Study of inequalities in hospital mortality using the Charlson comorbidity index

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Keywords
Hospital mortality. Information systems. Aged. Differential mortality. Social inequity. Delivery of health care. Inpatients. SUS (BR). Hospitals, private.

Abstract

Objective
The evaluation of quality and equity in healthcare attendance requires adequate study methods and information systems. Thus, this study was performed with the objective of comparing mortality among elderly patients attended within the private network and within the Brazilian national health system (SUS).

Methods
An information system that recorded causes of hospitalization and associated diseases (comorbidity) in relation to public and private hospital admissions was utilized. The hospitalization of 21,695 patients in Ribeirão Preto, State of São Paulo, in 1998 and 1999 was studied. These patients had diseases of the circulatory and respiratory systems. Analysis was done via the methodology put forward by Charlson, in which comorbidities are scored to give the Charlson comorbidity index and age over 50 years (per decade) is scored to give the Charlson comorbidity-age index. The patients were stratified according to comorbidity and decade of age over 50 years, with separation of hospitalizations via SUS from those via the private network (non-SUS). The coefficient of hospital mortality was calculated for each stratum.

Results
It was observed that the risk of death increased almost sixfold when the number of associated diseases increased. The risk of death for SUS patients was more than twice the risk for non-SUS patients (relative risk: 2.12). Significant differences between SUS and non-SUS patients were found by associating the patient's comorbidity with decade of age. When the risk of death was very low or very high, there were no statistical differences between SUS and non-SUS patients. In other, intermediate situations, precisely where the attendance might make a difference, the mortality among SUS patients was more than twice as great (relative risk: 2.14).

Conclusions
The difference in mortality between SUS and non-SUS patients, according to Charlson's criteria, is significant among patients of intermediate risk, for whom the care is most important. The Charlson comorbidity index correlates with hospital mortality.

INTRODUCTION

Several studies have given evidence of the relationships of social inequality with healthcare, such as in relation to the risk of becoming ill, progression of the illness, consumption of services and differences in medical attendance.[1,13,16,18,22,23] Yazlle Rocha[24] (1997) found in the municipality of Ribeirão Preto, Brazil, that hospitalizations among economically active individuals formed two social subsets. Professions with higher incomes, and members of their families, were predominant among hospitalizations within

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Based on master's dissertation presented to the Faculdade de Medicina de Ribeirão Preto, USP, 2001.
Received on 7/8/2003. Reviewed on 8/4/2004. Approved on 17/5/2004.

the private network, while workers of lower income predominated among hospitalizations within the public network. By analyzing patients who progressed to death within the three funding systems – private, healthcare plans and the public system – these authors observed differences in the coefficient of hospital mortality, average duration of hospitalization and average age of the patients. Subsequently, also in Ribeirão Preto, Guedes[15] (2000) worked on the hospitalizations that took place during 1998 and showed that the average age of individuals hospitalized through the Brazilian national health system (*Sistema Único de Saúde* – SUS) was less than in the private network (non-SUS), and that the rate of hospital mortality among SUS patients was greater than among non-SUS patients.

The ideal would be a single, universal medical system, independent of whether services were provided by public assistance or private entities. This would enable there to be conditions of equity for the different social strata in relation to healthcare. For this reason, quality and performance assessments for healthcare services have gained prominence, along with comparative analyses of outcome indicators, with emphasis on hospital care (Martins,[17] 2000).

Hospital mortality is a traditional indicator of hospital performance and will probably continue to be so for a long time. It expresses a crucial dimension of the quality of the care provided: the final outcome. Among the performance indicators, hospital mortality has been utilized for identifying variations between providers that can be attributed to quality problems.[2,3,8,9,11,14] Nonetheless, differences between hospitals may be derived from medical practice, the profile of cases treated, or the interaction between these elements. The risk factors for the death of patients (seriousness of the cases) are the variables for adjusting hospital mortality rates in comparative studies. According to Blumberg[2] (1986), adequate adjustment is very important in this type of study, since patients with different health characteristics that imply different treatments cannot be analyzed as if they were similar. Comparisons of the lengths of hospital stay, costs or mortality imply determination of the extent to which the observed differences can be attributed to the type of case admitted or the differences in the treatment (Martins,[17] 2000).

Knowledge of the severity, numbers and seriousness of the diseases coexisting with the principal diagnosis (cause of hospitalization) is important for predicting complications and unfavorable outcomes among hospitalized cases. DesHarnais[8] (1988) emphasized that the weight of secondary diagnoses (comorbidities) on the seriousness of the case varies according to the principal diagnosis, such that certain combinations of morbid conditions present greater risk than others. So far, the use of risk measurements for adjusting outcome indicators has been infrequent in Brazil.

The objective of the present study was to apply the methodology proposed by Charlson et al[4] (1987) to a hospital database, for adjusting outcome indicators among patients of over 50 years old in the region of Ribeirão Preto, and to compare the mortality observed among such patients attended by the private network with the mortality among such patients attended by SUS.

METHODS

To form their comorbidity index, Charlson et al[4] (1987) defined 17 clinical conditions. The method utilizes these clinical conditions, which are annotated as secondary diagnoses, for measuring the seriousness of the case and weighting the effect of these conditions on the patient's prognosis, so as to adjust the risk. Scoring is established for each of the clinical conditions, on the basis of the relative risk, with weights ranging from zero to six (Figure 1).

Charlson also presented the possibility of utilizing this comorbidity index in combination with age (Figure 2), thereby forming a single index from these two.

Weight	Clinical condition
1	Myocardial infarct
	Congestive cardiac insufficiency
	Peripheral vascular disease
	Dementia
	Cerebrovascular disease
	Chronic pulmonary disease
	Conjunctive tissue disease
	Slight diabetes, without complications
	Ulcers
	Chronic diseases of the liver or cirrhosis
2	Hemiplegia
	Moderate or severe kidney disease
	Diabetes with complications
	Tumors
	Leukemia
	Lymphoma
3	Moderate or severe liver disease
6	Malignant tumor, metastasis
	Aids

Figure 1 - Charlson comorbidity index – weighting of the clinical conditions present among secondary diagnoses.

Age group	Points
0-49 years	0
50-59 years	1
60-69 years	2
70-79 years	3
80-89 years	4
90-99 years	5

Figure 2 - Weighting for age.

Thus, the scoring described in Figure 1, for the comorbidities receives the addition of specific weighting that corresponds to the patient's age. In this way, one point is attributed for each ten-year period, starting from the age of 50 years. For example, for a patient aged 70, three points are attributed (Figure 2). This quantity is added to the other score, if this individual presents any of the comorbidities listed in Figure 1.

The Charlson comorbidity index was originally proposed for use in longitudinal studies of chronic diseases, in which previous hospitalizations are generally considered.[4,5] However, there is evidence that it has validity for measuring the seriousness of cases in a single hospitalization.[6,7,10,17,19]

The database for the study was the hospital data processing center of a medical teaching institution in Ribeirão Preto. This center is responsible for all the hospitals in the city (14 hospitals) and a further 22 hospitals in other municipalities in the region, and it continually receives hospital statistics from them. From 1998 onwards, with the utilization of the Tenth Revision of the International Classification of Diseases (ICD-10), the system started to record in the database up to four secondary diagnoses, as well as the principal diagnosis. The information is checked, coded and electronically processed, and goes through a consistency program that checks for 33 types of incoherencies, contradictions and inconsistencies (Simões,[21] 1991).

In comparison with other databases, this one presents some advantages: a) universal coverage of all hospitalizations, whether or not these were funded by SUS; b) the possibility of annotating up to four secondary diagnoses; c) it reflects practically all the demand for hospitalization in the region.

The sample studied included all the hospitalizations that took place in the region of Ribeirão Preto during the period from January 1, 1998, to December 31, 1999. Patients aged 50 years or more who were hospitalized with a principal diagnosis that is included in chapters IX and X (respiratory tract and circulatory diseases) of ICD-10 were selected. In addition to this, these patients were selected because their hospitalization was motivated by a great probability that death might occur: this event was utilized here as an outcome measurement. Patients were included if they presented a definitive diagnosis causing the hospitalization that was among the following diagnostic groups: ischemic heart diseases (I20-I25), cardiac insufficiency (I50), hypertensive diseases (I10-I15), cerebrovascular diseases (I60-I69), or influenza and pneumonia (J10-J18).

In accordance with the above criteria, a total of 21,695 cases were selected. After sorting the cases according to the principal diagnosis as defined by ICD-10, the respective weighting for each case was applied, in conformity with the numbers and severity of secondary diagnoses, following the methodology recommended for the Charlson comorbidity index (CCI) and also the Charlson comorbidity-age index (CCAI). The program utilized was Epi Info 6.04D. Thus, a 62-year-old patient hospitalized because of hypertensive disease who presented chronic obstructive pulmonary disease as a comorbidity would receive a score of one from the CCI and three from the CCAI. If this patient also presented a secondary diagnosis of congestive cardiac insufficiency, the score would be two from the CCI and four from the CCAI. Once the cases were weighted in this manner, the overall results were analyzed and matching was done between the mortality indices, now adjusted, for the patients attended by SUS and by the private network.

RESULTS

Table 1 shows the distribution of hospitalizations according to the principal diagnosis and the age group. The two age groups that predominated were 60 to 69 years and 70 to 79 years, accounting for practically 60% of all cases. The most frequently found diagnostic groups were influenza and pneumonia (J10-J18) and ischemic heart diseases (I20-I25), which together totaled practically 50% of the cases.

The distribution of hospitalizations according to hospital category resulted in 12,406 hospitalization through SUS and 9,289 through non-SUS. The general hospital mortality index was 12.1 among SUS patients and 9.4 among non-SUS, thus resulting in a relative

Table 1 – Distribution of hospitalizations, selected according to the principal diagnosis and age group, 1998 and 1999.

ICD-10 Classification	Age groups 50-69	60-69	70-79	80-89	90+	Total
I10-I15	829	941	716	244	38	2,768
I20-I25	1,532	1,993	1,228	354	39	5,146
I60-I69	830	1,160	1,160	675	103	3,928
I50	730	1,206	1,296	794	137	4,163
J10-J18	905	1,368	1,716	1,361	340	5,690
Total	4.826	6.668	6.116	3.428	657	21.695

Source: Hospital Data Processing Center of Riberão Preto
ICD-10: International Classification of Diseases, Tenth Revision

Table 2 - Distribution of hospitalizations of males and females according to hospital category, mortality, relative risk and p-value.

Hospitalization	Male	Mortality (%)	RR	p	Female	Mortality (%)	RR	p
SUS	6,307	12.5	1.29	<0.01	6,099	11.5	1.28	<0.01
Non-SUS	4,832	9.7			4,457	9.0		
Total	11,139	11.3			10,556	10.5		

SUS: Sistema Único de Saúde (Brazilian National Health System)
RR: Relative risk

risk of 1.29 times more for SUS patients, using the chi-squared test, with statistical significance ($p < 0.01$).

Table 2 presents the distribution of hospitalizations and mortality among male and female patients attended by SUS and non-SUS. The mortality continued to be greater among the SUS patients: 12.5 to 9.7 for the men and 11.5 to 9 for the women. The relative risk was 1.29 for the men and 1.28 for the women, both with statistical significance via the chi-squared test ($p<0.01$).

Table 3 presents the distribution of SUS and non-SUS patients, stratified by the CCI and the respective mortality rates, the relative risk and the *p* value. The mortality coefficient increased in the higher-risk CCI strata, and ranged from 9.0 to 52.9 among the SUS patients and from 8.7 to 31.1 among patient within the private network. The mortality continued to be higher among the SUS patients and reached twice the rate for non-SUS patients in group three of the CCI. The differences were statistically significant in the strata 1, 2 and 3.

The distribution of SUS and non-SUS patients according to the CCAI stratification, the respective mortality rates and the *p* value are presented in Table 4. The mortality coefficient increased with higher strata of the CCAI and ranged from 6.1 to 71.4 for SUS patients and from 5.0 to 41.7 for non-SUS patients. The mortality within SUS continued to be higher than for the corresponding strata of non-SUS patients – and the relative risk for the patients within the public system reached double in stratum six. There was no statistically significant difference between the initial strata (1 and 2) and final stratum (7), while there was a difference between the other, intermediate strata.

DISCUSSION

There is wide-ranging debate and interest regarding the quality of the medical services offered to the general population. This interest is even greater when it comes to public services funded by the government and destined for everyone. Such services are, however, mainly utilized by the more needy population that does not have the means for access to medical services within the private network.

Table 3 - Comparison of mortality between SUS and non-SUS patients, using Charlson comorbidity index (CCI), relative risk (RR) and p-value. Region of Ribeirão Preto, 1998 and 1999.

CCI	Patients	Mortality SUS	Mortality Non-SUS	RR	P
0	15,976	9.0	8.7	1.03	NS
1	2,691	17.0	9.6	1.78	<0.01
2	2,288	18.6	11.3	1.64	<0.01
3	515	31.5	15.7	2.0	<0.01
4	183	45.9	31.1	1.47	NS
>4	42	52.9	25.0	2..12	NS

SUS: Sistema Único de Saúde (Brazilian national health system); CCI: Charlson comorbidity index; RR: relative risk; NS: not significant

Table 4 - Distribution of SUS and non-SUS patients with mortality adjusted using the Charlson comorbidity-age index (CCAI), relative risk (RR) and p-value.

CCAI	Patients	Mortality SUS	Mortality Non-SUS	RR	P
1	3,755	6.1	5.0	1.21	NS
2	5,325	7.6	6.9	1.09	NS
3	5,626	10.2	8.2	1.24	0.01
4	4,206	15.0	12.6	1.19	0.02
5	1,864	22.6	15.4	1,47	<0.01
6	658	34.4	16.1	2.14	<0.01
7	202	43.4	33.8	1.29	NS
>7	59	71.4	41.7	1.71	<0.05

SUS: Sistema Ùnico de Saúde (Brazilian national health system); CCAI: Charlson comorbidity-age index; RR: relative risk; NS: not significant

In evaluating hospital deaths, the central concern must be focused on identifying the deaths that can be considered to be avoidable. It has to be recognized that there is a risk of death that is inherent to the patient and defines his chances of survival, but that quality problems in the patient care process may increase this risk.[12,20] In this light, and for a given evaluation to be valid, the differences in risk factor prevalence between patients attended in different hospitals or by different doctors need to be taken into consideration. Such differences modify the seriousness of cases attended and, thus, similar treatment for groups with different nosological and attendance profiles should be avoided. This is particularly important when patients from the public network and private network are compared, because it may often be the case that different and non-comparable populations of patients are being dealt with. Yazlle Rocha & Simões[25] (1999) highlighted the negative aspects of how patients are selected for SUS in the region of Ribeirão Preto, considering that, as well as attending to the patients who are financially needy, SUS ends up being responsible for the cases that are more complex, more burdensome and less resolvable. Thus, the higher mortality found in the present study among SUS patients, in absolute and relative terms, may be the result of the greater complexity or seriousness of the cases attended by the public network.

The application of the CCI to SUS and non-SUS patients shown in Table 3 indicates that, in the initial band of CCI equal to zero (absence of comorbidity), in which the majority of patients are concentrated, the mortality is low for both groups. In subsequent bands, there is progressive raising of the mortality rate concomitant with increased scoring from the CCI. In the final bands, mortality rates that are much greater than the average are reached, thus showing that there is a correlation between the CCI scoring and mortality. When the mortality for SUS and non-SUS patients is compared after adjustment by the CCI (Table 3) is compared, some interesting findings are noted. In all the CCI scoring bands, mortality is greater for SUS patients than for non-SUS patients, as can be seen from the relative risk (RR). Nonetheless, in the absence of comorbidity (CCI = zero) the difference is almost nonexistent (RR=1.03) and without statistical significance. For the greatest scores (CCI=4 and CCI>4), which represent the cases of greatest risk, although differences exist, these too are not statistically significant. The differences only acquire statistical significance at intermediate scores (CCI=1, CCI=2 and CCI=3), or in other words, at scores that the methodology aims to identify as medium-risk and for which the attendance care given is certainly more decisive.

The application of the CCAI to all the cases (Table 4) also reflected this reality, and the result was very similar to what was found when the CCI was applied, with increased mortality for the bands of greater scores, for both groups. Table 4 shows the result from this comparison, in which the mortality for SUS patients is always greater, as shown by the relative risk. These differences too are not significant in the initial bands, while reaching statistical significance in the intermediate bands. Just in this case, in the band of greatest CCAI (CCAI>7), despite having a small number of patients, the difference reached the level of significant, because of the very high mortality among patients attended by SUS, in relation to non-SUS patients (71.4% and 41.7%, respectively). The medical and hospital care is less relevant if the risk of death is very low or very high, and gains greater importance in intermediate cases, in which the attenuation of the risk of dying is the most desired result.

Yazlle Rocha[24] (1997) and Guedes[15] (2000) found that the average age among patients hospitalized through SUS is generally lower than for non-SUS patients. In the first adjustment (Table 3), in which only the comorbidities were considered (CCI), this lower average age may have favorably influenced the result among SUS patients, even though a greater mortality rate persisted. When the adjustment took the age group into account (CCAI; Table 4) and when the age was the preponderant factor, which was the case of the matching for the more advanced age groups that naturally are more fragile, the mortality within SUS was notably greater than for non-SUS patients.

Finally, it must be considered that it would be of great interest to have a standardized index that was reliable and feasible and would allow comparisons of patients with similar diagnoses but with differing degrees of complexity or seriousness, thereby contributing towards better assessment of the attendance provided. Such initial differentiation might result in greater care dedicated at earlier stages to cases that are more complex.

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