Factors influencing patients' length of stay

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Abstract

This study was conducted to evaluate the ability of AN-DRG version 3.1 to predict variation in patients' length of stay in hospital (LOS) and identify other factors that can influence the LOS by using routinely collected hospital morbidity data. A total of 18 DRGs that comprised 4,589 episodes were analysed. Multiple regression was used to model length of stay as a function of a number of independent variables. Overall only 37.6% of variation in mean length of stay could be explained. DRGs predicted 30% of the total variation. Other factors such as age, payment classification, source of referral, specialty of doctor, and ethnic group also influenced patient length of stay. It was concluded that the limited explanation was a consequence of a lack of a better indicator of severity within DRGs.

Introduction

With rapidly rising health care costs, governments and other major funders of health care services have been searching for mechanisms to control expenditure and evaluate the efficiency of health care delivery. The pursuit of technical efficiency in the health care service has become an important objective. Diagnosis Related Groups (DRGs) have been developed as a part of this process.

Australian National Diagnosis Related Groups (AN-DRG) classification is revised frequently to maintain its validity. AN-DRG version 3.1 addressed some shortcomings of earlier versions, but there is still heterogeneity within DRGs due to differences in complications and comorbidities and other clinical and non-clinical factors. At present, AN-DRGs have been replaced by Australian Refined Diagnosis Related Groups (AR-DRG), which improves the method of calculating a patient's clinical complexity level (Commonwealth Department of Health and Family Services, 1998).

DRG development is aided through statistical analysis to ensure that the classification of DRGs maximises clinical meaningfulness and maintains intra-group homogeneity. As part of this analysis, length of stay (LOS), the number of bed days per inpatient episode, is often used to indicate the level of hospital resources consumed (Berki et al., 1984). Moreover, it is one of the parameters used to approximate the level of resource consumption for a particular episode of care and as an indicator of homogeneity (Commonwealth Department of Human Services and Health, 1995). An analysis of the determinants of length of stay, therefore, may provide useful information for assessing the quality of DRG classification and improving the efficiency of the delivery of health care.

This study explored DRGs and other factors that potentially influence length of stay in a large urban teaching hospital in Western Australia. Its aim was to evaluate the ability of AN-DRG version 3.1 to explain variation in length of stay and determine whether there are differences in length of stay among categories defined by

independent variables. Thus for all selected episodes, its objective was to determine whether factors such as age, gender, ethnic group, source of referral, payment classification, admission type, physicians, and DRGs significantly predict the variation in length of hospital stay.

Method of study

Collection of Data

Hospital data for the period July 1995 to June 1996 were obtained from the Hospital Morbidity Database System (HMDS) in the Health Department of Western Australia. The DRG classification used in the study was AN-DRG classification version 3.1 since version 4 started to be used in WA in mid-1999. Initially all episodes that were admitted to a large teaching hospital, which provides statewide health services, were selected, resulting in a total of 56,323 episodes. Facilities to which patients could be discharged have an impact on length of stay (Cowper et al., 1997 and Weingarten et al., 1998). Therefore in order to reduce variance, only those episodes that were discharged home were selected, removing 3,958 episodes. Because there is no variation in sameday admission, these episodes were also excluded, which resulted in 19,676 episodes being available for the analysis. Finally to ensure adequate sample size, only those DRGs in which the numbers of episodes were at least 1% of all discharges were included in the study. This reduced the numbers of episodes to a total of 4,589.

Statistical Analysis

The statistical methods for data analysis are based on an assumption that the values of dependent variable are normally distributed. The distribution of length of stay was examined, but because of its skewed distribution, the natural log transformation of length of stay was used to meet the assumption of normality. As a result, geometric mean (GM), as well as its standard deviation (GSD), were calculated for the length of stay. All length of stay statistics are reported after a reverse transformation as days. Frequency distributions of the category variables and age groups were initially determined. A t-test or One-way analysis of variance (ANOVA) was performed to determine whether there was a difference in mean length of stay between category groups. Multiple linear regression with forward stepwise selection was used to model length of stay as a function of all nine independent variables including age, gender, ethnic group, admission type, source of referral, payment classification, marital status, DRG and specialty of doctor at the time of discharge. Adjusted R square was used to show explained proportions of variance in the dependent variable.

Results

The average LOS for all episodes was 4.62 days (GSD: 2.07). The results of one way ANOVA or t-test show that there was a significant difference in mean length of stay within some category variables. Table 1 shows percent of discharged episodes and geometric mean in these independent variables.

Table1: Percent of discharged episodes and GM LOS for significant ($p<0.01$) category variables.

Variables	Percent (%)	Geometric mean LOS (days)
1.Source of referral		
Emergency Department	79.5	4.45
Waiting List	14.4	4.84
Outpatients Department	1.9	5.44
Interhospital Transfer	1.6	7.05
Postadmission change	2.4	7.28
2. Payment Classification		
Private	13.8	4.03
Public	78,1	4.78
WCA*	0.7	4.99
MVIT+	0.7	5.58
3. Gender		
Male	57.5	4.56
Female	42.4	4.81
4. Marital Status		
Not currently married	95.7	4.57
Currently married	4.3	6.20
5. Age group (years)		
<30	8.1	3.45
30-49	16.2	4.77
50-59	14.4	4.13
60-69	21.6	5.08
70-79	24.4	4.91
80+	15.2	5.20

Note: * Workers Compensation Assurance.
+ Motor Vehicle Insurance Trust.

The variable of source of referral recorded the source where patients came from. The categories that had significant mean differences are reported in the table. Three thousand six hundred and forty-nine episodes were admitted into the hospital from its Emergency Department, these had the smallest mean length of stay. Those cases that had the longest LOS were patients who were admitted as postadmission change (change in type of episode of care during the time in hospital). Patients admitted from this referral source were mainly in DRG 291, 297 and 843.

The payment classification variable indicated how the hospital was paid for the service provided to the patient. Only the four categories that had significant mean difference are reported. Three thousand five hundred and eighty-five episodes were public paid with a GM LOS of 4.78 days. Six hundred and thirty-four private paid

episodes had the shortest GMLOS. While 32 episodes that were in DRG 420 and paid by MVIT had the longest GM LOS.

Age was collapsed into six age groups for analysis of descriptive statistics and one-way ANOVA. Although only accounting for 372 episodes, those aged less than 30 years had the shortest GMLOS. Those aged 80+ had the longest GMLOS (n=699).

Table 2 Percent of discharged episodes and GM LOS classified by Specialty of doctor at time of discharge

Specialty of doctor at time of discharge	Percent (%)	Geometric mean LOS (days)
Specialty in General Surgery	10.8	3.55
Specialty in Cardiology	29.1	3.75
Specialty in General Medicine	28.2	4.65
Specialty in Neurology and Stroke	1.9	6.45
Specialty in Respiratory Medicine	2.7	7.45
Specialty in Oncology	0.3	10.40
Specialty in Psychiatry	5.4	16.61

As doctors are responsible for patients' treatment as well as the time of discharge, they can influence patients' length of stay. In the database, the specialty of the consultant doctor was recorded at admission and discharge of patients. But only the variable, specialty of doctor at the time of discharge, was selected. The WA morbidity data system classified doctors into 23 specialties. Table 2 shows the specialty of doctor at time of discharge that had the most influence on mean length of stay. The two most common specialties were Cardiology and General Medicine, who discharged 1,335 and 1,296 episodes respectively. Moreover within the same DRG, patients treated by specialty in Cardiology stayed shorter on average than those treated by other specialties. Two hundred and forty-eight episodes discharged by Psychiatrists had the longest GM LOS. Patients under the care of oncologists also stayed longer than patients treated by doctors from other specialties.

The frequency and geometric mean length of stay of each DRG was calculated and are presented in Table 3. Five hundred and thirty episodes discharged from the hospital had a procedure of trans-vascular percutaneous cardiac intervention (DRG 297) with a GM LOS of 4.23 days. The most common disease was heart failure and shock (DRG 252). Five hundred and thirteen episodes in this DRG, which accounted for 11.2% of discharged episodes, were discharged with a GM LOS of 5.64 days. Two hundred and fifty-three episodes discharged in DRG 843 stayed much longer than others, while DRG 261 had the lowest GM LOS. Distributions of DRG 270, DRG 314 and DRG 347 were very skewed even after log transformation. Therefore median was reported instead of geometric mean length of stay in the table.

Table 3 Analytical results for selected DRGs.

Category	DRG	Frequency	% of discharged episodes	GM LOS (days)	Association with Mean LOS
Circulatory System	261	195	4.2	2.98	-
Circulatory System	274	174	3.8	3.57	-
Circulatory System	280	165	3.6	3.86	-
Digestive System	330	129	2.8	3.95	-
Circulatory System	269	274	6.0	4.13	-
Circulatory System	297	531	11.6	4.23	+
Musculoskeletal System	420	246	5.4	4.29	N
Circulatory System	249	279	6.1	5.24	N
Digestive System	367	207	4.5	5.31	+
Circulatory System	273	230	5.0	5.32	+
Circulatory System	252	513	11.2	5.64	N
Nervous System	38	127	2.8	6.04	N
Respiratory System	177	398	8.7	6.54	+
Circulatory System	291	316	6.9	9.33	+
Mental Disorder	843	253	5.5	16.43	+
Digestive System	347	142	3.1	2.00*	-
Circulatory System	270	238	5.2	3.00*	-
Digestive System	314	172	3.7	3.00*	N

Notes:*Median was used instead of geometric mean because of skewed distribution of LOS.

N no association.

\+ Positive association.

\- Negative association.

In order to identify whether each category has its own effect on variation in mean length of stay, all category variables were recoded as dummy variables with values 0 and 1 before they entered the multiple regression. The category variable of interest was coded as 1, while others were controlled under coding of 0. The results show that age, ethnic group, gender, three payment classifications, thirteen different kinds of DRGs, six doctor specialty groups, and two sources of referral could significantly explain overall 37.6% of variation in mean length of stay when all other variables were controlled. Table 4 shows the significant predictors with their coefficient and partial correlation.

The most effective explanatory variable among all predictors was DRG 843, major affective disorder. This variable alone explained 13% of total variation. DRG 291 had a positive association with mean LOS and explained 6.3% of total variation. DRG 261 had a negative association with mean LOS and could explain 2.1% of variation.

Episodes of patients who were discharged by Cardiologists, which explained 1.4% of total variation, were significantly shorter compared to those discharged by other specialties. Care by specialists of General Surgery and General Medicine also had a significant negative association with episodes' length of stay and explained 1.3% and 0.7% of total variation respectively. On the other hand, treatment by Oncologists, Neurologists, and Respiratory Medicine specialists had a positive association with patients' length of stay. But they explained a small proportion of variation in mean length of stay.

Patient's age had a significantly positive association with mean length of stay. This variable explained 5.0% of total variation. Female patients stayed longer than males, but gender only explained 0.13 % of total variation.

Patients admitted from hospital waiting list and outpatient department had a negative association with mean length of stay. They explained 3.7% and 0.3% of total variation respectively. Episodes of care paid by public payment, MVIT, and WCA had a positive association with length of stay. But they only explained a small proportion of variation in length of stay.

Table 4 Significant predictors from the multiple regression

Significant predictors *	Coefficients (β)	SE of β	Partial correlation
DRG843-Mental Disorder	0.514	0.020	0.360
DRG291-Circulatory Disease	0.349	0.020	0.251
Age	0.004	0.000	0.223
DRG177- Respiratory Disease	0.046	0.017	0.041
DRG270-Circulatory Disease	-0.203	0.018	-0.162
Waiting list	-0.175	0.013	-0.192
DRG367- Digestive Disease	0.243	0.026	0.138
DRG261- Circulatory Disease	-0.196	0.020	-0.146
Specialty in General Surgery	-0.160	0.021	-0.115
DRG269- Circulatory Disease	-0.128	0.017	-0.109
DRG280- Circulatory Disease	-0.153	0.021	-0.106
Cardiologist	-0.120	0.015	-0.119
Specialty in General Medicine	-0.074	0.013	-0.085
DRG347- Digestive Disease	-0.110	0.025	-0.066
DRG274- Circulatory Disease	-0.060	0.022	-0.041
Oncologist	0.302	0.064	0.070
DRG330- Digestive Disease	-0.075	0.024	-0.047
Outpatients	-0.103	0.028	-0.055
Ethnic group	0.061	0.020	0.045
DRG273- Circulatory Disease	0.078	0.019	0.059
Gender	0.019	0.008	0.036
DRG297- Circulatory Disease	0.049	0.016	0.044
Public Payment	0.034	0.010	0.053
MVIT	0.167	0.047	0.052
Specialty in Respiratory Medicine	0.077	0.028	0.041
WCA	0.116	0.047	0.037
Neurologist	0.064	0.029	0.033
Constant	0.400	0.032	

* For overall model: F=103.47; df=27,4561; p=0.00

Discussion

This study analysed DRGs and other factors that influence patient length of stay by using data routinely collected as part of the hospital morbidity system. Multiple regression analysed whether variability of length of stay could be predicted by independent variables. Results revealed that overall only 37.6% of variation was significantly explained by the model. DRGs predicted 30% of variation in length of stay.

Association of DRG with length of stay

It is well accepted that a patient's medical condition is the principal determinant of length of stay. Thirteen DRGs were found to significantly predict about 30% of variation in mean log length of stay, although the impacts as well as the extent to which they explained the variation differed. Amongst all DRGs, DRG 843, major affective disorder, was associated with the largest proportion of explained variation. This is related to the fact that it had the greatest mean length of stay. The reason why patients in this DRG stayed much longer than others could be that there is no objective standard to assess the outcome of treatment. Another possible reason is that types of patients might differ from other DRGs, which needs to be investigated further.

The level of variation that can be significantly explained by DRG 270 (Unstable angina without special complication and comorbidity) is greater than for DRG 269 (Unstable angina with special complication and comorbidity). DRG 291 (Coronary bypass without invasive cardiac investigatory procedure without major complication and comorbidity) and DRG 261 (Chest pain) also explain more variation than other DRGs. These findings suggest that the ability of DRG to predict the variation in mean length of stay is related to the extent of the intra-DRG homogeneity.

The DRG that had the most episodes is DRG 252, heart failure and shock. This is probably because heart failure is a disease that is hard to manage and likely to recur, resulting in high admission and readmission rates. But this DRG could not significantly predict variation in LOS in the final multiple regression model. This may be because this most common DRG inevitably has a great influence on the overall mean length of stay. This can result in a failure to detect an association when using multiple regression analysis.

DRGs are formed on the basis of the homogeneity of diseases that can be evaluated by the indicator of LOS and have been used for health resource allocation to hospital. In other words, patient length of stay should be highly related to DRGs. But the results from this study show that all DRGs only predicted 30% of variation in mean length of stay. Overall about two thirds of variation is left unexplained. The reason that AN-DRG 3.1 failed to predict more variation in length of stay may be due to issues of case severity level, which adds to the heterogeneity of DRGs. Patients with a number of complications and comorbidities (CCs) are likely to be more resource intensive to treat, resulting in longer hospital stay. In DRG version 3, only the most severe CCs were used as an indicator of case severity, which underestimates the severity level of patients. Data limitations prevented analysis of other clinical and non-clinical factors that could influence patient LOS.

Association of other factors with length of stay

Other factors also explain some variation in length of stay, and may be worth considering for hospital funding purposes.

Publicly funded and Workers Compensation Assurance (WCA) patients stayed longer than private patients. This finding is consistent with previous studies that a patient's payment status might lead the patient to become actively involved in decisions affecting the length of stay (Moinpour et al.1990 and Kuykendall et al. 1995). On the other hand, payment type can be closely related to a patient's disease type. Patients covered by the MVIT were only in DRG 420 and associated with the longest stay, since this group of episodes were involved with motor vehicle accidents. Consequently they may be more medically serious than other patients within the same DRG.

Ethnic group was recorded as non-Aboriginal and Aboriginal. Non-Aboriginal patients stayed shorter (GM=4.59) than Aboriginal patients (GM=5.18). This variable could explain variations in mean log length of stay in the multiple regression model but the result of a two-tailed t-test showed the mean difference to be insignificant. This could be due to an interaction between ethnic group and age, gender or DRGs. A reason for Aboriginal patients staying longer than non-Aboriginal may be due to geographic issues. This could pertain to delays in organising transport back to a remote area or possibly result in only the sicker and more complex cases from remote areas being transferred to the teaching hospital. Another explanation may involve the issue of compliance and other social factors that may influence the time of discharge. These thoughts were consistent with the analysis of high length of stay outlier episodes in the East Pilbara by Russell-Weisz and Hindle (2000). Moreover, it is considered that " the DRG system is weak in describing morbidity patterns in Aboriginal and similar communities where there is a high burden of disease and multiple comorbidities are commonplace" (Russell-Weisz and Hindle, 2000).

Referral from hospital waiting list and outpatients department could predict the variation in mean length of stay, but interhospital transfer and postadmission change with much longer mean LOS could not influence the overall variation. The possible reason is that the variability in waiting list and outpatients was less than interhospital transfer and postadmission change. Patients admitted as interhospital transfer or postadmission change stayed longer on average, which might be due to medical conditions for these episodes that were more complex or additional conditions were diagnosed after their admission.

The effects of specialty of doctor on length of stay were mixed. Episodes treated by Oncologists and Psychiatrists had longer stays, which were probably due to the characteristics of the diseases. On the other hand, episodes of care by cardiologists in different DRGs had shorter stays, suggesting that physicians' discretion also can affect patient length of stay. However, this can be confounded by some factors such as disease category, comorbidity, as well as severity of illness they treat.

Conclusions

AN-DRG version 3.1 only predicted about 30% of variation in length of stay. The proportion of variation explained by individual DRGs differed according to the extent of intra-DRG homogeneity. It is likely that this low degree of explanation is a consequence of within-DRG heterogeneity. This lack of an indicator of severity within DRGs is one explanation for the heterogeneity. The quality of the DRG classification has been improved in the version 4 of AR-DRG. This new version is revised by undertaking complicating clinical factor analysis, which includes CCL (clinical complexity level), complicating principal diagnosis and certain procedures, and so on (Commonwealth Department of Health and Aged Care, 1998). Further research is needed to investigate whether individual DRGs in AR-DRG version 4 can predict more variation in length of stay, to establish that it is a more valid classification.

Patients within the same DRG differed in length of stay when they were admitted from different referral sources or in different payment classifications. Moreover, within-DRG length of stay also differed when episodes were treated by different specialty of doctor. Further study is needed to investigate whether factors such as specialty of doctor, referral source and payment classification can be manipulated for curtailing LOS while maintaining the same outcome level after incorporation of a severity indicator.

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