

Assessing the availability of casemix information in hospital database systems in Rio de Janeiro, Brazil

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Abstract

Objective. This article considers the possibility that using secondary diagnoses extracted from hospital medical records of patients would modify the diagnosis related groups (DRG) allocated to a case and the Charlson comorbidity index (CCI) calculated from data in the Brazilian hospital information system.

Design. This study used two databases: the administrative database of the Brazilian health care system which consists of claim forms abstracted from medical records and is primarily linked to reimbursement, and the medical records that correspond to a sample of claims forms of which the first data source is composed. Changes in DRG were tested by analyzing percent of agreement and the κ index. Logistic regression was employed to evaluate the impact of using CCI scores.

Settings and patients. This study is based on a sample of claim forms and medical records ($n=1331$) from a number of private acute-care hospitals which had contracts with the municipality of Rio de Janeiro in 1986.

Results. Use of information on comorbidity shown in medical records caused changes both in the classification of cases into DRG and in the scores of the CCI. The impact of restrictions on the number of secondary diagnoses in the Brazilian administrative database is comparatively more important for the CCI than for DRG allocation since the Charlson method is based on an additional model where every case of comorbidity is taken into account cumulatively for the final score.

Conclusion. These findings indicate the importance of taking a number of measures to improve the quality of information systems in order to increase their potential role in the evaluation of Brazil's health services.

Keywords: casemix, comorbidity, database, severity

The practice of resorting to large information systems for the purposes of research and evaluation of health services has expanded over the past 20 years. These information systems afford advantages but can also cause problems [1–4]. An important concern is that they make sufficient information available to meet methodological needs when, to give an example, variations in casemix must be taken into consideration. When comparing hospital care in terms of length of stay, costs or health outcomes, it is essential to determine to what extent the results observed are due to differences in the complexity of the cases admitted.

Various classification systems have been drawn up for

measuring casemix [5]. Systems vary according to their conceptual structure and characteristics, as well as in the methods employed for measuring the severity of cases [5–10]. Among the issues raised in debates on payment system problems and quality of care, measurement of case severity is a critical issue as it permits division of the patient pool into homogeneous groups based on their resource consumption and/or clinical risks [10–17]. Moreover, the severity of a disease may be a major confounding factor for studies concerning care outcome, when adjustment for risk factors is therefore essential.

Once it is realized how important the degree of severity of illness is for quality of care assessment, discussion of the

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adequacy and validity of casemix measurement methods increases in importance. There are several patient classification systems. One, the diagnosis related groups (DRG), fails to address adequately the element of severity [13,18–21]. This criticism partly explains the various modifications made in each DRG revision. Since the severity of cases in each DRG may exert an influence on both the consumption of resources and the length of stay, this last variable is used as a criterion for regrouping [22].

To obtain more valid measurements of case severity for care outcome studies it is important to use clinical variables that are not always mentioned in claim forms. In certain cases, the necessary information can be found only in medical records. Debates concerning the adequacy of information in administrative information systems for analyzing the use and outcomes of hospital care have brought about recommendations for more data on the characteristics of patient diseases and medical procedures. This in turn emphasizes the increase in the number of associated diagnoses and procedures employed. As a result, there is now a larger number of fields for diagnosis and procedure codes on claim forms, especially in the USA. Coding now consists of more than the five diagnoses and three procedures used at the time when the DRG system of classification was introduced in the USA [10].

Despite these improvements, the limitations of DRG classification have led to specific methods for assessing the severity of cases. Some methods use associated diagnoses to forecast the risks faced by the patient, without requiring supplementary information from a medical chart. One example of this is the Charlson comorbidity index (CCI) [23], a method employed for making risk adjustments. It is an index created by using weights for specific clinical conditions identified as comorbidities, which can be used for evaluating some hospitalization outcomes such as mortality rate [24,25]. The quality and value of this type of classification system depends, however, on the comprehensiveness and the precision of the diagnostic codes.

The aim of this study is to evaluate the impact of the availability of more diagnostic information on two methods of assessing casemix. The first method is defined as a severity measure of resource use – DRG [26]; the other is defined as a severity measure focused on clinical definitions – the CCI [23]. More precisely, this article considers the possibility that using secondary diagnoses extracted from hospital medical records of patients would modify the DRG allocated to a case and the CCI calculated from data in the Brazilian hospital information system. The study poses the question “Does limitation of the number of diagnoses contained in the Brazilian hospital information system bias the casemix assessment that is based on these diagnoses?”

In 1983, Brazil’s federal government decided to introduce a system of prospective financing for private hospitals based on per case payments. The payment unit of the Brazilian prospective payment system is based on a classification system created in 1981 in which coherent medical conditions or surgical procedures with similar resource consumption at that time were grouped. Since then the Brazilian in-patient

classification system has never undergone any systematic review. Moreover, the output unit does not take demographic or clinical characteristics of the patients into consideration: it is centred solely on the type of health care given (clinical, surgical, therapeutic and diagnostic procedures) [27]. This implies that, in Brazil, the groups formed in the regrouping of procedures are probably internally more heterogeneous than the variation observed in each DRG in relation to length of stay and resource consumption. In addition these groups are not useful for identifying patients with different levels of severity of illness.

While the limitations of data input and their impact on the quality of information are frequently a topic of discussion in the USA, in Brazil this problem is even more critical. In fact, although the Brazilian hospital information system permits the use of certain classification systems such as the DRG for assessing casemix, the scant diagnostic information available – only the principal and one secondary diagnosis are recorded in the Brazilian information system – probably has a detrimental effect on the accuracy of the results arrived at by means of this system. Yet initiatives to modify claim forms with a view to furnishing more information on comorbidity and complications encounter strong resistance. The most frequent arguments put forward are: (i) the expense for hospitals and the information system itself; and (ii) the failure to exploit the currently available potential of the information system. The goal of the study presented in this article is to contribute new arguments to this debate, with reference to the utility of improving the quantity and quality of diagnostic information in the database.

Methods

Data sources

The first data source used for this study is the database of the Brazilian health care system that consists of claim forms [Hospital Authorized License (AIH) forms] abstracted from medical records and primarily linked to reimbursement. The collection of AIH forms builds up a large administrative database which covers all admissions financed by the Brazilian health care system, approximately 70% of all admissions in the country. Based on the AIH form, the hospital submits its accounts to the federal government for payment. This form furnishes information on the identity of the patient, the care provided during hospitalization, and some data on the outcome. The data used for the present study are drawn from 29 private acute-care hospitals that had contracts with the National Institute of Social Security of the municipality of Rio de Janeiro, Brazil, in 1986. The second data source consists of the medical records that correspond to the sample of claim forms of which the first data source is composed. The data originated from a previous study of this same database [27,28].

Abstracting medical records

The data collection instrument used to abstract from medical records was drawn up with a view to recording the same

information as that on the AIH form: that is, clinical and demographic variables as well as the outcome of hospitalization. The number of fields allocated to secondary diagnoses (comorbidity and complications) was increased to allow entry of up to four secondary diagnoses. This instrument was subjected to a pilot test in which medical records were reviewed in order to make the necessary adjustments to the instrument. The team for reviewing medical records consisted of three physicians, who received approximately 40 hours of training in data collection from the medical records. The data collection document was filled out after a single reading of the medical records. Diagnoses were coded according to the International Classification of Diseases, 9th edition (ICD-9) by authorized professionals.

Samples

Sampling of AIH forms took place in two stages. In the first stage, a sample was taken from the 29 private acute-care hospitals involved in the study. The hospitals were classified into clusters based on number of admissions, mortality rate, distribution of beds according to medical specialities, and the number of beds assigned to intensive care. The second stage consisted of random sampling of AIH forms: 10 acute-care hospitals were selected and 1934 forms were obtained based on the number of admissions at each sampled hospital. The study was designed to analyze the consistency of data in the whole database, not by hospital.

The medical record review instrument was applied to 1331 of the 1934 selected cases (69%). This loss of samples is mainly due to the fact that some hospitals refused to provide access to their medical records despite the various strategies employed to increase the response rate. In a comparison of the characteristics of responders and non-responders, certain differences between the two groups were noted. There were fewer surgical procedures and deliveries among the non-responders [27,28]. Among the non-responders, an over-representation of hospitalizations was noted in cases where the principal diagnosis was varicose veins (ICD-9: 454.9).

All the medical records reviewed ($n=1331$) were included in the analysis of impact on case classifications by DRG. For analysis of the impact on the CCI the study used cases in which hospitalization resulted in death or discharge, and admissions not related to childbirth ($n=826$).

Data analysis

Diagnosis related group

The choice of a tool for estimating hospital resource consumption fell on the DRG classification system, and the study used the second version of this system published in the USA in 1985. Use of the Portuguese software developed by Portugal's Ministry of Health and the International Health Systems was authorized for this study of the validity of DRG use in Brazil [29].

In order to analyze the impact caused by secondary diagnoses, a study was made of the changes in the distribution of cases between the DRG, comparing the results obtained based on information in medical records with that obtained

by using AIH forms only. Changes in DRG were tested by calculating the percentage of agreement and the κ index. Kappa was used for analysing changes between DRG belonging to the same major diagnostic category and for analysing five pairs of the most frequently used DRG that are affected by the presence or absence of comorbidity and complications. Cohen's κ statistics, satisfactory for nominal or categorical data [30,31] measure agreement by accounting for agreement due to chance. Landis and Koch (quoted by Fleiss [31]) suggest different classifications for κ values: values above 0.75 can be considered excellent, and values below 0.40 can be considered unsatisfactory.

It must be stressed that the sampling by cluster that we used gives rise to greater errors than does random sampling, but offers the advantage of simplifying data collection. Since κ statistics presume random sampling, the results must be interpreted with caution in order to avoid rejecting the null hypothesis (i.e. no agreement), which should be included. To minimize this problem, the confidence interval used was 99%.

Charlson comorbidity index

Co-existing diseases are an important factor in foreseeing complications and unfavourable outcomes for hospital cases. Charlson and her collaborators [23] chose 17 clinical conditions to be part of a comorbidity index. These conditions were weighted according to their relative severity, the following weights being assigned: 0,1,2,3,6. This comorbidity index was conceived on an empirical basis from a study of a group of 604 patients at the New York Hospital [23]. The proposed method combines age and comorbidity variables in a single index. This is an advantage in cutting down on the number of covariates to be included in the analyses. Risk related to age is entered by assigning a weighted score for each 10-year period, starting at the age of 50 years [23,32].

The CCI generally takes comorbidity of previous hospitalizations into account because the same index was originally prepared for longitudinal studies of chronic diseases [23]. There are, however, studies which use the CCI successfully in the analysis of only one hospitalization [24,25, 33,34]. On the other hand, some papers point out the reliability factor of weights applied to patients admitted as emergency cases or admitted for elective reasons [35].

Some authors [24,25,33] have adapted the CCI [23] to codes of diseases in the International Classification of Diseases, 9th edition, Clinical Modifications (ICD-9-CM). On this subject, Romano [35,36] stressed that a comparison of the translations of the ICD-9-CM shows differences in results. It is, however, not the intention of this paper to discuss the validity of the method proposed by Charlson, nor the discrepancies in disease code translations. The version used here is that of D'Hoore and his collaborators [34] and applied to the International Classification of Diseases, 9th edition, which is also used in Brazil.

The conditions and weights proposed by Charlson [23] were also used here in order to verify to what extent the scores obtained showed significant changes between scores based only on the first secondary diagnosis and scores based

Table 1 Percentage of agreement of DRG pairs with and without comorbidity or complication using information from claims forms and medical records

Diagnosis related groups	<i>n</i>	%
DRG with comorbidity and/or complications from administrative data	91	6.8
DRG with comorbidity and/or complications from medical records	72	12.9
Simple concordance of the DRG	1241	93.2

on all four secondary diagnoses collected from the medical records. Logistic regression was employed to evaluate the impact of using CCI scores when examining hospital care outcomes. The outcome of hospitalization – death or discharge – was retained as a dichotomous variable. In the logistic regression, six models were constructed. The different CCI scores resulting from using one and from using four secondary diagnoses were the independent variables entered into the models. In accordance with the methodology proposed by Charlson [23], these scores should be weighted by the patient's age factor. The objective was to study the improvement of the logistic regression model and the odds ratio by adding more diagnostic information when calculating weighted and unweighted CCI scores. Firstly, four models were tested using first one and then four secondary diagnoses for both weighted and unweighted scores – in all cases the scores were coded as ordinal variables. Secondly, two models were tested: one for one secondary diagnosis and one for four secondary diagnoses – with weighted scores coded as dummy variables. For the dummy variable coding, the following regrouping was undertaken: category 1, CCI score equals 1; category 2, CCI score equals 2; category 3, CCI score equals 3; category 4, CCI score above 3; base category 5, CCI score equals 0.

Results

Of the 1331 medical records reviewed, 42.5% (565) contained one secondary diagnosis, 17.8% (237) contained two, 6.6% (88) contained three, and 1.9% (15) contained four.

The use of information on diagnoses obtained from medical records brought about a change in DRG in 6.8% of cases (Table 1). When evaluating the impact of secondary diagnosis as supplementary information, the study found that, for DRG in which casemix assessment is based on the presence of comorbidity and/or complications, the percentage of cases assigned to this type of DRG increased from 6.8% to 12.9% after introducing information contained in the medical record (Table 1), which means a doubling of the number of cases in the more complex DRG.

The range of variation between DRG within each major diagnostic category (MDC) in the κ index (which measured the agreement of DRG classification) was 0.65–0.92, a very

large difference indeed (Table 2). Perfect agreement ($\kappa = 1.00$) was found in the case of the DRG for the MDC 3, 9, 13, 15 and 18. The κ index was also high ($\kappa = 0.88$) in the case of the five most frequent DRG pairs, based exclusively on whether comorbidity and complications do or do not exist. The degree of agreement for the DRG of MDC 1 ($\kappa = 0.66$) and MDC 7 ($\kappa = 0.66$) is only moderate.

It was observed that in 7.8% of the sampled cases clinical conditions related to the CCI score were present in the first secondary diagnosis. In the second secondary diagnosis, the presence of such clinical conditions amounted to 4.1%; in the third, the percentage dropped to 1.7%; and in the fourth it dropped even more, to 0.6% (Table 3). Among the cases where information on the secondary diagnosis existed, a different score of 0 was noted in 18.4% of cases that included a first secondary diagnosis. This percentage increased to 23% in cases with two secondary diagnoses, to 26.1% in those with three secondary diagnoses, and to 32% in cases with four secondary diagnoses (Table 3).

The CCI score calculated on four secondary diagnoses extracted from medical records (0.292) is almost double that which is based on only one secondary diagnosis (0.156) (Table 4). The degree of association between the two scores is considered high; simple agreement amounts to 92.3% and the κ index to 0.68 (Table 4).

Approximately 10% of the scores based on one secondary diagnosis are above or equal to 1. This figure increases to 16.5% if the second, third and fourth secondary diagnoses contained in medical records (Table 5) are taken into account. As could be expected, mortality rates increased as CCI scores increased.

In an analysis of the improvements in the logistic models for checking hospital care results (χ^2 of the model) and the odds ratio by using more precise calculation of the CCI scores, an increase of 46.1% was noted in the χ^2 of the model after the introduction of more than one (four) secondary diagnoses (Table 6). After adding the age variable to the CCI score for the four secondary diagnoses, an improvement of 172.8% was noted in the model.

When combined scores with age as a dummy variable are used, the model improves by 11.6%. However, if we consider the total deviation (complete or initial model) without any variable (425.09), we find in the cases examined that the various CCI scores contribute only little to diminishing this deviation: the χ^2 of the various models varies between 17.53 and 70.9 which represents approximately 4 and 16% of the initial deviation (Table 6). Moreover, it should be stressed that the drop in the initial deviation is due more to the result of weighting age in the scores.

Discussion

Because the information on secondary diagnosis in the Brazilian hospitalization database is limited to only one category, there was reason to expect an impact when adding a secondary diagnosis extracted from the medical record. The results obtained show that using medical records as a supplementary

Table 2 Kappa index of the diagnosis related groups (DRG) in major diagnostic categories (MDC) and most common DRG pairs with and without complications and comorbidity

Major diagnostic category ¹	κ of DRG	99% CI
MDC 1: diseases and disorders of the nervous system	0.66	0.47–0.85
MDC 4: diseases and disorders of the respiratory system	0.77	0.62–0.92
MDC 5: diseases and disorders of the circulatory system	0.92	0.76–1.08
MDC 6: diseases and disorders of the digestive system	0.82	0.67–0.95
MDC 7: diseases and disorders of the hepatobiliary system and pancreas	0.66	0.46–0.86
MDC 8: diseases and disorders of the musculoskeletal system and connective tissue	0.92	0.81–1.03
MDC 10: endocrine, nutritional and metabolic diseases and disorders	0.83	0.52–1.13
MDC 11: diseases and disorders of the kidney and urinary tract	0.80	0.61–0.99
MDC 12: diseases and disorders of the male reproductive system	0.86	0.49–1.13
MDC 14: pregnancy, childbirth, and puerperium	0.91	0.84–0.97
DRG combined in pairs ²	0.88	0.82–0.94

¹ MDC # 2, 17, 20, 21, 22 without observations.

² Most frequent DRG pairs: 372/373: vaginal delivery with and without complicating diagnoses; 370/371: caesarean section with and without comorbidity and/or complication; 210/211: hip + femur procedure except major joint age >69 and/or comorbidity and/or complication and age 18–69 years without comorbidity and/or complication; 89/90: simple pneumonia + pleurisy age >69 years and/or comorbidity and/or complication and age 18–69 years without comorbidity and/or complication and age 0–17 years; 161/162: inguinal + femoral hernia procedures age >69 years and/or comorbidity and/or complication and age 18–69 years without comorbidity and/or complication.

CI, Confidence interval.

Table 3 Frequency distribution of the secondary diagnosis and the Charlson comorbidity index (CCI)

CCI	Secondary diagnosis			
	First	Second	Third	Fourth
0	1227	1276	1308	1323
1	54	35	11	5
2	46	17	12	3
3	1	0	0	0
6	3	3	0	0
% Case index >0 ¹	7.8	4.1	1.7	0.6
% Case index >0 from comorbidity ²	18.4	23.2	26.1	32.0

¹ Percentage of clinical conditions from scoring the CCI of the total cases. Example for the first secondary diagnosis: 104/1331 = 7.8%.

² Percentage of clinical conditions from scoring the CCI of the cases with secondary diagnosis. Example for the first secondary diagnosis: 104/565 = 18.4%.

source of information on comorbidity and complications increases the number of cases classified in more complex DRG and increases the mean value of the CCI.

In general, the differences between the number of comorbidities contained in the two data sources are as much due to under-recording of diagnoses as to the limits inherent in the diagnostic information in administrative data that can be coded [10]. In this study, 17.5% of the medical records included more than one secondary diagnosis. However, they included four secondary diagnoses in only 1.9% of cases. This result can be linked either to the low severity of cases in the hospitals studied, or to the quality of information in

medical records. It is known that, by comparison with public hospitals, private hospitals contracted to the Brazilian federal government treat a less severely ill caseload. The average age of patients in the sample was 40 years, and 11.3% of the patients were more than 69 years old.

Impact on DRG information for the first secondary diagnosis was found in 42% of the medical records reviewed. Introducing four secondary diagnoses extracted from medical records caused DRG changes in 6.8% of the cases. The size of the effect caused by introducing more secondary diagnoses has two possible explanations: (i) the secondary diagnoses encountered had no particular impact on major complications

Table 4 Association measures in the Charlson comorbidity index (CCI) considering one secondary diagnosis and the CCI considering four secondary diagnoses

Statistic	
Percentage agreement	92.3
κ (confidence interval)	0.68 (0.63–0.74)
Cramer's V	0.74
Somers' D symmetric	0.72
Means ratio	1.88 ($\times 4 = 292$; $\times 1 = 156$)
$\Delta \Sigma$	112 ($s_4 = 241$; $s_1 = 129$)
Δ Mode	0 ($m_4 = 0$; $m_1 = 0$)

in the DRG classification system; (ii) using age as an alternative means for classifying patients in more complex DRG, as is the case of the DRG version [37] used in this study, minimized the impact of more information on secondary diagnoses. The impact on the classification of cases into DRG would perhaps have been stronger if the changes introduced in the more recent versions [22] had been taken into account. In the updated version of the DRG, comorbidity and complications take on a much greater importance, and a distinction is made between patients according to the classifications of secondary diagnosis [22].

By considering only DRG categories based on the existence of comorbidities and complications, we noted that the percentage of cases assigned to more complex DRG increased considerably when data were taken from medical records. International studies on the validation of DRG also mention major impacts on DRG pairs due to computing problems and the availability of information on secondary diagnoses [38–40].

Impact on the Charlson comorbidity index

The impact of supplementary use of secondary diagnoses contained in medical records on the CCI [23] was found to be meaningful, both with regard to analysis of relative risk outcome and to logistic regression if the comorbidity index was considered to be an ordinal independent variable. When the index was used as a dummy variable, which is more important for an older and less healthy population, the more comprehensive diagnostic information led to differences in the size of odds ratios.

Moreover, if the first secondary diagnosis recorded on the AIH form was used instead of the one in the medical record, only four admissions would be classified with a score greater than zero. When medical record data were used, 104 admissions were classified with a score greater than zero.

The results also indicated that relevant information on secondary diagnoses related to the methodology proposed by Charlson could be obtained equally well from the third and fourth comorbidities. The effect of CCI scores on the outcome of care was not negligible and showed a significant increase when age was considered in the score.

To conclude, measuring casemix is a means of differentiating hospitals and admissions according to their degree

of complexity. If the DRG classification system and the CCI are used to draw up casemix indices based solely on information on the AIH form, there is a danger of underestimating the complexity of the profile of hospital cases. The limited input of diagnoses possible in the Brazilian information system may generate problems for quality assessment as a result of the omission of relevant comorbidities.

Furthermore, the precision of the CCI will certainly depend on the thoroughness and accuracy of input of diagnostic codes into the database. However, the presence of certain diagnoses will have different impacts, depending on the type of case examined and the degree of complication. Moreover, depending on the objective of the survey, information on previous comorbidities may be necessary.

Procedures for recording, collecting and coding information may negatively affect the quality of diagnostic information. The hospitals sampled had no discharge summaries. Information was extracted from medical records by administrative staff who were also responsible for coding diagnoses and procedures. Medical records are frequently wrongly filled out and may contain illegible, incomplete and imprecise information. This makes re-transcription difficult.

Conclusions and recommendations

This study of the information available on secondary diagnoses indicates that, in the case of Brazil, the use of comprehensive information on diagnoses which is often implicit in medical records, affects the precision of results and introduces changes in the measurement of casemix and the severity of cases, such as the DRG classification system and the methodology proposed by Charlson. The impact of a limited number of secondary diagnoses in the Brazilian administrative database is comparatively more important for the CCI than for the DRG system, since the CCI is based on an additional model where every case of comorbidity is taken into account cumulatively for the final score. On the other hand, in the DRG decision tree (a hierarchical model) only the secondary diagnosis which is more important for hospital resource consumption is retained.

Despite the limitations of the administrative database in Brazil, use of this database in hospital care may contribute to the assessment of the utilization and quality of health care services. Insufficient clinical and diagnostic information is an inherent characteristic of administrative databases.

In general, the results of this study indicate that the effect of using supplementary medical records as a source of information on secondary diagnoses was, as expected, important. This impact is likely to increase when public hospital admissions are considered. In addition, the results of this study allow evaluation of the possible impact of a more complete input of additional diagnoses on this type of analysis. Results also point out the importance of improving the quality of medical records. Some imprecision and lack of information in medical records is caused by

Table 5 Frequency distribution of outcome (dead or alive), the Charlson comorbidity index (CCI) and death rate for one and four secondary diagnoses

CCI	One secondary diagnosis ¹				Four secondary diagnoses ²			
	<i>n</i> Dead (%)	<i>n</i> Alive (%)	Total (%)	Death rate (%)	<i>n</i> Dead (%)	<i>n</i> Alive (%)	Total (%)	Death rate (%)
0	46 (78.0)	698 (90.7)	744 (90.1)	6.2	35 (59.3)	655 (85.4)	690 (83.5)	5.1
1	3 (5.1)	48 (5.4)	44 (5.3)	6.8	9 (15.3)	57 (7.4)	66 (8.0)	13.6
2	8 (13.6)	27 (3.5)	35 (4.2)	22.9	9 (15.3)	47 (6.1)	56 (6.8)	16.1
>2	2 (3.4)	1 (0.1)	3 (0.3)	66.7	6 (10.2)	8 (1.0)	14 (1.7)	42.9
Total	59 (100)	767 (100)	826 (100)	7.1	59 (100)	767 (100)	826 (100)	7.1

¹ Mantel-Haenszel $\chi^2=4.79$, 1 degree of freedom, $P<0.05$.

² Mantel-Haenszel $\chi^2=16.58$, 1 degree of freedom, $P<0.00$.

Table 6 Models to predict death adjustment with the Charlson comorbidity index based on one and four secondary diagnoses

Model ¹	Coefficient	Standard error	Odds ratio	Model χ^2
Score: 1 SD	0.723	0.173	2.06	17.53 (df=1)
Score: 4 SD	0.595	0.127	1.81	25.61 (df=1)
Score: 1 SD (age weighted)	0.540	0.074	1.72	60.86 (df=1)
Score: 4 SD (age weighted)	0.533	0.071	1.70	69.02 (df=1)
Score: 1 SD ² (age weighted)	(1) 2.06 (2) 1.67	(1) 0.599 (2) 0.645	(1) 7.81 (2) 5.29	63.60 (df=4)
(4 category)	(3) 2.20 (4) 3.04	(3) 0.571 (4) 0.490	(3) 9.04 (4) 20.82	
Score: 4 SD ² (age weighted)	(1) 2.09 (2) 1.29	(1) 0.658 (2) 0.773	(1) 8.07 (2) 3.64	70.99 (df=4)
(4 category)	(3) 2.47 (4) 3.22	(3) 0.614 (4) 0.535	(3) 11.79 (4) 25.07	

¹ Score 1 SD = comorbidity index with one secondary diagnosis; score 4 SD = comorbidity index with four secondary diagnoses; score 1 SD (age weighted) = comorbidity index with one secondary diagnosis with age weighting; score 4 SD (age weighted) = comorbidity index with four secondary diagnoses with age weighting.

² The level scale was recorded into five dummy variables: category (1), comorbidity index 1; (2), comorbidity index 2; (3), comorbidity index 3; (4), comorbidity index greater than 3; (5), comorbidity index 0 (base category). Likelihood χ^2 for intercept only = 425.09; df, degrees of freedom.

erroneous identification, or inaccurate data input and coding of diagnoses. To achieve improvement in these areas, it is necessary to train personnel for work with identification, classification and coding of diagnoses.

Some limitations of the results of this study are due to the characteristics of the sampling methods which only permitted overall analyses without allowing for evaluation of the impact of comorbidity cases in relation to a specific

principal diagnosis. Moreover, choice of a method for measuring severity other than the CCI could lead to different results, since other comorbidity indexes do not put the same weight on clinical conditions, and are not based on the same conditions [41–43]. Furthermore, due to the characteristics of the database it was impossible to take any comorbidities present prior to hospitalization into consideration. However, analyses undertaken by Deyo [24]

and Roos [33] suggest that, even when diagnoses related only to a sole admission are available, the index is useful for explaining short-term results and resource consumption.

Had it been possible to use the more recent versions of the updated DRG system, the classification of cases into DRG could have generated more powerful data [22]. As a result, the findings reported here do not exclude the possibility that supplementary use of secondary diagnoses from the medical records could have greater impact if other methods were used.

Additional studies should be carried out to examine the validity of diagnostic information in medical records, using explicit criteria as reference. It is also important that this type of study be taken up again, this time analysing data referring to Brazilian public hospitals.

The following recommendations are made: adoption of standardized forms to gather data for the AIH form; improvement in completeness of secondary diagnoses abstraction; increase in the number of fields available for input of current diagnoses and procedures carried out during hospitalization in order to improve the quality of information and thereby ensure that analyses carried out founded on this database are more correct and reliable.

The modifications described would be desirable with regard to the potential use of this database for evaluating services as well as for administration and regulation. In this way, changes and measures for improving data quality would be useful for controlling and adjusting the severity of cases. These changes would also be of use in tracing a profile of the morbidity of the population, for achieving a more in-depth knowledge of health care needs and, lastly, for improving the payment system, either by changing the existing payment unit in order to reach a more homogenous regrouping of patients from the point of view of the severity of cases and the resources required, or by adopting more sophisticated systems such as the DRG classification system.

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