-	-	17	(1.3%)
432.1	Subdural haemorrhage	-	-	13	(1%)
437.3	Cerebral aneurysm, non-ruptured	-	-	12	(0.9%)
432.9	Unspecified intracranial haemorrhage	-	-	10	(0.7%)
434.1	Cerebral embolism without mention of cerebral infarction	-	-	6	(0.4%)
437.9	Unspecified cerebrovascular disease	-	-	3	(0.2%)
432	Non-traumatic extradural haemorrhage	-	-	2	(0.1%)
	<b>Total</b>	<b>25</b>	<b>100%</b>	<b>1340</b>	<b>100%#</b>

\*ICD-9-CM = International Classification of Diseases version 9 Clinical Modification. # Percentage rounded.

**4: Number (percentage) by age group and gender of all adult stroke patient separations from the Prince Henry/Prince of Wales Hospitals from 1 July 1995 to 30 June 2000**

Age groups (years)	Frequency				Total	
	Male		Female			
14-29	4	(31%)	9	(69%)	13	(1%)
30-39	9	(75%)	3	(25%)	12	(1%)
40-49	33	(59%)	23	(41%)	56	(4%)
50-59	71	(61%)	45	(39%)	116	(9%)
60-69	155	(63%)	91	(37%)	246	(18%)
70-79	235	(51%)	224	(49%)	459	(34%)
80-89	152	(38%)	244	(62%)	396	(29%)
90-99	16	(24%)	51	(76%)	67	(5%)
<b>Total</b>	<b>675</b>	<b>(49%)</b>	<b>690</b>	<b>(51%)</b>	<b>1365</b>	<b>(100%)*</b>

\*Percentage rounded

separations (admissions and discharges) between 1 July 1995 and 30 June 2000.

The study subjects were selected by DRG (37 and 38) to identify all stroke patients. The system used for coding patient separations between June 1995 and June 1998 was the International Classification of Diseases version 9 Clinical Modification (ICD-9-CM) (National Coding Centre, 1996), and from July 1998 to June 2000 the International Classification of Diseases version 10 Australian Modification (ICD-10-AM, 1st ed.) was used (National Centre for Classification in Health, 1998). All ICD-10-AM codes were mapped to ICD-9-CM codes for the purposes of analysis. The DRG grouper, Australian National Diagnosis Related Groups (AN-DRG) version 3.0 (3M Health Information Systems and Commonwealth Department of Human Services and Health, 1993), was current from 1 July 1993 to 30 June 1998 when an upgrade to Australian Refined Diagnosis Related Groups (AR-DRG) version 4.1

(Commonwealth Department of Health and Aged Care, 1998) was introduced. The Prince of Wales/Prince Henry Hospital upgraded to AR-DRG version 4.1 on 1 July 2000. All DRG version 4.1 codes were mapped to DRG version 3.0 codes for analysis. The patient population spanned two coding systems, making the grouping of patients a complex task. The process of arranging the data into a format for analysis was a detailed and time-consuming exercise: there were 1246 secondary codes representing complications and comorbidities, and these were classified, with the aid of a clinician, into 41 categories for the purpose of analysis. Secondary codes were grouped by systems (eg, respiratory) and common conditions (eg, hypertension, diabetes).

AR-DRG version 4.1 now classifies stroke patients into four DRGs rather than two. DRG 37 has been reclassified in AR-DRG version 4.1 into two groups: B70A 'Stroke with severe or complicating diagno-

sis/procedure' and B70B 'Stroke with other complication or comorbidity'. DRG 38 maps to B70C in AR-DRG version 4.1: 'Stroke without other complication or comorbidity'. The fourth stroke code, B70D, is defined by 'Stroke, died, or transferred < 5 days'. Whilst there is an option within the DRG to account for severe or complex diagnosis or procedure and complication or comorbidity, there is no partition for age in these DRGs. This results in patients across all ages being grouped together with no accounting for their differences in age, which may affect length of stay.

**Procedure**

The process of arranging data in a format suitable for analysis can be intricate and lengthy. The data for this study were obtained from two modules (Admissions, Transfers and Separations module and the Disease Index module) of the hospital's inpatient statistics collection. The patient records from each module were linked and merged using Microsoft Excel Version 97. As most patients had one or more secondary codes representing a complication or comorbidity, each row of patient data (eg, medical record number and date of admission) needed to be duplicated to ensure all data items for each patient were present for each row containing a secondary code. Data are reported as mean ± standard deviation (SD) for parametric data and median and interquartile (IQ) range for skewed data. The *t*-test was used to compare parametric continuous data and the Mann-Whitney *U* test was used to compare non-parametric continuous data. Differences in proportions were compared using the  $\chi^2$  test. Pearson's correlation coefficient was used to measure linear association. Microsoft Access (Version 97), Microsoft Excel (Version 97) and the Statistical Package for Social Sciences (SPSS) (Version 10, Chicago, Ill) were used for data manipulation and analysis.

**Results**

There were 1365 separations involving 1218 patients at Prince Henry/Prince of Wales Hospitals with a principal diagnosis of stroke between 1 July 1995 and 30 June 2000. One hundred and twenty-two (10%) of the 1218 patients had more than one separation: 104 (8.5%) had two separations, and 18 had three or more separations.

**DRG and principal diagnosis code**

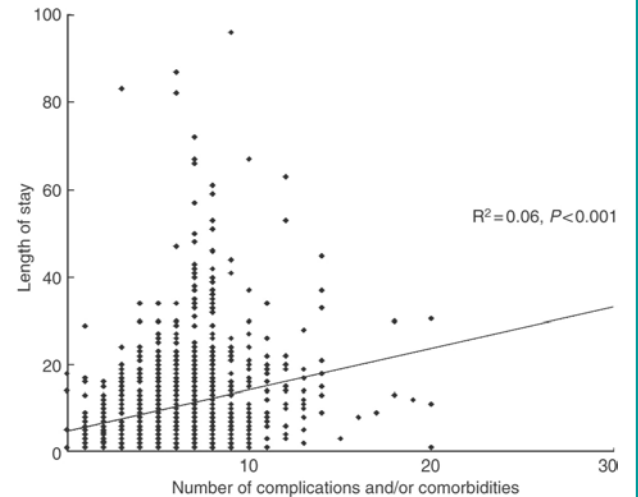
The majority of the study patients were coded to DRG 37 (Box 1), indicating that 67% of patients admitted for stroke during the study period experienced complications and/or comorbidities. According to the AN-DRG version 3.0 grouper, these subjects required greater resource use. When the subjects were subdivided into DRG 37 and 38, no significant gender differences were found ( $P>0.1$ ).

The median age of patients in DRG 37 and DRG 38 was 77 years (74 years for males and 80 years for females) and 72 years (70 for males and 73 for females), respectively. Patients with complicated stroke

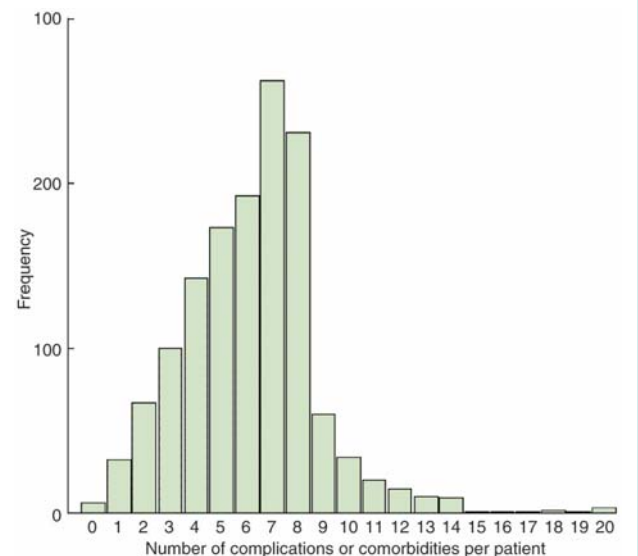
**5: Length of stay categorised by number of weeks of all adult stroke separations from the Prince Henry/Prince of Wales Hospitals from 1 July 1995 to 30 June 2000**

<u>Length of stay</u>	<u>Number of separations</u>	<u>Total</u>
<1 week	621	(46%)
1-2 weeks	442	(32%)
3-4 weeks	170	(13%)
4-5 weeks	65	(5%)
5-6 weeks	26	(2%)
6-7 weeks	18	(1%)
>7 weeks	23	(1%)
<b>Total</b>	<b>1365</b>	<b>(100%)</b>

**6: Number of complications and/or comorbidities, per patient, of all adult stroke patient separations from the Prince Henry/Prince of Wales Hospitals from 1 July 1995 to 30 June 2000**



**7: Number of complications or comorbidities, per patient, of all adult stroke patient separations from the Prince Henry/Prince of Wales Hospitals from 1 July 1995 to 30 June 2000**



(DRG 37) were significantly older compared with patients in DRG 38 (Mann-Whitney *U* test,  $P < 0.001$ ).

The most commonly occurring principal diagnosis was 434.91: 'Cerebral artery occlusion with mention of cerebral infarction' (37.4%) (Box 2).

Principal diagnoses varied with age; thus, the frequency of the principal diagnosis was subdivided using 40 years of age at discharge as a cut-off, following clinical recommendation. The most commonly occurring principal diagnosis for patients under 40 years of

**8: Frequency of complications and comorbidities of all adult stroke patient separations from the Prince Henry/Prince of Wales Hospitals from 1 July 1995 to 30 June 2000**

<u>Complication/comorbidity category*</u>	<u>Frequency</u>	<u>Total</u>
Hemiplegia and paralysis	771	(9.1%)
Vestibular disorders and hearing loss	738	(8.7%)
Ischaemic heart conditions	667	(7.9%)
Coma, altered level of consciousness, dizziness and disorientation	475	(5.6%)
Electrical conducting disorders of the heart	407	(4.8%)
Gastrointestinal, liver and pancreatic conditions	385	(4.6%)
Respiratory diseases and infections	375	(4.4%)
Dementia, acute brain syndromes, schizophrenia	367	(4.4%)
Renal failure and other renal and prostatic conditions	351	(4.2%)
Vascular disease	281	(3.3%)
Diabetes	270	(3.2%)
Accident (excluding fall)	235	(2.8%)
Hypercholesterolaemia and hyperlipidaemia	230	(2.7%)
Neoplasm	211	(2.5%)
Alcohol and other drug use	205	(2.4%)
Disorders of skin and soft tissue	202	(2.4%)
Neuropathy	183	(2.2%)
Arthropathy, joint disorders, osteoarthritis and rheumatoid arthritis	180	(2.1%)
Visual field defect and other visual disturbances	179	(2.1%)
Degenerative eye diseases and conditions	149	(1.8%)
Previous myocardial infarction	143	(1.7%)
Other	126	(1.5%)
Bone disorders, osteoporosis and fractures	114	(1.4%)
Speech disorders including aphasia	108	(1.3%)
Hypertension	107	(1.3%)
Tobacco use	104	(1.2%)
Biochemical, electrolyte and fluid disorders including volume depletion	102	(1.2%)
Fall	86	(1.0%)
Psychiatric disease	78	(0.9%)
Thyroid conditions	77	(0.9%)
Gout	75	(0.9%)
Parkinson's, ataxia and other neural degenerative disorders	74	(0.9%)
Heart valve defects	71	(0.8%)
Person living alone	50	(0.6%)
Infection	49	(0.6%)
Other conditions of the brain	47	(0.6%)
Dysphagia	46	(0.5%)
Haematological and blood disorders	41	(0.5%)
Epilepsy, other condition of the brain	38	(0.5%)
Allied health intervention	32	(0.4%)
Obesity	15	(0.2%)
<b>Total</b>	<b>8444</b>	<b>(100%)*</b>

\*Percentage rounded

age was subarachnoid haemorrhage, followed by cerebral thrombosis and cerebral embolism. The highest occurring principal diagnosis in patients over 40 years of age was cerebral artery occlusion with cerebral infarction (Box 3).

**Age and gender**

There was no significant gender bias in adult stroke patients, with 690 females (51%) and 675 males (49%) identified during the study period. Men were significantly younger ( $P<0.001$ ), with a median age of 72 years (IQ range, 64–79) compared with women, who had a median age of 77 years (IQ range, 70–84). The overall median was 75 years (IQ range, 67–83 years).

Age was negatively skewed, indicating that the majority of patients were in the higher age groups. The majority of patients were aged between 60 and 89 years (81%) and only 25 patients (2%) were aged 14–39 years. There were more males in the 30–69-years age groups, but there were more females aged 0–29 years and over 80 years (Box 4).

**Length of stay**

The median length of stay for the 1365 separations was 8 days, with a range of 1 to 96 days. Some 46% of patients stayed in hospital for less than 1 week after their stroke, 78% of patients were discharged within 2 weeks, 96% of patients were discharged within 5 weeks and 23 patients (1%) remained in hospital for longer than 7 weeks (Box 5). The length of stay was positively skewed. There was a significant variation in length of stay by age category ( $P<0.001$ , Box 6).

**Complications and comorbidities**

The majority of patients ( $n = 1358$ , 99.5%) had at least one comorbidity or complication. The median number of events per patient was six (IQ range, 4–6). The fre-

quency distribution of number of complications or comorbidities per patient is shown in Box 7. The most frequently occurring complication or comorbidity group was 'hemiplegia and paralysis' (771, 9.1%) (Box 8). Stroke patients in DRG 37 (those with complications) had a significantly longer length of stay compared with patients in the DRG 38 group (Mann–Whitney  $U$  test  $P<0.001$ ). There was a significant correlation between length of stay and number of complications and comorbidities ( $P<0.001$ , Box 7). There was also a significant association between age and number of complications and comorbidities ( $P<0.001$ ).

**Source of admission**

The majority of stroke patients (84.8%) presented to hospital as emergency admissions (Box 9).

**Discussion**

The analysis of all patients admitted for stroke to the Prince Henry/Prince of Wales Hospital over a period of 5 years has supported the findings in the literature that the risk of stroke increases with age, and half of the population affected are over 75 years of age. As age increases, so does the number of certain complications and comorbidities and length of hospital admission. Furthermore, as there are more survivors of stroke now than in previous years and the lifespan of the Australian population is increasing, there is likely to be an increased demand on hospital resources from stroke patients in the future (Anderson et al, 1993).

The findings in the present study illustrate the inequalities of episode-based funding when applied to stroke patients. If funding is based on the average cost weight for stroke patients, hospitals receive the same funds for patients with longer admissions, or more complications or comorbidities, as for uncomplicated stroke patients. It was suggested by Gillett in 1992, in a paper presented to the Fourth National Australian Casemix Conference, that an elderly allowance or earlier discharge to community facilities may partially compensate for the increased costs associated with treating an elderly population. Whilst the AN-DRG version 3.0 grouper that was used in the study has been superseded by AR-DRG version 4.1 and 4.2, there is still no division within the stroke DRGs to assign a higher cost weight to older patients. Despite the fact that the most complex of patients may be assigned the highest cost-weighted stroke DRG, the cost weight may not adequately reimburse hospitals for many of the very old and clinically complex stroke patients with long admissions.

Hospitals that treat a large elderly population may be disadvantaged if funding is based on DRGs (Gillett, 1992). Bassler and colleagues (1994) found that DRGs with complication and comorbidity splits only partially accounted for older age. They found that version 1.0 AN-DRGs did not account for age-related lengths of stay in the elderly population. Patients coded to the DRGs with complication or comorbidity splits were older ( $P<0.01$ ) when the data were pooled. This study not only supports the finding of the previous study that older patients are

**9: Source of referral of all adult stroke patient separations from the Prince Henry/Prince of Wales Hospitals from 1 July 1995 to 30 June 2000**

Source of referral	Number	Total
Emergency admission	1157	(84.8%)
Hospital in same area health service	121	(8.86%)
Other medical practice other than a private psychiatric practice	50	(3.67%)
Other hospital	18	(1.32%)
Type change admission*	13	(0.95%)
Outpatients	5	(0.4%)
Community health	1	(0.07%)
<b>Total</b>	<b>1365</b>	<b>(100%)#</b>

\*Type change admissions occur when patients are recategorised from one type of admission to another (eg, from acute to rehabilitation).

# Percentage rounded.

likely to have longer admissions and more complications and comorbidities, but demonstrated that, while a DRG may have a split for complications and comorbidities, this does not account for older age.

## Conclusion

This study has shown the value of analysing the data contained in inpatient statistics collections to investigate issues related to funding of health services. The findings raise the question as to whether casemix funding should be based solely on DRGs for complicated conditions such as stroke, or whether additional measures should be used for funding allocation. A major driver of cost is length of stay, but as shown here the DRG does not predict length of stay accurately. This raises two alternative proposals. Firstly, the use of a predictive formula for each DRG could be employed, incorporating age and selected complications and comorbidities. Alternatively, the DRG-based payment could be modified by an outcome measure that reflects the quality and/or the efficacy of care, such as death, complications of care, discharge or readmissions. It is acknowledged that the latter would require considerable work to refine and validate the output measure. Health information managers working in hospitals are largely responsible for the input and quality checks on the data contained in state and territory data collections. They should also initiate analysis of these data to assist in funding and planning health services, as well as for research purposes.

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