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HOSPITAL-RELATED MORTALITY IN NSW PRELIMINARY RISK-ADJUSTMENT

Paul Corben, Shing Chung (Simon) Fung, David Lyle
Epidemiology Branch
NSW Health Department

INTRODUCTION

This article reports on the analysis of in-hospital mortality using routinely collected data for rudimentary risk-adjustment. A previous article[1] presented crude in-hospital case fatality rates for NSW hospitals over the past five years and discussed the need for appropriate risk-adjustment before using such measures as indicators of the quality of hospital care.

Because the mortality outcomes of hospitals or clinical services are influenced by many factors other than the quality of medical care, adjustment for these factors is necessary before meaningful comparisons of mortality rates can be made between hospitals or over time. While routinely collected inpatient data in NSW do not contain measures of case severity or physiological status, other risk-stratifying data items are available. Such items include age, gender, source of referral (whether a routine or emergency admission), diagnoses and procedures performed during the inpatient episode. We report initial attempts to use such data in the development of hospital-related mortality indicators.

METHODS

We calculated in-hospital case fatality rates (CFRs) using pooled data from the NSW Inpatient Statistics Collection for financial years 1991-92 and 1992-93, excluding same day cases (i.e. those admitted and discharged home on the same calendar day). As in the previous article we used the following definition of CFR:

CFR (expressed as percentages) = 100* (No. inpatient deaths) / (No. hospital separations)

The number of deaths and separations was aggregated for each combination of hospital, Australian National Diagnosis Related Group (ANDRG), age group, gender and patient source of referral and CFRs calculated for each cell. Records were grouped to ANDRG Version 1[2] using ANDRG Version 2.0 software. All records assigned to an ANDRG which includes separation mode (died or transferred) in the decision tree (ANDRGs 244, 247, 700, 701, 702, 703, 704) were regrouped after recoding separation mode to "Other including discharged home". Records were assigned to one of 19 age groupings beginning with infants (under one year), one-four years, then in five-year age groups to 85 years and over. Patient source of referral categories were collapsed to two levels: "non-routine" admissions (including all admissions through Accident and Emergency units and transfers from other health care facilities) and other "routine" admissions (all other admissions). The resulting matrix contained 567,126 cells.

For use in indirect standardisation, average CFRs were calculated by aggregating deaths and separations across hospitals and across ANDRGs. We calculated three sets of indirectly standardised case fatality rates (ISCFRs) for hospitals. First, we applied the average overall CFR to hospital caseloads to calculate expected deaths and compared these results with observed deaths. Second, we calculated ISCFRs by applying average CFRs in age, gender and source of referral groups to hospital caseloads in these groupings. The third set of ISCFRs was calculated by applying average CFRs in ANDRG, age, gender and source of referral groups in a similar way.

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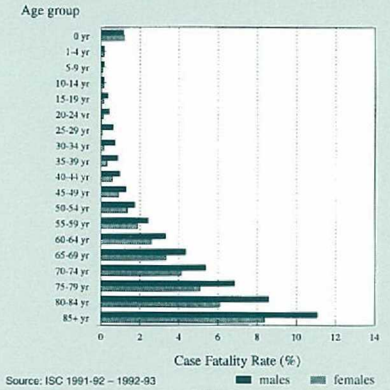
Correspondence

Please address all correspondence and potential contributions to:

The Editor,
NSW Public Health Bulletin,
Public Health Division,
NSW Health Department
Locked Bag No 961,
North Sydney NSW 2059
Telephone: (02) 391 9218
Facsimile: (02) 391 9232

FIGURE 1

CASE FATALITY RATES IN NSW HOSPITALS
ALL ANDRGs, 1991-92 – 1992-93 BY AGE AND SEX



Source: ISC 1991-92 – 1992-93

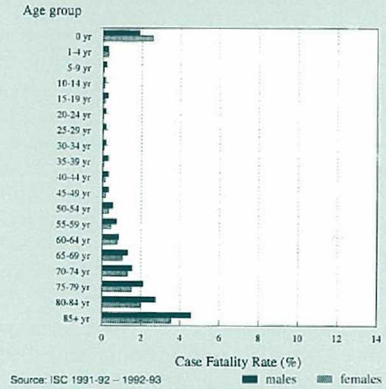
FIGURE 2

CASE FATALITY RATES IN NSW HOSPITALS
MEDICAL ANDRGs, 1991-92 – 1992-93 BY AGE AND SEX

Source: ISC 1991-92 – 1992-93

FIGURE 3

CASE FATALITY RATES IN NSW HOSPITALS
OPERATIVE ANDRGs, 1991-92 – 1992-93 BY AGE AND SEX



Source: ISC 1991-92 – 1992-93

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We estimated the systematic and random components of variance in the calculated ISCFRs using the variability index developed by Chan and Gibberd[3] and calculated approximate 95 per cent confidence intervals for the variability index using the normal approximation.

Hospitals were grouped according to a NSW Health Department classification which considers the level of services provided, casemix complexity and hospital size[4].

We used the SAS V6.08 PROC GLM procedure to estimate the proportion of variation in CFRs attributable to each of the main effect categorical variables: hospital, hospital service level, ANDRG, age group, gender and source of referral. CFR estimates were weighted according to the number of separations in the rate's denominator. We did not consider interactions of main effects.

We also calculated age-sex-adjusted ISCFRs for hospitals using separations from all public and private hospitals in NSW for financial year 1992-93 for the following conditions or procedures:

- acute myocardial infarction (AMI) (ICD-9CM code 410);
- cerebrovascular accident (CVA) (430-438);
- aortic aneurism (441);
- head injury (800, 801, 803, 804, 850-854);
- hip fracture (820); and
- coronary artery bypass grafts (CABG) (procedure code 36.1).

RESULTS

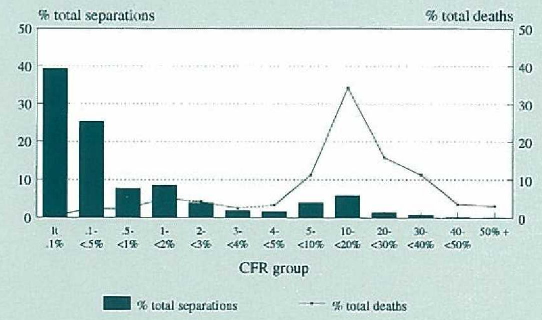
Over the two-year period 1991-92 and 1992-93, the NSW ISC reported approximately 1.96 million hospital separations (excluding same day cases) and 45,268 in-hospital deaths, for an overall CFR of 2.31 per cent. The vast majority (89.2 per cent) of deaths were classified to Medical ANDRGs, with 10.4 per cent within Operative ANDRGs and the balance (0.4 per cent) in Other ANDRGs. Over the same period about 1.14 million separations were assigned to Medical ANDRGs (58.0 per cent) and about 800,200 to Operative ANDRGs (40.8 per cent). The average CFR for Medical ANDRGs was 3.55 per cent while that for Operative ANDRGs was 0.57 per cent.

Overall, the CFR for males exceeded that for females (2.83 per cent v 1.90 per cent, $p < 0.0001$) and with the exception of the males in the infant group, CFR estimates for males exceeded those for females in all age groupings (Figure 1). The highest CFR for both males and females was found in the oldest age group, with CFRs of 11.06 per cent and 8.37 per cent respectively. Similar patterns were observed for age and sex groups for Medical and for Operative ANDRGs (Figures 2 and 3). The lowest CFR for males was in the 10-14 age group (0.15 per cent) and for females in the 25-29 age group (0.08 per cent).

After regrouping as described above, ANDRGs-specific CFRs varied over a wide range. Six ANDRGs showed CFRs above 40 per cent, no deaths were recorded for 86 ANDRGs and a further 64 ANDRGs had CFRs below 0.01 per cent. The highest CFR was 66.7 per cent (14 deaths) for ANDRG 912 (Extensive burns without Operating Room procedure) followed by ANDRG 705 (Neonate admission weight < 750 grams, CFR = 61.6 per cent, 215 deaths), and ANDRG 248 (Circulatory disorders with AMI without invasive cardiac investigative procedures, with complications/comorbidities,

FIGURE 4

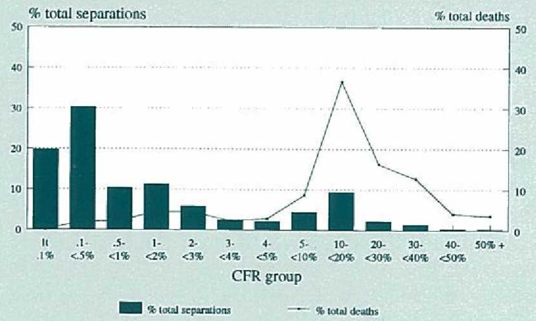
PERCENT OF TOTAL SEPARATIONS AND PERCENT OF TOTAL DEATHS FOR ALL ANDRGs BY CASE FATALITY RATE (CFR) GROUPING



Source: ISC 1991-92 – 1992-93

FIGURE 5

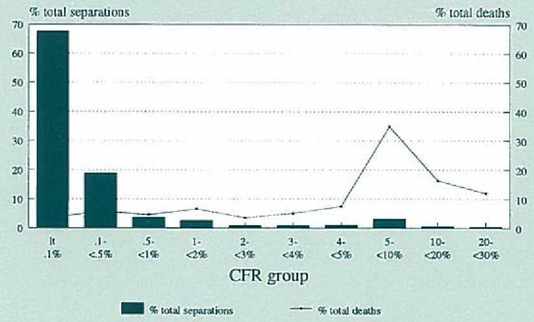
PER CENT OF TOTAL SEPARATIONS AND PER CENT OF TOTAL DEATHS FOR MEDICAL ANDRGs BY CASE FATALITY RATE (CFR) GROUPING



Source: ISC 1991-92 – 1992-93

FIGURE 6

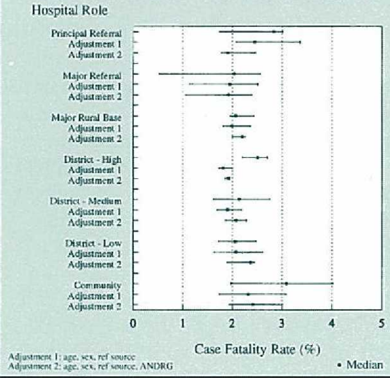
PER CENT OF TOTAL SEPARATIONS AND PER CENT OF TOTAL DEATHS FOR OPERATIVE ANDRGs BY CASE FATALITY RATE (CFR) GROUPING



Source: ISC 1991-92 – 1992-93

FIGURE 7

CRUDE AND ADJUSTED CASE FATALITY RATE NSW PUBLIC HOSPITALS, 1991-92 AND 1992-93 MEDIAN AND 25-75 PERCENTILE RANGES



CFR = 51.8 per cent, 1,195 deaths). The highest number of deaths was recorded in ANDRG 34 (Specific cerebrovascular disorders except transient ischaemic attack, CFR = 19.6 per cent, 3,578 deaths) and ANDRG 170 (Respiratory neoplasms, CFR = 32.2 per cent, 2,771 deaths).

We charted the proportion of cases within ANDRG-specific CFR ranges against the proportion of total deaths observed within these groups, overall (Figure 4) and for Medical (Figure 5) and Operative (Figure 6) ANDRGs. As the figures illustrate, most deaths occur in a relatively small number of clinical groupings. Overall, 79.5 per cent of deaths occur in ANDRGs with CFRs above 5 per cent, while these groups account for 12.2 per cent of total separations. For Medical ANDRGs, 81.8 per cent of deaths occur in ANDRGs with CFRs above 5 per cent, with these ANDRGs accounting for 18.0 per cent of Medical separations. Operative ANDRGs show 63.2 per cent of deaths occurring in ANDRGs with CFRs above 5 per cent while these account for only 4.2 per cent of Operative separations.

Using indirect standardisation, we calculated ISCFRs for hospitals within service role groupings (Figure 7). We plotted the 25-75 interquartile ranges of crude CFRs against ISCFRs after adjusting for age, sex and source of referral (Adjustment 1) and ANDRG, age, sex and source of referral (Adjustment 2). Adjustment 1 reduced the median CFR within each hospital service role grouping except the District-Low grouping and had some impact on the interquartile range. The figure also shows the impact of Adjustment 2, with adjusted rates generally showing narrower interquartile ranges and CFRs (crude and Adjusted 1) being revised down for the larger, referral hospitals and being revised up for other hospital categories. For example, the median crude CFR for the nine Principal Referral hospitals was revised from 2.83 to 2.45 per cent after adjustment for age, sex and source of referral and further reduced to 1.93 per cent after additional standardisation using ANDRGs. In contrast, the seven Major Rural Base hospitals showed a median crude CFR of 2.07 per cent, which was reduced to 1.99 per cent with Adjustment 1 but increased to 2.20 per cent with Adjustment 2.

The analysis of variance of CFRs indicated that, together, hospital service role, hospital, ANDRG, age group, gender and source of referral account for 33.98 per cent of the total

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variation (Figure 8). The remaining 66 per cent of variation not accounted for by these factors and includes unmeasured factors such as illness severity, other hospital-specific factors including quality and a component of random variation.

Using Pearson product-moment correlation coefficients we found no evidence of association between any of the calculated ISCFRs and hospital throughput. However, Spearman rank correlation coefficients indicated a statistically significant association ($r=0.41$, $p<0.0001$) between ISCFRs using only Operative ANDRGs and volume while those for Medical ISCFRs showed no such correlation ($r= 0.009$, $p=0.85$). For 11 hospitals showing significantly high overall ISCFR but low ISCFR using Adjustment 1 (age and sex), six recorded high ISCFRs for Medical groupings but low for Operative groupings, four were high for Medical groupings and average for Operative groupings and one showed an average Medical ISCFR and was significantly high for the Operative grouping. We found similarly complex inter-relationships for other hospital groups.

Using the Chan and Gibberd variability index, we estimated the systematic and random components of the variance of ISCFRs. When the overall average CFR (2.31 per cent) was applied to hospital caseloads to produce an expected number of deaths, the index estimated that 97.8 per cent of the variance in ISCFRs was non-random. Standardisation by age and gender (Adjustment 1) reduced this percentage to 91.6 per cent while Adjustment 2 across all patient types further reduced this estimate to 50.5 per cent. ISCFRs calculated for Operative ANDRGs showed 40.5 per cent of the variance as systematic variance while Medical ANDRGs showed 66.3 per cent systematic variance. We were unable to apply Chan and Gibberd's Chi-square approximation to obtain confidence limits for their variability index but used the normal approximation. The crude, Adjustment 1, and Adjustment 2 for Medical ANDRGs ISCFRs showed 95 per cent confidence intervals which did not include zero, indicating strong evidence for remaining systematic variation in the ISCFRs.

Examining the variance of crude and ISCFRs for each of the specific conditions and procedures listed earlier we noted strong evidence of systematic variance in:

- head injuries (both crude and age-sex adjusted); and
- cardiovascular disease (both crude and age-sex adjusted)

but not for aortic aneurisms, hip fractures, AMI or CABG.

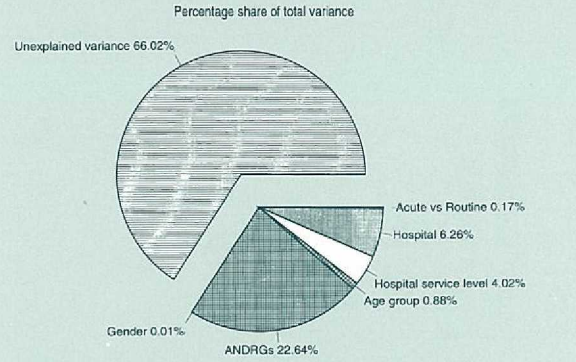
Discussion

In this preliminary analysis we examined some readily available risk-adjusting data items and demonstrated the impact of simple risk adjustment on in-hospital CFRs. The chosen variables were unable to explain more than about 34 per cent of observed variation in case fatality rates. More promising results have been reported elsewhere[5] for specific patient groups, using severity scores and severity surrogates.

The adjustments presented here do not include adjustment for patient severity of illness although, due to the ANDRG classification hierarchy, some account of complexity and complications is included. Nor did we attempt to include consideration of hospital or physician characteristics. Other investigators[6] have found that both hospital and physician characteristics are important but inconsistent predictors of in-hospital mortality.

FIGURE 8

SOURCES OF VARIATION IN IN-HOSPITAL MORTALITY RATES, NSW 1992-93



Source: NSW Inpatient Statistics Collection, 1992-93 (HOIST)

We have not attempted to identify individuals in our analyses and, in using hospital separations as the numerator for CFRs, we have under-estimated the mortality risk faced by individuals. In NSW we face considerable but not insurmountable technical difficulties in identifying individuals in administrative data systems. We aim to report on progress in this area this year.

Proposed changes[7] to health information systems in NSW would reduce the complexity of such analyses.

Many attempts[5,8] to use administrative data to assess patient outcomes have been reported. However, there is no consensus about the best choice of risk factors or adjustment methods. The one common thread of such articles is that the use of administrative data sets for outcomes research will place increasing demand on data collection mechanisms for the delivery of consistent and high quality data and inclusion of additional information useful to outcomes research. We may also expect that the patient (rather than treatment) focus[9] of outcomes research will have significant impact on the classification systems we develop. For example, existing classification schemes and information systems make it difficult to distinguish between complications of care and pre-existing comorbidities[10] and difficult consistently to apply comorbidity indices to administrative data.

This article emphasises the need for appropriate risk-adjustment when assessing patient outcomes and serves as a warning against the temptation to produce simplistic measures of the complex interaction of the many aspects of hospital care which influence outcomes. Our analysis also demonstrates the potential problems facing the development of a general index of mortality for hospitals rather than the analysis of particular procedures and conditions. This analysis may guide us in our identification of high- and low-risk patient groups for which focused study

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Public Health Abstracts

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behavioural differences and a much higher rate of accidents among the left-handed.

Turner BS. *Br Med J* 1993; 307:1578.

Pelvic Inflammatory Disease

Pelvic inflammatory disease refers to infection of the uterus, fallopian tubes and adjacent pelvic structures that is not associated with surgery or pregnancy. This infection is almost always the consequence of sexually transmitted bacterial infections. Problems of infertility and ectopic pregnancy are the direct result of this medical, social and economic problem. The most important causative organisms are *Chlamydia trachomatis* and *Neisseria gonorrhoeae*. More than half of all cases are caused by one or both of these sexually transmitted micro-organisms.

Prevention of sexually transmitted diseases, or vigorous treatment with antibiotics when they occur, is essential.

McCormack WM. *New Eng J Med* 1994; 330:115.

Fluoride Poisoning

A disturbing report from Alaska has shown that excess added fluoride to public water systems was the cause of an outbreak of acute fluoride poisoning. The poisoning caused nausea, vomiting, diarrhoea and abdominal pain. Some 296 people were poisoned and one died. The fluoride concentration of the water samples from the implicated source was 150 milligrams per litre – about 150 times the standard level recommended. The greatly excessive fluoridation occurred because there were major electrical and mechanical defects in the fluoride pumping system. The fluoride pump worked four times faster than expected, which dramatically increased the fluoride concentration in the holding tank.

Gessner BD, Beller MD, Middaugh JP et al. *New Eng J Med* 1994; 330:95-9.

Changing Onset of the Menarche

The menarche indicates the capacity to reproduce. It is the onset of menstruation in females. In the past century there has been a decrease in age toward earlier menarche of about three to four months a decade. The age of the menarche is determined by factors which act in combination, including genetics, socioeconomic conditions, health, nutrition and some types of exercise. The importance of genetic factors is illustrated by the similar age of menarche in members of an ethnic population and in mother-daughter pairs.

Studies in the United Kingdom and in Canada suggest the levelling out of the age of the menarche and indeed an increase in the age of the menarche which has been recently observed is probably a consequence of the fashion towards being slim and to undertake exercise.

Rees M. *Lancet* 1993; 342:1375.

Alcohol Intake and Myocardial Infarction

The effects of alcohol consumption on cardiovascular disease are complex. Although heavy alcohol intake increases overall mortality and mortality due to cardiovascular diseases, moderate intake appears to exert a protective effect against coronary heart disease compared with drinking no alcohol. A large American study has confirmed these findings and identified that one of the mechanisms involved is that alcohol appears to increase levels of high density lipoprotein cholesterol – the "protective" cholesterols.

Gaziano JM, Buring JE, Breslow JL et al. *New Eng J Med* 1993; 329:1829-34.

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and monitoring would be fruitful. Case reviews conducted by expert committees[11] have classified 64 per cent of deaths reviewed as inevitable or fortuitous – a fact which underlines the need to develop finely tuned instruments to detect quality of care differences between institutions. A single measure is not appropriate for all conditions.

The next steps in our exploration of hospital-related mortality will include:

- evaluation of reported methods for using existing inpatient data in the measurement of comorbidity and severity of illness and in risk adjustment; and
- comparison of the use of routinely reported inpatient data and these algorithms against results derived from more comprehensive clinical databases, e.g. Trauma Registries.

1. Lyle D, Fung SC, Corben P, Churches T. Hospital-related mortality in NSW: Preliminary results: *NSW Public Health Bulletin* 1994; 5(3):25-28.
2. 3M Health Information Systems & Commonwealth Department of Health Housing & Community Services. Australian National Diagnosis Related Groups Definitions Manual Version 1.
3. Chan LY, Gibberd RW, Dickman PW. A new index to measure systematic regional variation in mortality (unpublished).
4. NSW Public Hospital Comparison Data 1991/92. NSW Health Department, State Health Department Publication No. (IC) 93-134.
5. US Congress, Office of Technology Assessment. The Quality of Medical Care: Information for Consumers, OTA-H-386 (Washington, DC; US Government Printing Office, June 1988) Chapter 4, pp 73ff.
6. Burns LR, Wholey DR. The effects of patient, hospital and physician characteristics on length of stay and mortality. *Medical Care Review* 1991; 29(3):251-271.
7. NSW Health Department. NSW Health Information Management Strategy Report Volume 1 (in press).
8. Romano, PS. Can administrative data be used to compare the quality of health care? *Medical Care Review* 1993; 50(4):451-477.
9. Orchard C. Comparing healthcare outcomes. *Brit Med J* 1994; 308:1493-1496.
10. Romano PS, Roos LL, Jollis GJ. Response: Further evidence concerning the use of a clinical comorbidity index with ICD9-CM administrative data. *J Clin Epidem* 1993; 46(10):1085-1090.
11. Warden JC, Borton CL, Horan BF. Mortality associated with anaesthesia in New South Wales, 1984-1990. Unpublished.