

Recorded categories of non-principal diagnoses in Victorian public hospital transient ischaemic attack and stroke admissions

Shyamala G Nadathur

Abstract

Information about the number and types of non-principal diagnoses (NPDs) would make an important contribution to prediction of outcome and hence patient management. The study reported here is based on analysis of three fiscal years of the Victorian public hospital transient ischaemic attack (TIA) and stroke admissions. The incidence of NPDs and co-occurrence of NPD-associated prefix categories (that identify the onset or relevance of each condition to the episode) are described in each of the broad stroke subtypes. The distributions of length of stay and in-hospital deaths in the cohorts without and with NPDs and in the various prefix categories are determined. The study also compares the age and gender distribution in the various subpopulations of interest. The importance of collecting complete and accurate data on nature of NPDs and its potential in describing the complexity of presentation are discussed.

Keywords (MeSH):

Comorbidity; Risk Factors; Cerebrovascular Disorders; Coding; Medical Records Systems, Computerised; Data Collection; Stroke; Transient Ischemic Attack; Cerebral Infarction.

Introduction

In clinical practice, more than one diagnosis per patient is frequently encountered. Comorbidity, which can be defined as the coexistence of multiple conditions in a single individual, has been shown to modify the prognosis of the disease state (Chen et al. 2001; Kazmierski 2006; Piccirillo 2000). Conditions that contribute to patient and/or disease complexity are often high resource users; therefore, they present opportunities for continuously improving efficiency and optimising outcome (Lee, Soffel & Luf 1992; Naessens et al. 1992; Norcini 2005; Taheri, Butz & Greenfield 1999).

In order to continuously improve quality of practice, clinicians and health managers require information about clinical presentation and outcome of care (Braithwaite & Westbrook 1996; Naessens et al. 1992). In Australia, there are a number of core centrally collected datasets that currently assist the providers, purchasers, and consumers of health services in their perform-

ance measurement analysis and decision making. The Victorian Admitted Episodes Dataset (VAED) is one such important state level data collection of admitted patients in Victorian hospitals. The VAED contains demographic, clinical and administrative details of every admitted episode of care occurring in all Victorian hospitals registered under the Health Services Act 1988. Using the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Australian Modification (ICD-10-AM) in accordance with the Australian Coding Standards and the Victorian Additions to the Australian Coding Standards, diagnosis codes (based on clinical documentation in the medical records) reflecting injuries, disease conditions, patient characteristics, and circumstances impacting upon a specific episode of care are also recorded in the VAED (Australian Institute of Health and Welfare [AIHW] 2000). In Victoria for many years, a single-character prefix corresponding to each of the recorded ICD-10-AM diagnosis codes

is also noted in the dataset to identify the onset or relevance of each condition to the episode of care.¹ From the above, it can be seen that the dataset attempts to capture information on the nature of both the principal and the additional diagnoses.

In this paper, the term *non-principal diagnosis* (NPD) is used to describe the 'additional diagnosis' as it was considered to be the less ambiguous and more descriptive term with an immediate broader understanding outside of the coding and casemix arena. Stroke and transient ischaemic attack (TIA) were the conditions of choice for this study. In general, strokes are a common problem for hospitals as a leading cause of adult disability and the third most common cause of death (Anderson et al. 1993; Bennett & Magnus 1994). Stroke patients use a considerable number of hospital bed days and lead to a large cost for any hospital. Their presentation can be varied and complex, which in turn can add to the challenge of their management (Collins et al. 2000; Dunbabin 1992; Roe et al. 1996). Therefore, there is merit in determining the nature of non-principal diagnoses in strokes.

TIA's are known to be an important risk factor for stroke (Johnston et al. 2006; Sacco 2004). In fact, the recent trend in clinical thinking acknowledges that there is a continuum between TIA and stroke. Recently a comprehensive guideline for prevention of stroke in patients with ischaemic stroke or TIA was published by the American Heart Association/American Stroke Association and the Council on Stroke (Sacco et al. 2006). This statement was co-sponsored by the Council on Cardiovascular Radiology and Intervention and affirmed by The American Academy of Neurology. The Sacco (2006) guideline stated that the distinction between TIA and ischaemic stroke has become less important; especially with more widespread use of modern brain imaging technology, many patients with symptoms lasting less than 24 hours are found to have an infarction.

In 2007 Mitka published a communiqué in the *Journal of the American Medical Association*

stressing the importance of rapid diagnosis and treatment of TIA's in order to reduce recurrent stroke risk (Mitka 2007). In this article, the blurred boundaries between TIA and stroke were also discussed, including quotes from Louis R Caplan (Chief of the Cerebrovascular/Stroke Division at Beth Israel Deaconess Medical Centre, Boston), who believes that the separation between the two is 'artificial'. Therefore, in the present study, episodes classified as TIA were included along with various types of 'stroke' admissions as one of the 'broad stroke subtype'; however, where appropriate, distinction between TIA and stroke subtypes was also made.

Aims of the study

The study reported here is based on analysis of three fiscal years of the Victorian public hospital TIA and stroke admissions. The specific aims were to: (a) compare the age and gender distribution in the various subpopulation of interest; (b) describe the incidence of NPDs and the co-occurrence of NPD-associated prefix categories in each of the broad stroke subtypes; and (c) determine the distribution of length of stay (LOS) and the incidence of in-hospital deaths in the cohorts without and with NPDs and in the various prefix categories. The importance of collecting complete and accurate data on the nature of NPDs and its potential in describing the complexity of presentation are discussed.

Method

Dataset and definitions

The de-identified subset of VAED from over three consecutive fiscal years (for the period 1 July 1999 to 30 June 2002) was used in this study. For the collection period, at least one principal diagnosis code with up to 11 optional codes in the first year and 24 optional codes in the second and third years could be reported. A *Principal Diagnosis* is defined as the diagnosis established, after study, to be chiefly responsible for occasioning the patient's episode of care in hospital or attendance at the health facility (AIHW 2000). The *Primary diagnoses* are those which are present at the commencement of a specific episode of care and for which the patient received treatment or investigation during a specific

¹ Victoria's system of prefixes is similar to, but not exactly the same as definitions in Australian Coding Standard 0048 Condition of Onset Flag (National Centre for Classification in Health, 2008). See <http://www.dhs.vic.gov.au/health/hdss/icdcoding/vicadditions/vicadd08.pdf>

episode of care. The first diagnosis field is always a Primary diagnosis and is referred to as Principal Diagnosis. In the non-principal-diagnosis fields, if a diagnosis code is present, the corresponding prefix field will contain one of the following codes: Primary diagnosis (P), Associated Condition (A), Complication (C), and Morphology codes for neoplasms (M) (VDHS 2000; 2001).

In this study, prefixes P, A, and C were examined. The revised version containing further clarified definitions of prefixes was used in the second and third years of the study (VDHS 2000; 2001). Accordingly, an *Associated Condition* is defined as one that is present at admission but not treated or investigated during the current episode of care. It may be (a) the untreated underlying disease of a condition that was treated, or (b) a condition or state that influenced the patient's health status or care during this episode of care, but which was not specifically treated, or (c) a condition or state that affected the treatment given and/or LOS that was not treated during this episode of care. A *Complication* is a condition that was not present at the commencement of the episode of care; a previously existing condition that was not diagnosed until after the episode of care started is not a complication. A complication may be a condition resulting from misadventure during surgical or medical care; that is, an abnormal reaction to or later complication of surgical or medical care, or a condition that arose during the current episode of care.

For each episode, the dataset therefore has one principal (and primary) diagnosis code. All admitted episodes in Victoria public hospitals with a principal diagnosis of either a TIA or stroke were selected. A previous study (Nadathur & Groom 2006) had reported that there were issues in the placement of TIA and stroke codes and concepts within the appropriate grouper and made some recommendations for cohort selection. As per the suggestion in the earlier paper, the selection of TIA and stroke codes was done using both the clinicians' and coders' perspectives. Thus, the following codes were used in the selection of the study cohort:

- all G45: Transient Cerebral Ischaemic Attacks and related syndromes or TIA except G45.4 (Transient Global Amnesia)

- all I60: Subarachnoid Haemorrhage or SAH
- all I61: Intracerebral Haemorrhage or ICH
- all I62: Other Non-traumatic Intracranial Haemorrhage or OntICH
- all I63: (Cerebral Infarction or CI), and
- I64: Stroke, not specified as haemorrhage or infarction or SnsHorI.

After selection of the cohort, the data underwent extensive screening, cleaning, and transformation prior to merging the admission years. The Principal Diagnosis of each of the episodes was also used to assign the episodes to a broad stroke subtype. Using the diagnosis codes and their corresponding prefixes, the episodes with at least one occurrence of NPD were identified. Further restructuring and transformation of the data were done to obtain information on the associated prefix categories. The following quality checks were done:

- A detailed examination of the merged dataset was done to check the effectiveness of the existing basic data edits.
- In order to assess if there are any differences between the three study years, the patterns of occurrence of non-principal diagnoses (and the associated prefix categories) and the distribution of various parameters were compared.
- A manageable sample ($n = 1,797$ or 7%) of the study population, consisting of patients in the 60 to 64 years of age group, was examined in greater detail to check in case a variety of prefixes had been used and whether they were legitimate prefixes or not. In addition, face validity assessment was made regarding adherence to the prefixing rules. This particular sample study population was chosen because it had representation of all the broad stroke subtypes and a recording of at least 11 NPDs of all prefix categories.

Data analysis

Microsoft Access (2003 Edition, Version 11.8), Microsoft Excel (2003 Edition, Version 11.8) and the Statistical Package for Social Sciences (SPSS Version 10, Chicago, IL) were used for data manipulation and analysis. The study employed both descriptive and comparative statistics. Numbers, percentages, and 95% confidence intervals were obtained: the confidence intervals

were calculated using the calculator at http://www.dimensionresearch.com/resources/calculators/conf_prop.html. Median and intra-quartile (IQ) range are reported for skewed data. The Visual Bander function in the SPSS was used to determine intelligent groupings for continuous data. The Mann–Whitney U test was used to compare the differences between two independent groups on non-parametric continuous data. The chi-square test of independence was used to determine whether two categorical variables are related.

Results

Results are reported under the following major headings: Incidence of NPDs and co-occurrence of prefix categories; Gender and age distribution; NPDs and prefix categories in broad stroke subtypes; Hospital deaths, NPDs, and Prefix-Groupings; and Length of stay, NPDs, and Prefix-Groupings. (The term *Prefix-Groupings* refers to the categories of possible combinations of prefixes that can be recorded with a single principal diagnosis.)

Incidence of NPDs and co-occurrence of prefix categories

Of the admitted episodes in public hospitals, 90.2% ($n = 26,182$, 95% confidence interval $\pm 0.35\%$) had at least one other diagnosis in addition to a principal TIA/stroke diagnosis. Within the cohort with at least one NPD, 83% (95% confidence interval $\pm 0.46\%$) received treatment or investigation during the current episode for a least one (non-principal) primary diagnosis; a quarter (95% confidence interval $\pm 0.52\%$) had complication(s); and 64% (95% confidence interval $\pm 0.58\%$) had associated condition(s).

Fifty-six percent of the episodes ($n = 14,745$; 95% confidence interval $\pm 0.6\%$) had multiple NPDs of mixed prefixes. The largest group of episodes (33%; $n = 8,638$; 95% confidence interval $\pm 0.57\%$) with multiple prefixes had both primary diagnoses and associated conditions; and 21% ($n = 5,507$; 95% confidence interval $\pm 0.49\%$) of the episodes had a recording of both primary diagnoses and complications in a single

episode of care. The number of episodes with a least one P, A, or C prefix were 7,525 (29%; 95% confidence interval $\pm 0.55\%$), 3,616 (14%; 95% confidence interval $\pm 0.42\%$), and 296 (1%; 95% confidence interval $\pm 0.13\%$), respectively; and 3,770 (14 %; 95% confidence interval $\pm 0.43\%$) episodes had NPD codes belonging to all three (P, C, & A) prefix categories.

Gender and age distribution

There was an almost equal proportion of the genders: 50.9% of males in the group with at least one NPD and 47.7% of males when there was no other diagnosis. The age distribution in both groups was similarly negatively skewed (-1.2), with a median age of 75 years (IQ range 17 years) in those with other diagnoses versus 74 years (IQ range 22 years) in those without. There was a significant difference ($U = 34432272.5$, $p < .001$) in the age distribution between the two groups.

In the group with at least one NPD, the median age for Cerebral Infarcts (CI) was 75 years (IQ range 15 years) compared to a median of 66 years (IQ range 21 years) for haemorrhagic strokes. The hospital deaths were found to increase exponentially with age. The 60-year-old patients and those younger made up 20% of the up to four days LOS group; this age group decreased to 14% when the length of stay was longer than four days.

NPDs and prefix categories in broad stroke subtypes

The proportion of NPDs in the broad stroke subtypes are given in Table 1. This table has the following information: (a) the number and percentage of episodes with and without NPD in each of the broad stroke subtypes (read horizontally in rows); and (b) the number and percentage of the broad subtypes in the cohorts with and without at least one NPD (read vertically in columns).

Figure 1 represents the distribution of the broad stroke subtypes in each of the Prefix-Groupings:

- noPnoCA (*no* primary diagnosis, *no* complication and *yes* to associated conditions)
- noPCnoA (*no* primary diagnosis, *yes* to complication and *no* associated condition)

Table 1: Non-principal Diagnoses and Broad Stroke Subtypes

BROAD STROKE SUBTYPES BASED ON PRINCIPAL DIAGNOSIS	NON-PRINCIPAL DIAGNOSES		BROAD STROKE SUBTYPE TOTALS	
	ABSENT	PRESENT		
	Number	1450	5785	7235
Transient Ischaemic Attack	% within broad subtype	20.0%	80.0%	
	% within NPD absent or NPD present	51.2%	22.1%	
	Number	274	1266	1540
Subarachnoid Haemorrhage	% within broad subtype	17.8%	82.2%	
	% within NPD absent or NPD present	9.7%	4.8%	
	Number	282	2889	3171
Intracerebral Haemorrhage	% within broad subtype	8.9%	91.1%	
	% within NPD absent or NPD present	10.0%	11.0%	
	Number	165	1018	1183
Other Non-traumatic Intracranial Haemorrhage	% within broad subtype	13.9%	86.1%	
	% within NPD absent or NPD present	5.8%	3.9%	
	Number	303	9548	9851
Cerebral Infarction	% within broad subtype	3.1%	96.9%	
	% within NPD absent or NPD present	10.7%	36.5%	
	Number	358	5676	6034
Stroke, not specified as Haemorrhage or Infarction	% within broad subtype	5.9%	94.1%	
	% within NPD absent or NPD present	12.6%	21.7%	
	Totals for 'NPD Absent' and 'NPD Present'	2832	26182	29014

- noPCA (*no* primary diagnosis, *yes* to complication and *yes* to associated conditions)
- PnoCnoA (*yes* to primary diagnosis, *no* complication and *no* associated condition)
- PnoCA (*yes* to primary diagnosis, *no* complication and *yes* to associated conditions)
- PCnoA (*yes* to primary diagnosis, *yes* to complication and *no* associated condition)
- PCA (*yes* to primary diagnosis, *yes* to complication and *yes* to associated conditions).

Since this cohort contains at least one other diagnosis in addition to the principal diagnosis, there is naturally no case that has all of the three NPD-associated prefix categories missing; therefore, this option is not represented in the figures.

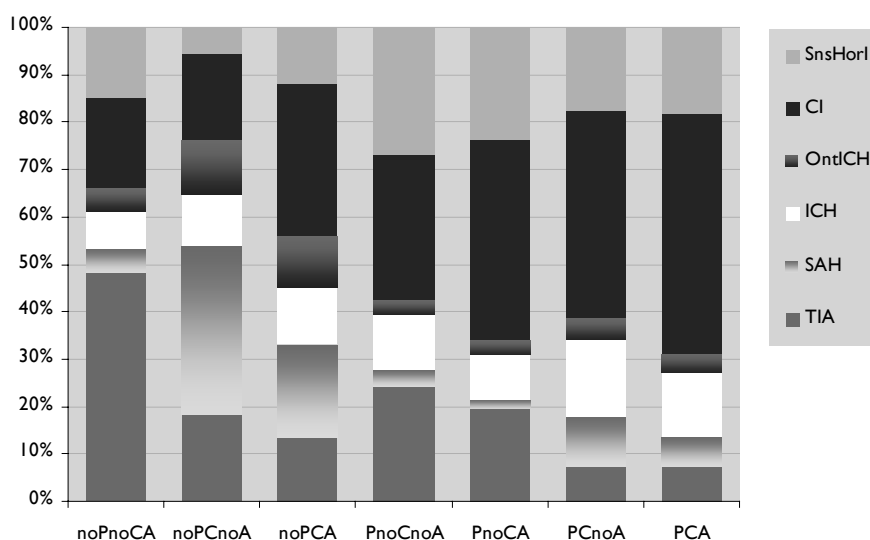


Figure 1: The Distribution of Broad Stroke Subtypes within Prefix-Groupings

Hospital deaths, NPDs, and Prefix-Groupings

Fourteen percent of those who were classified as CI had an in-hospital mortality compared to 25% for haemorrhagic strokes. Within the 12% ($n = 3,496$, 95% confidence interval $\pm 0.37\%$) of TIA and strokes who died in hospital, 92.6% ($n = 3,236$, 95% confidence interval $\pm 0.9\%$) had at least one non-principal diagnosis. Within the cohort with NPD, the proportion in each of the Prefix-Groupings that died in hospital is represented in Figure 2.

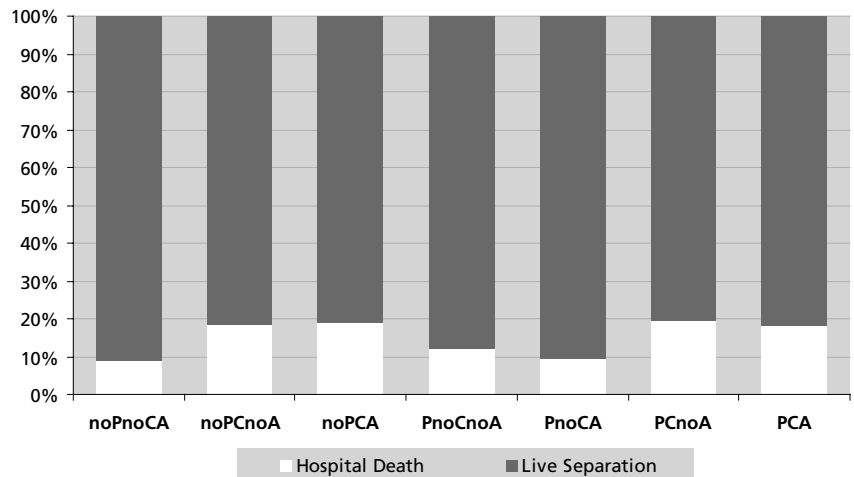


Figure 2: The Proportion of Hospital Deaths within Prefix-Groupings

Length of stay, NPDs and Prefix-Groupings

The median LOS of episodes with at least one NPD was six days (IQ range 11 days) compared with one day (IQ range two days) for those with no other diagnosis other than the principal. In both groups, the distribution of LOS was positively skewed; when other diagnoses are present, the distortion becomes larger (13.0) than when absent (7.3). There was a significant difference ($U = 15215925.0$, $p < .001$) in the LOS distribution between the two groups. When the LOS was less than or equal to four days, 24% of admissions had a Principal Diagnosis of cerebral infarction; this increased to 48% cerebral infarction admissions when the LOS was greater than four days. Figure 3 represents the distribution of the LOS groups in each of the Prefix-Groupings within the cohort with a least one non-principal diagnosis.

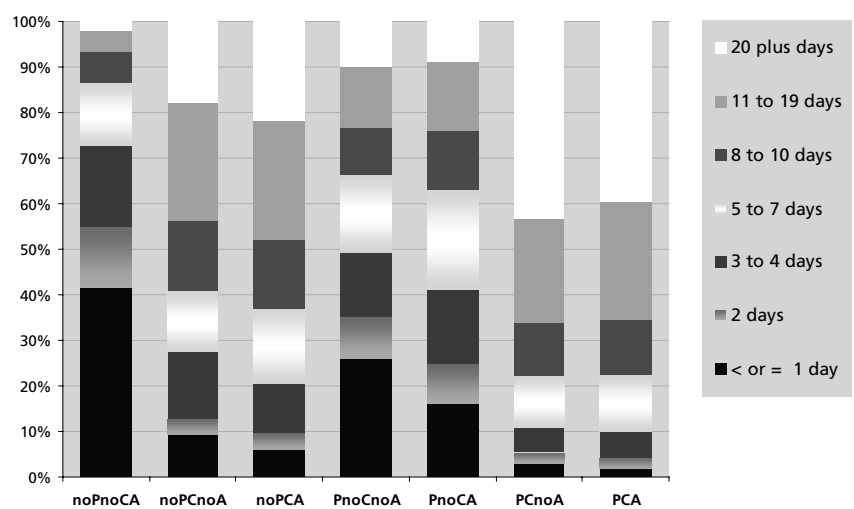


Figure 3: The Distribution of LOS Groups within Prefix-Groupings

Irrespective of which broad stroke subtype they belonged to, those with complications had the longer LOS: median LOS of four days (IQ range 7) without versus 14 days (IQ range 20) with

complications. Having primary diagnoses made the least difference: three days (IQ range 6) for those without versus seven days (IQ range 11) for those with a primary diagnosis. Presence of associated conditions made no difference: both groups had a median of 6 days and IQ range of 11 days.

Data-quality checks

Each of the three study years contained between 9,214 and 10,104 stroke or TIA episodes, thus contributing 32% to 35% each towards the merged ($N = 29,014$) dataset. The patterns of occurrence of NPDs and prefixes in the three study years were compared. The first admission year had slightly more episodes (95%) with one or more NPD when compared with year 2 (87%) and year 3 (90%). A similar pattern of distribution of primary diagnoses and complications between and within the admission years 2 and 3 was seen. There was a larger percentage of associated conditions in year 1: 71% as compared to 50% and 51% in years 2 and 3, respectively.

There were no differences in gender, broad stroke subtype, or hospital death ratios among the three admission years. There were no significant differences in distribution of age (median 75 to 76 years IQ range 17 to 18 years) and LOS (median 5 to 6 days, IQ range 10 to 11 days) among the admission years.

A detailed data examination confirmed that the existing basic edits was effective and that the study admission years had all of the diagnosis codes and their corresponding prefixes systematically filled in starting from position one.

After an in-depth examination of the diagnosis codes and their respective prefixes in the sample (consisting of 7% of the study population as described under the Method quality checks), an experienced coder found that a variety of legitimate prefixes have been used.

Discussion

The overall focus of the study reported here was to explore the nature and value of the recorded prefixes associated with non-principal diagnoses in the Victorian public hospital admitted dataset.

Recorded non-principal diagnoses, age and gender

The present study revealed that over 90% of admitted TIA and stroke episodes in the Victorian public hospitals had at least one non-principal diagnosis. Other researchers agree with the present observation that stroke patients usually have additional clinical diagnoses that have existed or that may occur during the clinical course of a patient with the index disease (Fischer et al. 2006; Johansen et al. 2006; Kazmierski 2006; Wee & Hopman 2005).

There was a significant difference in the age distribution but not in gender between the episodes with and without non-principal diagnoses. In both groups, the age distribution was skewed towards the much older age range (median age 74 to 75 years, IQ range 17 to 22 years). Royle, Callen and Craig (2004) also noted that stroke patients did not have a significant gender bias, but exhibited an age skewing with the majority in the older age groups. Increase in prevalence of complexity/comorbidity with age has been well-documented (Boruk et al. 2005; Johansen et al. 2006).

Categories of NPDs

In the group with at least one NPD, there were all possible combinations of prefix categories or Prefix-Groupings, with 56% of the episodes having multiple NPDs of mixed prefix categories. Over 80% received treatment or investigation during the current episode for a least one (non-principal) primary diagnosis; a quarter had complications; and nearly two in three episodes had associated condition(s). Similarly, an Australian study (Royle et al. 2004) reported that the majority (99.5%) of their stroke patients had at least one comorbidity or complication, with a median number of events per patient of six (IQ range of four to six events). A Netherlands study (Evers et al. 2002: 21-22) concluded that the factors highly correlating with inpatient costs were the level of functioning after stroke, comorbidity, complications, and 'days of stay for non-medical reasons'.

Broad stroke subtypes, NPDs and associated prefixes

The proportion of episodes with and without NPDs varied between the broad subtypes. As expected, TIAs had a smaller proportion of episodes with at least one NPD and cerebral infarcts the largest (see Table 1). However, among the cohort with at least one NPD, those classified as TIAs had the second highest incidence (22.1%) after cerebral infarctions (36.5%). TIAs were also found to have recordings of all combinations of prefix categories or Prefix-Groupings (see Figure 1). The CI group was the largest (38% to 51%) with a recording of multiple prefix categories (noPCA, PnoCA, PCnoA and PCA). In agreement with a previous finding (Lefkovits et al. 1992), this study also found cerebral infarction patients were older than those with cerebral haemorrhage. As discussed, the older groups are more likely to have complexity/comorbidities that contribute to morbidity/mortality, providing at least a part explanation for the above findings.

Differences in risk factors and comorbidities among the stroke subtypes have been reported in the literature. For example, population-based studies have suggested that vascular risk factors differ between stroke subtypes (Schulz & Rothwell 2003). Moreover, an epidemiological study (Kolominsky-Rabas et al. 2001) revealed substantial underlying risk factor differences between etiologic subtypes of ischaemic stroke and their impact on long-term survival and recurrence. Further research is needed to ascertain both the number and the nature of the recorded NPDs associated with the different broad stroke subtypes in the study dataset.

The emerging picture has disclosed that the presentation of TIA and strokes in Victorian public hospitals can be varied and complex, which in turn has a potential to impact on care duration and outcome. There has been a report (Collins et al. 2003) that the coexisting conditions/diagnoses, either by compromising an individual's ability to function optimally or by having prognostic significance as a risk factor of stroke, can significantly influence the outcome. Therefore, the distribution of LOS and the incidence of hospital deaths in the cohorts with and without NPDs and the associated Prefix-Groupings were examined.

Incidence of hospital deaths

In the study years, 12% of the patients admitted to Victorian public hospitals with TIAs/strokes died, and nearly 93% of those who died had at least one non-principal diagnosis. The Prefix-Groupings containing complication had the highest percentages of hospital deaths (see Figure 2), whereas a recent review (Kazmierski 2006) listed comorbid conditions at admission as one of the most important predictors of in-hospital mortality. Lefkovits and colleagues (Lefkovits et al. 1992) observed that age had a marked adverse effect on mortality, independent of stroke type, with the probability of death increasing by 3 +/- 0.5% per year from 20 to 92 years, whereas gender had no effect. In the present study, hospital deaths exponentially increased with age. Even though those in the CI group were older, a quarter of the admitted haemorrhagic stroke patients had died in hospital compared to 14% of the admitted CIs. Similarly, it has been reported (Lee, Somerford & Yau 2003) that, among the first time stroke and TIA admissions to Western Australian hospitals, the survival rate at 28 days was lowest for hemorrhagic stroke. A detailed inventory of the number and nature of the NPDs in the broad stroke subtypes, with particular emphasis on their ability to contribute towards mortality, would make useful contribution to their management.

Distribution of length of stay

Royle, Callen and Craig (2004), following a study of 1365 stroke separations in the Prince Henry/Prince of Wales Hospital (Sydney) over a period of five years, reported a median length of stay of eight days. In the study reported here, the median LOS of episodes with recorded NPDs (six days, IQ range 11) was significantly longer when compared to those with only a principal diagnosis (one day, IQ range 2). Figure 3 shows that there was a consistent high-end LOS distribution in Prefix-Groupings (noPCnoA, noPCA, PCnoA and PCA) containing complications. Regardless of the broad stroke subtype, the presence of complications was found to have the greatest impact on LOS, with the median LOS of 14 days (IQ range 20) in those with complication versus four days (IQ range 7) in those without. Similarly, the above-mentioned Australian study (Royle, Callen

& Craig 2004) found a significantly ($p < .001$) longer LOS for patients with complication when compared to those without.

As already observed, CI was the largest group with a recording of multiple prefix categories. When the LOS was up to four days long, 24% of admissions had a Principal Diagnosis of CI, with the incidence of CI doubling when the LOS was greater than four days. It should be noted here that the age distribution also changed with LOS: those patients 60 years old and younger made up 20% of the 'up to four days LOS' group and decreased to 14% when the LOS was longer than four days. As already noted, those patients with CI were older than those with cerebral haemorrhage.

There is good documentation in the literature of the influences of the various patient factors on length of stay. Longer LOS has been reported (Monane et al. 1996) to be significantly associated with greater comorbidity. A study of strokes in an acute care teaching hospital showed that severity and comorbidity together with age were good predictors of LOS, death, and unplanned re-admission (Roe et al. 1996). Similarly, Wee and Hopman (2005), following an investigation of stroke rehabilitation inpatients, concluded that the number of stroke-related impairments needs to be included in the prediction of discharge function, rehabilitation LOS, and discharge destination. A Scottish study (Davenport, Dennis & Warlow 1996), investigating the influence of variations in casemix on clinical outcome indicators (fatality at 30 days and 12 months and Oxford handicap scale at 12 months for survivors) for admitted acute stroke, concluded that the variation in casemix had a crucial influence on the interpretation of studied outcome. In addition, the impact of age, sex, and comorbidity on in-hospital mortality, LOS, and readmission rates in hospitalised stroke patients in Canada has recently been reported (Johansen et al. 2006). Therefore, it is important to take into account the various patient factors, and particularly the complexity of presentation, in the prediction of outcome including LOS.

Data-related limitations

The two plausible data-related limitations of study involving administrative data collections are (a) the year-to-year variation in data dictionary and rules (hence recording); and (b) the quality of coding. Therefore, these areas were examined further. All of the admission years had all of the diagnosis codes and their corresponding prefixes systematically filled in starting from position one. Each of the three study years equally contributed to the merged dataset. There was no difference in gender, proportion of the broad stroke subtypes, hospital deaths, age, and LOS distribution among the three admission years. The patterns of occurrence of NPDs and the associated prefixes in the three study years were compared. The first admission year had slightly more episodes and had a larger proportion of associated conditions. This could be due to the increase in the number of categories used in the collection of NPD made during this year. In addition, since the first year had a reduced number (11 versus 24) of options for recording occurrences of other diagnoses, it is possible that in that year the resource-linked diagnoses were entered first, leaving out other 'less important' diagnoses (Susan Peel, Manager, Coding & Casemix Education, Southern Health, Victoria, pers. comm.).

To check that a variety of prefixes were used and that they are all legitimate prefixes, 7% of the study population consisting of the 60 to 64 years age group with at least eleven NPDs and a representation of all of the broad stroke subtypes, was examined. A thorough examination of the data by an experienced coder did not find any obvious irregularity at the State dataset level (without comparison with medical record). All assignment of prefixes appeared to be correct, but this could not be confirmed without record review. An audit of the study years' medical records across Victoria would be required to ascertain if the noticed differences in the first year is because of different patient presentation or a problem in correctly classifying prefixes.

Conclusions and future directions

This study examined the recorded NPDs, using the associated prefix categories, in the admitted TIA and stroke episodes contained in the three fiscal years of the Victorian public hospital dataset. There was confirmation of the prior reports of high occurrence of NPDs and its relationship with older age groups without gender bias. All of the possible combinations of prefixes were seen, with more than half of the episodes having multiple NPDs of mixed prefix categories. The proportion of episodes with CI was the largest. However, among the cohort with at least one NPD, those classified as TIAs had the second highest incidence after CIs. TIAs were also found to have recordings of all combinations of prefix categories and CI was the largest group containing multiple prefix categories. This study also found that patients with CI episodes were older than those with cerebral haemorrhage, which might explain some of the above findings. Further research is needed to ascertain both the number as well as what are the recorded NPDs associated with the different broad stroke subtypes.

The study revealed that the presentation of TIA and strokes are varied and complex, which in turn has a potential to impact on LOS and in-hospital deaths. The dataset NPDs varied among the broad subtypes, with TIAs having the smallest and cerebral had a recording of 12% in-hospital deaths for admitted TIA/strokes, with nearly 93% of those who died having at least one non-principal diagnosis. In contrast to previous findings, episodes that have at least one NPD that is classified as complication (and not comorbid conditions at admission) had the highest proportion of hospital deaths. In this study, as expected, hospital deaths exponentially increased with age. Even though the CI cases were an older group, the death rate for admitted CI patients was half that of those with haemorrhagic stroke admissions. The median LOS of episodes with recorded NPDs was significantly longer when compared to those with only a principal diagnosis. The presence of complications was again found to have the greatest impact on LOS, with a consistent high-end LOS distribution when there was at least one NPD classified as complication. The incidence of CI doubled when comparing up

to four day LOS with greater than four days; age distribution also increased with longer LOS. This is not surprising as those patients with CI were older than those with cerebral haemorrhage and there have been reports that older groups are more likely to have complexity/comorbidities that contribute to morbidity/mortality.

From this study, it can be seen that the prefix categories recorded with NPDs can help to better define the nature of the presentation. It should be noted here that in recognition of the value of recording all NPDs, the Department of Human Services (DHS) in Victoria has, in more recent years (from the 2003-2004 financial year), made provision to record up to 40 diagnoses. As a result of the perceived problems and/or queries raised, the VDHS is constantly improving the definition of the prefixes and establishing guidelines that are more stringent. All these improvements provide the potential for recording more accurate and complete details of the patient and disease presentation.

There are nation-wide, well-established checks and balances for recording diagnosis codes that assure coding quality is maintained. In addition, state-wide audits, like the recently conducted first (of three-year) audit that checked for compliance to several reporting requirements including prefixes, would help improve the quality of the admitted dataset. The progressive monitoring of the correct and full assignment of prefixes is likely to increase the reliability of this valuable information in the dataset. More detailed and accurate information on complexity of presentation would not only help correct for the confounding influence of variations in casemix when different cohorts are compared, but also help to better guide patient management. It is envisaged that future research will categorise the non-principal diagnoses recorded in the dataset for TIAs/strokes in terms of broad disease groups and take into account their prefix categories when attributing a weighting for their potential to contribute towards patient and disease complexity, and, therefore, the process and outcome of care.

Acknowledgements

The author would like to thank the clinicians, coding and Casemix staff at Southern Health (Melbourne, Australia) and the Victorian Department of Human Services for their advice. Associate Professor Damien Jolly (Monash Institute of Health Services Research, Monash University, Melbourne) provided statistical advice. Professor Jim Warren (Chair in Health Informatics, University of Auckland, New Zealand) served as a source of constructive critique in the writing phase of this paper. This work has been supported by a grant from the Victorian Department of Human Services.

References

- Anderson, C. S., Jamrozik, K. D., Burvill, P. W., Chakera, T. M., Johnson G. A. and Stewart-Wynne E. G. (1993). Ascertaining the true incidence of stroke: experience from the Perth Community Stroke Study, 1989-1990. *Medical Journal of Australia* 158(2): 80-84.
- Australian Institute of Health and Welfare (AIHW) (2000). AIHW: *National Health Data Dictionary, Version 9.0*. Canberra, AIHW.
- Bennett, S. A. and Magnus, P. (1994). Trends in cardiovascular risk factors in Australia. Results from the National Heart Foundation's Risk Factor Prevalence Study, 1980-1989. *Medical Journal of Australia* 161(9): 519-527.
- Boruk, M., Chernobilsky, B., Rosenfeld, R.M. and Har-El, G. (2005). Age as a prognostic factor for complications of major head and neck surgery. *Archives of Otolaryngology - Head and Neck Surgery* 131(7): 605-609.
- Braithwaite, J. and Westbrook J.I. (1996). Future health services managers' and health information managers' views on information technology: a pilot survey. *Health Information Management* 26(2): 82-87.
- Chen, A.Y., Matson, L.K., Roberts, D. and Goepfert, H. (2001). The significance of comorbidity in advanced laryngeal cancer. *Head and Neck* 23(7): 566-572.
- Collins, D., McConaghy, D., McMahon, A., Howard, D., O'Neill, D. and McCormack, P.M. (2000). An acute stroke service: potential to improve patient outcome without increasing length of stay. *Irish Medical Journal* 93(3): 84-86.
- Collins, T.C., Petersen, N.J., Menke, T.J., Soucek, J., Foster, W. and Ashton, C.M. (2003). Short-term, intermediate-term, and long-term mortality in patients hospitalized for stroke. *Journal of Clinical Epidemiology* 56(1): 81-87.
- Davenport, R. J., Dennis, M.S. and Warlow, C.P. (1996). Effect of correcting outcome data for casemix: an example from stroke medicine. *British Medical Journal* 312(7045): 1503-1505.
- DHS (2000). Victorian Additions to Australian Coding Standards - Effective 1 July 2000. Victorian Department of Human Services (VDHS). Available at: <http://www.dhs.vic.gov.au/ahs/archive/hdss/vicadd20.htm> (accessed 6 September 2008).
- DHS (2001). Victorian Additions to Australian Coding Standards - Effective 1 July 2001. Victorian Department of Human Services (VDHS). Available at: <http://www.dhs.vic.gov.au/ahs/archive/hdss/vicadd01.htm> (accessed 6 September 2008).
- Dunbabin, D. (1992). Cost-effective intervention in stroke. *Pharmacoeconomics* 2(6): 468-499.
- Evers, S., Voss, G., Nieman, F., Ament, A., Groot, T., Lodder, J., Boreas, A. and Blaauw, G. (2002). Predicting the cost of hospital stay for stroke patients: the use of diagnosis related groups. *Health Policy* 61(1): 21-42.
- Fischer, U., Arnold, M., Nedeltchev, K., Schoenenberger, R.A., Kappeler, L., Hollinger, P., Schroth, G., Ballinari, P. and Mattle, H.P. (2006). Impact of comorbidity on ischemic stroke outcome. *Acta Neurologica Scandinavica* 113(2): 108-113.
- Johansen, H. L., Wielgosz, A.T., Nguyen, K. and Fry, R.N. (2006). Incidence, comorbidity, case fatality and readmission of hospitalized stroke patients in Canada. *Canadian Journal of Cardiology* 22(1): 65-71.
- Johnston, S.C., Nguyen-Huynh, M.N., Schwarz, M.E., Fuller, K., Williams, C.E., Josephson, S.A., Hankey, G.J., Hart, R.G., Levine, S.R., Biller, J., Brown, R.D. Jr., Sacco, R.L., Kappelle, L.J., Koudstaal, P.J., Bogousslavsky, J., Caplan, L.R., van Gijn, J., Algra, A., Rothwell, P.M., Adams, H.P. and Albers, G.W. (2006). National Stroke Association guidelines for the management of transient ischemic attacks. *Annals of Neurology* 60(3): 301-313.
- Kazmierski, R. (2006). Predictors of early mortality in patients with ischemic stroke. *Expert Review of Neurotherapeutics* 6(9): 1349-1362.
- Kolominsky-Rabas, P. L., Weber, M., Gefeller, O., Neundoerfer, B. and Heuschmann, P.U. (2001). Epidemiology of ischemic stroke subtypes according to TOAST criteria: incidence, recurrence, and long-term survival in ischemic stroke subtypes: a population-based study. *Stroke* 32(12): 2735-2740.
- Lee, A. H., Somerford, P.J. and Yau, K.K. (2003). Factors influencing survival after stroke in Western Australia. *Medical Journal of Australia* 179(6): 289-293.

- Lee, P.R., Soffel, D. and Luft, H.S. (1992). Costs and coverage. Pressures toward health care reform. *Western Journal of Medicine* 157(5): 576-583.
- Lefkovits, J., Davis, S.M., Rossiter, S.C., Kilpatrick, C.J., Hopper, J.L., Green, R. and Tress, B.M. (1992). Acute stroke outcome: effects of stroke type and risk factors. *Australian and New Zealand Journal of Medicine* 22(1): 30-35.
- Mitka, M. (2007). Rapid diagnosis and treatment of TIAs help reduce recurrent stroke risk. *The Journal of the American Medical Association* 298(20): 2358-2359.
- Monane, M., Kanter, D.S., Glynn, R.J. and Avorn, J. (1996). Variability in length of hospitalization for stroke. The role of managed care in an elderly population. *Archives of Neurology* 53(9): 875-880.
- Nadathur, S.G. and Groom, A. (2006). Coding and DRG relationships in stroke and Transient Ischaemic Attack (TIA). *Health Information Management Journal* 35(1): 38-44.
- Naessens, J. M., Leibson, C.L., Krishan, I. and Ballard, D.J. (1992). Contribution of a measure of disease complexity (COMPLEX) to prediction of outcome and charges among hospitalized patient. *Mayo Clinic Proceedings* 67(12): 1140-1149.
- Norcini, J. J. (2005). Current perspectives in assessment: the assessment of performance at work. *Medical Education* 39(9): 880-889.
- Piccirillo, J. F. (2000). Importance of comorbidity in head and neck cancer. *Laryngoscope* 110(4): 593-602.
- Roe, C. J., Kulinskaya, E., Brisbane, M., Brown, R. and Barter, C. (1996). A methodology for measuring clinical outcomes in an acute care teaching hospital. *Journal of Quality in Clinical Practice* 16(4): 203-214.
- Royle, M., Callen, J. and Craig, M. (2004). 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. *Health Information Management* 32(1): 5-12.
- Sacco, R.L. (2004). Risk factors for TIA and TIA as a risk factor for stroke. *Neurology* 62 (8 Suppl 6): S7-11.
- Sacco, R.L., Adams, R., Albers, G., Alberts, M.J., Benavente, O., Furie, K., Goldstein, L.B., Gorelick, P., Halperin, J., Harbaugh, R., Johnston, S.C., Katzan, I., Kelly-Hayes, M., Kenton, E.J., Marks, M., Schwamm, L.H. and Tomsick, T. (2006). Guidelines for prevention of stroke in patients with ischemic stroke or transient ischemic attack: a statement for healthcare professionals from the American Heart Association/American Stroke Association Council on Stroke: co-sponsored by the Council on Cardiovascular Radiology and Intervention: the American Academy of Neurology affirms the value of this guideline. *Stroke* 37(2): 577-617.
- Schulz, U.G. and Rothwell, P.M. (2003). Differences in vascular risk factors between etiological subtypes of ischemic stroke: importance of population-based studies. *Stroke* 34(8): 2050-2059.
- Taheri, P.A., Butz, D.A. and Greenfield, L.J. (1999). Paying a premium: How patient complexity affects costs and profit margins. *Annals of Surgery* 229(6): 807-811; discussion 811-814.
- Wee, J.Y. and W. M. Hopman (2005). Stroke impairment predictors of discharge function, length of stay, and discharge destination in stroke rehabilitation. *American Journal of Physical Medicine and Rehabilitation* 84(8): 604-612.

Shyamala G Nadathur BSc, CertIT(BusAppl),
 GradDip(ClinImmunol), GradDip(InfoSystem), MSc,
 MHealthMgt, AFACHSE, MPHA, MHISA
 Project Manager, Southern Health
 Doctoral Candidate (Health Informatics)
 Monash Institute of Health Services Research
 Monash Medical Centre
 Locked Bag 29
 Clayton VIC 3168
 AUSTRALIA
 email: Shyamala.Nadathur@med.monash.edu.au ■