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Adverse outcome screening in hospitalizations of the Brazilian Unified Health System

ABSTRACT

OBJECTIVE: To assess the frequency of screening for potential adverse outcomes in hospitalizations of the Brazilian Unified Health System.

METHODS: A retrospective study, including all hospital admissions of adults in medical clinics (n = 3,565,811) and surgical clinics (n = 2,614,048) in Brazil in 2007. The Hospital Information System was used as a source of information. The measurement of adverse events was based on screening for eleven clinical conditions, as defined by previous international studies, recorded in the secondary diagnosis field. We performed bivariate and multivariate analysis to investigate associations between adverse events, death (dependent variable) and other variables such as age, use of the intensive care unit and performance of surgery.

RESULTS: The frequency obtained for both clinic types was 3.6 potential adverse events per 1,000 admissions, with a greater frequency in medical clinics (5.3 per 1,000) than in surgery clinics (1.3 per 1,000). There were differences in the profile of hospital admissions between the two clinics: medical clinics were characterized by a predominance of older adults, longer average length of stay, higher mortality rate and lower total cost of hospitalization. The most common potential adverse outcome was hospital-acquired pneumonia. Cardiac arrest had a higher risk of death (OR = 5.76) compared to other potential adverse outcomes. Increased cost for hospitalizations was associated with sepsis. The conditions used as the screening criteria were associated with greater odds of death even after the introduction of variables such as use of intensive care and surgery.

CONCLUSIONS: The high frequency of adverse outcomes in hospital admissions indicates a need to develop monitoring strategies and to improve quality of care for improved patient safety.

DESCRIPTORS: Hospital Care. Quality of Health Care. Outcome Assessment (Health Care). Hospital Mortality. Unified Health System. Patient Safety. Clinical Medicine.

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INTRODUCTION

Patient safety has increasingly attracted attention since the publication of the book "To Err is Human" by the Institute of Medicine in 2000.[9] Given the relevance of this topic, campaigns, programs and projects were launched to guide actions, promote best practices, reduce harm related to unsafe practices and encourage the development of harmful event and error reporting mechanisms.[10] According to the World Health Organization (WHO)[a] (2009), "*patient safety* is the *reduction* of *risk of unnecessary harm associated* with *health care* to an *acceptable minimum*." Acceptable minimum refers to current knowledge and findings available and the context within which care is provided. In order to create safer health settings, concern for patient safety should include errors in health care, especially those related to avoidable adverse events.[14]

WHO (2009) defines an adverse event *as* an *incident* which results in *harm* to a *patient*.[a] A systematic review of studies on adverse events showed a 9.2% mean incidence of adverse events, 43.5% mean preventable death rate and 7.4% death rate associated.[5] In addition to physical consequences, harm caused to a patient is associated with irreversible stressful ethical processes; health costs due to adverse events are a serious loss with prolonged hospital stay and increased mortality; and lagging lawsuits resulting in financial, organizational, and moral losses.[6] Unsafe patient care can amount to a loss of credibility of health services and poor relationship between patients and providers; an increase in financial and social costs, and potentially undermine achieving the expected results.[b]

Despite efforts to develop a classification,[18] there is no consensus on the definition of patient safety. Some authors define an adverse event as a synonym of an adverse outcome.[13,20] Rivard et al[16] claim that adverse outcome is a broader term that include adverse events and other health care outcomes such as death, disability, and cost, among others.

There is a lack of scientific production on adverse events in Brazil and it has become a focus of attention only recently.[6,12] Many studies assessing the occurrence of adverse events are based on medical records as a source of information. However, countries such as the United States,[8,13] and Belgium[20] that have built comprehensive databases use administrative data for screening adverse events and assessing health care outcomes and patient safety indicators.[1,19,20,22,23] Administrative data can particularly provide summarized information at reduced cost and time, offering new opportunities for assessing and monitoring the occurrence of adverse health events.[23] The use of administrative databases to assess patient safety is still incipient in Brazil. Rozenfeld[17] (2007) was the first to study adverse drug events using information available from the Brazilian National Hospital Database (SIH-SUS). SIH-SUS was originally developed as a hospital services payment system and now is used as a source of information on health care and hospital morbidities.[2,21]

The present study aimed to assess the frequency of screeners of adverse outcomes in hospital admissions in the Brazilian National Health System (SUS).

METHODS

Quantitative retrospective study based on SIH-SUS data. The study included 6,179,859 admissions of medical and surgical inpatients aged 17 years or more who were admitted in the SUS in Brazil in 2007.

Data of abridged files by federal unit were obtained from SIH-SUS. We chose to analyze hospital admission forms (AIH) type 1, known as "regular," regardless of length of stay. This exclusion criterion was applied because this study was designed to analyze only acute cases (short hospital stay). The assessment of the interrelationship between length of stay, case severity, and complications related to care in patients requiring long-term care becomes more complex when a screening method is used based on administrative data, as in the present study. SIH-SUS type 5 forms, known as "continuance forms," are mainly used in the specialty of psychiatry and long-term care. This form was not used in surgical admissions, and 2,295 type 5 forms were used in medical admissions (0.06% of all medical admissions) regardless of age. All admissions of patients younger than 18 years were excluded. Of 8,714,148l admissions of adults during the study year, 6,247,891 (71.7%) were medical and surgical; and 68,032 admissions with the same coding for principal and secondary diagnosis were excluded. A total of 6,179,859 admissions of medical and surgical inpatients were analyzed.

We chose here to use the term adverse outcome, i.e., unfavorable or undesirable outcome of patient care. A screening method was applied to assess conditions suspected to be consequences (adverse outcomes) of the care provided. Eleven adverse outcomes were identified based on the work by Needleman et al[13] (2002) and Van Den Heede et al[19] (2006). These conditions are screeners

[a] World Health Organization. The conceptual framework for the International Classification for Patient Safety: version 1.1: final technical
[b] Sousa P, Furtado C, Reis V. Patient safety research: a challenge for public health. In: Ovretveit J, Sousa P, editors. Quality and safety improvement research: methods and research practice from the International Quality Improvement Network (QIRN). Lisboa: Escola Nacional de Saúde Pública; MMC Karolinska Institutet; 2008. p.45-56.

of potential adverse outcomes and include: urinary tract infection; pressure ulcers; hospital-acquired pneumonia; shock/cardiac arrest; upper gastrointestinal bleeding; hospital-acquired sepsis; deep venous thrombosis; central nervous system complications; surgical wound infection; pulmonary failure and metabolic derangement. The main assumption of this approach is that these outcomes can be prevented by quality nursing care.[13]

Studies[13,20] have coded these conditions according to the International Classification of Diseases – 9th Revision, Clinical Modification (ICD-9-CM). Since this classification is not used in Brazil, screeners of adverse outcomes were coded according to the International Statistical Classification of Diseases and Related Health Problems, 10th Revision (ICD-10). The ICD-9-CM codes available in Van Den Heede et al study[19] (2006) were adapted and converted into the ICD-10 codes (Table 1). For that, it was sought equivalences between each diagnostic category and definition of inclusion and exclusion criteria. This process was carried out by a specialist trained in disease coding. Two screeners, hospital-acquired pneumonia and pulmonary failure, were coded J81 (pulmonary edema, not otherwise specified) of the ICD-10 because this code was duplicate in an earlier adaptation using ICD-9-CM. As there is insufficient diagnostic information in SIH-SUS, which can certainly underestimate hospital morbidity rates, we

Table 1. Screeners of adverse outcomes and related codes according to the International Statistical Classification of Diseases and Related Health Problems, 10th Revision.

Screeners of adverse outcomes	Codes[a]
Urinary tract infection	N39.0, T83.5
Pressure ulcer	L03.8, L89
Hospital-acquired pneumonia	J69.0, J95.4, J95.8, J95.9, J81, J15.0, J15.1, J14, J15.2, J15.8, J15.9, J18.0, J18.9
Shock/cardiac arrest	I46.9, R57.9, R09.2
Upper gastrointestinal bleeding	K25.0-K25.3, K25.9-K26.3, K26.9-K27.3, K27.9-K28.3, K28.9, K29.0, K29.6, K92.2, K22.8
Hospital-acquired sepsis	A41.9, A49.9
Deep venous thrombosis	I26.9, I80.8, I80.3, I80.2
CNS complications	R40, R42, F05.8, F44.8, F43.2, F43.8
Surgical wound infection	T79.3, T81.4
Pulmonary failure	J81, J80, J98.4
Metabolic derangement	E10.1, E11.1, E14.1, T81.1, R34, E87.0-E87.8, E15

[a] Adaptation of screeners to the International Statistical Classification of Diseases and Related Health Problems, 10th Revision, based on the coding as proposed by Van Den Heede et al[10]
CNS: central nervous system

chose not to exclude 697 cases with diagnostic information coded J81 due to the expected low frequency of screeners. In the present studied the 11 adverse outcomes in both medical and surgical inpatients were used in a different way from previous studies[13,20] that applied wound infection, pulmonary failure, and metabolic derangement for surgical inpatients only. A computer program was used to find this information in the secondary diagnosis field of SIH-SUS data using ICD-10 codes.

The strategy of analysis involved identifying screeners of adverse outcomes in both medical and surgical inpatients and a description of average length of hospital stay, death rate, and average reimbursement amount. Bivariate analyses were carried out to compare the risk of death for each screener and by specialty. The risk of death by screener was compared between medical and surgical patients.

Logistic regression was used to assess the association between screeners of adverse outcomes and death, adjusted for patient risk and care-related characteristics. This modeling was performed in three consecutive stages that included: (1) variables for risk adjustment of case severity, (2) screeners of adverse outcomes, (3) care-related characteristics. At the first stage, case severity was described based on demographic variables (age and gender), principal diagnosis, and type of admission (elective or emergency). Age was used as a categorical variable, and all the rest were dichotomous ones. The reference categories were male gender, Charlson index of zero and elective admission. The Charlson index[3] was applied to the variable principal diagnosis, given that the population studied was heterogeneous and this variable could not be used as categorical one. The Charlson index is applied to secondary diagnosis data and contains 19 conditions defined based on their association with the risk of death. The absolute relative risk was used to weigh the effect of each medical condition on the patient's prognosis.[11,15] The algorithm developed by Quan et al[15] defined the ICD-10 codes for each clinical condition of the Charlson index and was used to calculate this score. Comorbidity severity was not measured as the space for recording is limited to one secondary diagnosis, which was used as a source of information on the frequency of screeners of adverse outcomes.

The second stage of modeling included 11 screeners of adverse outcomes as dichotomous independent variables (yes/no). The third and last stage included care-related variables as follows: surgery (yes/no); length of stay (continuous variable); and intensive care unit (ICU) care (yes/no). The predictive ability of the models was tested with the use of C-statistics.

The statistical package SPSS version 17.0 was used in the data analyses.

The study was approved by the Research Ethics Committee of Escola Nacional de Saúde Pública (Protocol Nº 227/09; December 4, 2009).

RESULTS

There was a higher proportion of females among medical than surgical inpatients. The mean age was higher and the proportion of elderly was greater among medical inpatients. A secondary diagnosis was reported in 16.2% of all admissions, and was considerably higher in surgical inpatients (24.8%). Length of stay was longer among medical inpatients. The frequency of screeners of adverse outcomes was 0.36% higher in medical inpatients. Most admissions were in private hospitals contracted by SUS; however, there was a slightly higher proportion of medical inpatients in public hospitals. The proportion of deaths was higher in medical inpatients, as well as in emergency admissions and older patients (Table 2).

The most common reason (principal diagnosis) for hospital admission was diseases of the circulatory system (18.0%). The most common secondary diagnosis was external causes of morbidity and mortality (5.4%). Circulatory diseases (23.4%) were the most frequently reported condition as principal diagnosis in medical inpatients while the most common secondary diagnoses were external causes (1.4%) and diseases of the circulatory system (1.4%). Skin diseases (18.3%) and external causes of morbidity and mortality (10.8%) were the most common principal and secondary diagnoses in surgical inpatients, respectively.

The frequency of screeners of adverse outcomes showed a varied distribution. Hospital-acquired pneumonia was the most frequently reported one in both medical and surgical inpatients. Other frequently reported screeners were urinary tract infections and shock/cardiac arrest (Table 2).

The screeners of adverse outcomes were mostly seen in public (52.9%) and philanthropic hospitals (19.1%). The most common screener was shock/cardiac arrest in private hospitals and hospital-acquired pneumonia in public hospitals. Except for shock/cardiac arrest, all other screeners were mostly reported in public hospitals, with percentages ranging from 49.6% (upper gastrointestinal bleeding) and 64.8% (surgical wound infection). Private hospitals reported no cases of pressure ulcers and surgical wound infection, probably associated with shorter hospital stay and higher transfer rates.

The secondary diagnosis was mostly reported in Southeast Brazil (55.7%), followed by the Northeast (18.2%), and South (13.6%). The Northern State of Roraima (26.3%) showed the highest reporting rates of secondary diagnosis, followed by São Paulo (25.0%) and Brasília (22.4%). The 11 screeners of adverse outcomes were mostly reported in the Southeast, ranging from 73.8% (metabolic derangement) and 92.2% (surgical wound infection). The states of São Paulo and Rio de Janeiro showed the highest frequency in this region. No deep venous thrombosis cases were reported in the Northern region.

Hospital-acquired sepsis and deep venous thrombosis were the most costly conditions in both medical and surgical inpatients, but in the latter the average reimbursement amount for hospital-acquired pneumonia was also significant (Table 3). Pressure ulcer, sepsis and hospital-acquired pneumonia were associated with the longest hospital stays. Pressure ulcer was associated with an excess of eight days of hospital stay compared to the average stay for all screeners. Shock/cardiac arrest showed the highest crude death rate and risk of death (odds ratio [OR] = 5.76) compared to other screeners in both medical and surgical inpatients, followed by hospital-acquired sepsis. Hospital costs were higher in surgical inpatients.

Length of stay, reimbursement amount and death rate were higher in admissions with reporting of screeners of potential adverse outcomes (Table 3) when compared to hospitalizations without screeners recorded showing a length of stay of 5.1 days (SD = 7.4), an average reimbursement amount of R$ 724.04 (SD = 1,650.05) and a death rate of 5.5%. Cases without screeners had lower length of stay and hospital death than those admissions with reporting of screeners. The average reimbursement amounts by screeners were higher in surgical inpatients.

The logistic regression models for predicting death included the variables studied in three blocks (Table 4). The risk model (Table 4, Model 1) showed adequate discriminatory power (C = 0.73). The variables associated with patient risk were significant with OR indicating higher risk of death.

The inclusion of screeners of potential adverse outcomes (Table 4, Model 2) did not change the OR found in Model 1. The inclusion of descriptive care-related variables did not significantly change the OR in Model 2; a greater effect was seen for cases of hospital-acquired sepsis (Table 4, Model 3). ICU care showed an OR = 7.45, indicating greater disease severity. There were no significant changes in the models after the inclusion of the variables in each block; the ORs decreased slightly, except for screeners of shock/cardiac arrest and sepsis. Only OR of pulmonary failure was not statistically significant (Table 4, Models 2 and 3). The final model showed an adequate discriminatory power (C-statistic = 0.80, 95%CI 0.79;0.80).

Table 2. Profile of the study population, patient characteristics and frequency of screeners of adverse outcomes. Brazil, 2007.

Characteristics	Medical inpatients	Surgical inpatients	Total
Number of cases (%)	3,565,811 (57.7)	2,614,048 (42.3)	6,179,859 (100.0)
Demographic information			
Mean age in years (SD)	55 (19.8)	46 (17.6)	51 (19.4)
Median	57	44	51
Males (%)	48.7	47.8	48.3
Elderly – 60 or more (%)	45.2	24.1	36.3
Principal diagnosis[a]			
Charlson index > 0 (%)	35.7	11.8	25.6
Type of admission			
Elective (%)	3.8	41.7	19.8
Type of hospital			
Private (%)[b]	49.2	59.5	58.1
Public (%)[c]	50.8	40.5	41.9
ICU care (%)	4.9	7.2	5.9
Length of stay			
Mean (DP)	5.7 (7.6)	4.4 (7.1)	5.1 (7.4)
Median (days)	3	2	3
Care outcome (%)			
Discharge	88.2	92.2	89.9
Transfer	3.6	1.3	2.6
Death	7.4	3.1	5.6
Stay	0.7	0.8	0.8
New surgery	0	2.6	1.1
Total reimbursement amount			
Mean (SD)	455.9 (694.8)	1094.1 (2359.2)	725.8 (1652.9)
Mode	189.35	552.89	40.38
Median	319.74	483.36	383.36
Range	0;44485.24	0;68425.12	0;68425
Secondary diagnosis			
Records (%)	9.9	24.8	16.2
Screeners of adverse outcomes			
Frequency (number of cases)	19,029	3,330	22,359
Proportion of potential adverse outcomes (%)	0.534	0.127	0.362
Relative frequency of screeners (per 1,000 admissions)[d]			
Urinary tract infection	3,254 (0.9)	277 (0.1)	3,531 (0.6)
Pressure ulcer	455 (0.1)	143 (0.0)	598 (0.1)
Hospital-acquired pneumonia[e]	8,121 (2.3)	956 (0.4)	9,077 (1.5)
Shock/cardiac arrest	2,419 (0.7)	639 (0.2)	3,058 (0.5)
Upper gastrointestinal bleeding	1,613 (0.4)	240 (0.1)	1,853 (0.3)
Hospital-acquired sepsis	955 (0.3)	601 (0.2)	1,556 (0.2)
Deep venous thrombosis	250 (0.1)	92 (0.0)	342 (0.1)
CNS complications	239 (0.1)	12 (0.0)	251 (0.0)
Surgical wound infection	72 (0.0)	158 (0.1)	230 (0.0)
Pulmonary failure[e]	763 (0.2)	131 (0.1)	894 (1.2)
Metabolic derangement	888 (0.2)	81 (0.0)	969 (1.6)

Source: Brazilian National Health System Hospital Database
[a] Charlson Comorbidity Index. Score ≥ 1
[b] Includes private and charitable hospitals
[c] Included federal, state and local hospitals and public university hospitals
[d] Estimates: number of admissions with reporting of each screener / number of admissions by specialty and total per 1,000 hospital admissions
[e] There were detected 697 cases with code J81 that were included in two screeners: hospital-acquired pneumonia and pulmonary failure
ICU: intensive care unit; SNC: central nervous system

Table 3. Screeners of potential adverse outcomes and other care-related outcomes in medical and surgical inpatients. Brazil, 2007.

Screeners of adverse outcomes	Medical inpatients				Surgical inpatients				Total			
	DR (%)	ALS (SD)	ARA (SD)	OR (95%CI)	DR (%)	ALS (SD)	ARA (SD)	OR (95%CI)	DR (%)	ALS (SD)	ARA (SD)	OR(95% CI)
Urinary tract infection	14.9	11.5 (13.3)	679.95 (1136.27)	0.22 (0.20;0.25)	7.2	13.5 (15.1)	2069.77 (4054.94)	0.07 (0.04;0,11)	14.3	11.7 (13.4)	788.98 (1617.12)	0.20 (0.18;0.22)
Pressure ulcer	27.9	18.8 (20.2)	760.93 (1085.65)	0.600.49;0.74)	8.4	18.8 (22.4)	1381.12 (1817.76)	0.09 (0.05;0.16)	23.2	18.8 (20.7)	909.24 (1223.76)	0.44 (0.36;0,53)
Hospital-acquired pneumonia	41.2	11.8 (13.5)	1159.34 (1947.06)	1.20 (1.13;1.27)	45,1	18.1 (19.6)	3400.12 (4465.97)	0.80 (0.69;0.93)	41.6	12.5 (14.4)	1395.34 (2242.04)	1.10 (1.04;1.16)
Shock/cardiac arrest	71.7	7.2 (9.7)	991.63 (1504.38)	4.95(4.51;5.44)	88.9	9.6 (17.8)	2629.92 (4441.05)	12.4 (9.50;16.0)	75.3	7.7 (11.9)	1333.97 (2519.94)	5,76 (5.28;6.28)
Upper gastrointestinal bleeding	24.3	8.7 (11.1)	632.42 (929.39)	0.45 (0.42;0.54)	23.8	11.3 (12.3)	1901.30 (2504.86)	0.30 (0.22;0.41)	24.4	9.0 (11.3)	796.76 (1320.29)	0.44 (0.40;0.50)
Hospital-acquired sepsis	71.0	12.7 (15.2)	1489.10 (2197.00)	4.15 (3.60;4.80)	69.6	14.5 (18.8)	3590.65 (4223.61)	2.86 (2.36;3.46)	70.4	14.2 (16.8)	2300.82 (3300.32)	3.88 (3.47;4.34)
Deep venous thrombosis	35.6	12.8 (13.1)	1172.03 (2373.32)	0.87 (0.67;1.13)	50.0	12.7 (12.4)	2586.51 (2306.57)	1.04 (0.69;1.57)	39.5	12.8 (12.9)	1552.54 (2434.61)	0.96 (0.77;1.20)
CNS complications	22.6	7.2 (15.2)	502.25 (1036.99)	0.46 (0,34;0.62)	41.7	13,1 (13.0)	2380.31 (2365.78)	0.74 (0.24;2.34)	23.5	7.5 (15.1)	592.04 (1196.32)	0.45 (0.34;0.60)
Surgical wound infection	9.7	10.0 (10.0)	515.78 (587.70)	0.17 (0.08;0.37)	8.9	10.8 (10.8)	1483.16 (2334.72)	0.09 (0.05;0.16)	9.1	10.6 (10.6)	1180.33 (2011.55)	0.15 (0.09;0.23)
Pulmonary failure	33.2	9.4 (12.0)	1024.92 (1572.09)	0.77 (0.66;0.90)	55.7	11.7 (16.6)	2769.79 (5259.39)	1.32 (0.93;1.88)	36.5	9.7 (12.8)	1280.60 (2552.82)	0.84 (0.73;0.98)
Metabolic derangement	21.4	8.2 (10.5)	528.87 (726.67)	0.41 (0.35;0.49)	12.3	6.5 (8.8)	777.38 (823.78)	0.14 (0.07;0.27)	20.6	8.0 (10.3)	549.64 (738.02)	0.37 (0.32;0.43)
Total	38.8	10.9 (13.2)	970.53 (1659.83)	-	49.1	14.4 (18.0)	2768.49 (4021.88)	-	40.4	11.4 (14.1)	1239.62 (2274.72)	

Source: Brazilian National Health System Hospital Database
DR: death rate; ALS: average length of stay; ARA: average reimbursement amount; SD: standard deviation; OR: odds ratio (risk of death in those with reporting of screeners compared to those with no reporting); CNS: central nervous system

Table 4. Logistic regression: association between screeners of adverse outcomes and death. Brazil, 2007.

Model 1 – Variables associated to patient risk			
	Coef β	OR	95%CI
Female	-0.271	0.76	0.75;0.76
Age group (reference: 18-29 years old)			
30-39	0.401	1.49	1.46;1.52
40-49	0.811	2.25	2.20;2.29
50-59	1.161	3.19	3.13;3.25
60-69	1.414	4.11	4.04;4.18
70-79	1.714	5.55	5.45;5.64
80-99	2.143	8.52	8.37;8.67
Urgent admission	1.034	2.81	2.77;2.85
Principal diagnosis (Charlson Index)	0.496	1.64	1.63;1.65
Constant	-4.965	0.007	
Model 2 – Model 1 including screeners of adverse outcomes			
	Coef β	OR	95%CI
Female	-0.271	0.76	0.75;0.76
Age group (reference: 18-29 years old)			
30-39	0.399	1.49	1.46;1.52
40-49	0.805	2.23	2.19;2.27
50-59	1.152	3.16	3.10;3.22
60-69	1.404	4.07	4.00;4.14
70-79	1.7	5.47	5.38;5.57
80-99	2.128	8.39	8.25;8.54
Urgent admission	1.036	2.81	2.77;2.85
Principal diagnosis (Charlson Index)	0.491	1.63	1.62;1.64
Screeners of adverse outcomes			
Urinary tract infection	0.66	1.93	1.75;2.13
Pressure ulcer	1.378	3.96	3.25;4.83
Hospital-acquired pneumonia	2.088	8.06	7.70;8.44
Cardiac arrest	3.756	42.76	39.23;46.61
Upper gastrointestinal bleeding	1.408	4.08	3.66;4.56
Hospital-acquired sepsis	3.747	42.40	37.76;47.60
Deep venous thrombosis	2.318	10.15	8.07;12.76
CNS complications	1.299	3.66	2.71;4.95
Surgical wound infection	0.789	2.20	1.39;3.48
Pulmonary failure	0.1	1.10	0.94;1.29
Metabolic derangement	1.181	3.25	2.77;3.82
Constant	-4.976	0.007	

Continue

Tabela 4. Continuation

Model 3 – Model 2 including care-related variables: ICU care, surgery and length of stay			
	Coef β	OR	95%CI
Female	-0.234	0.79	0.78;0.79
Age group (reference: 18-29 years old)			
30-39	0.366	1.44	1.41;1.47
40-49	0.689	1.99	1.95;2.03
50-59	0.952	2.59	2.54;2.63
60-69	1.17	3.22	3.16;3.28
70-79	1.477	4.37	4.30;4.45
80-99	1.956	7.06	6.94;7.19
Urgent admission	0.738	2.09	2.06;2.12
Principal diagnosis (Charlson Index)	0.353	1.42	1.41;1.43
Screener of adverse outcomes			
Urinary tract infection	0.573	1.77	1.60;1.96
Pressure ulcer	1.285	3.61	2.94;4.43
Hospital-acquired pneumonia	1.822	6.18	5.89;6.49
Cardiac arrest	3.627	37.58	34.38;41.00
Upper gastrointestinal bleeding	1.314	3.72	3.31;4.17
Hospital-acquired sepsis	3.236	25.42	22.51;28.71
Deep venous thrombosis	1.954	7.05	5.54;8.98
CNS complications	1.266	3.54	2.61;4.81
Surgical wound infection	0.585	1.79	1.10;2.90
Pulmonary failure	0.112	1.11	0.94;1.31
Metabolic derangement	1.177	3.24	2.75;3.82
Surgery	-0.571	0.56	0.56;0.57
ICU care	2.009	7.45	7.38;7.52
Length of stay	0.013	1.01	1.01;1.01
Constant	-4.708	0.009	

Source: Brazilian National Health System Hospital Database
C-statistic: Model 1 = 0.728 (0.727-0.29); Model 2 = 0.734 (0.733-0.734); Model 3 = 0.797 (0.796-0.797).
Charlson Index Score ≥ 1; ICU: intensive care unit; CNS: central nervous system

DISCUSSION

This is a study with a tracking approach, i.e., designed to identify potential conditions associated to quality of care and patient safety.[7] A tracking approach comprises an initial assessment that requires a second assessment to ensure the occurrence of a given outcome and to identify major explanatory factors and intervention actions to prevent recurrence.[7] The risk adjustment is a key element because the outcome of care is a product of patient characteristics, adequacy of the care process and random errors.[7]

The 11 adverse outcomes defined in previous international studies[13,20] were used for measuring potential adverse outcomes sensitive to proper nursing care.[13,20] The frequency of screeners reported in the SIH-SUS in medical and surgical adult inpatients was 3.6/1,000 hospital admissions in Brazil in 2007. A higher frequency of screeners was found among medical (5.3/1,000) than surgical inpatients (1.3/1,000). International studies[13,20] have found greater overall frequency and by screener. The profile of admissions varied by specialty, with a predominance of older inpatients, longer hospital stays and higher death rate in medical inpatients. These data corroborate the literature[4,7,11] that describes an association of chronic condition, comorbidity, and disease severity in the elderly with increased risk of death and adverse outcomes.

The frequency of each screener of adverse outcomes varied in both specialties studied. In the bivariate analysis shock/cardiac arrest had a higher risk of death (OR 5.76, 95%CI 5.28;6.28) compared to all other screeners reported in both medical and surgical inpatients. Inpatients with screeners of adverse outcomes showed higher average hospital stay, higher average reimbursement amount, and greater death rates. Studies[13,20] have found a higher frequency of urinary tract infection, which contrasts with our finding of higher frequency of hospital-acquired pneumonia. However, other comparisons were not possible due to different methods and strategies used.

Despite limitations related to the source of information used, the risk of death adjusted to patient risk factors was associated with the presence of screeners. This association remained even after the inclusion of care-related variables, which highlights the importance of monitoring these events over time and by principal diagnosis or specific surgical procedure. The current study was limited by its purpose and design and the quality of patient- and care-related variables. The assessment of screeners of adverse outcomes, as with clinical performance indicators, indirectly shows quality of care since patient care was not assessed. The screeners of adverse outcomes are a primary tool that can be used to identify potential cases or hospitals at risk of providing care services of inadequate quality or below the expected standard. These screeners include medical conditions that do not allow to discriminating the relative importance of case severity and care quality issues and the interaction between these factors.

The present study also has limitations inherent to the use of administrative databases as a source of information.[23] The validity of screeners of potential adverse outcomes relies on the completeness and accuracy of diagnostic codes reported in the databases. The use of information from secondary databases restricts the type and the scope of variables studied, although this approach is widely used in comparative analyses of hospital performance. It is a relevant limitation considering there is insufficient hospital morbidity information available in the Brazilian administrative database. There is only a single field for reporting secondary diagnoses but as there is no information on their time of occurrence it does not allow to knowing whether a secondary diagnosis is a complication or comorbidity. Another aspect is regarding adequacy and quality of information reported in the SIH-SUS, especially regarding the limitation to a single secondary diagnosis. Data quality issues including low reporting of secondary diagnosis (16.8% for medical and surgical inpatients) may have affected accuracy of the measures estimated. Furthermore, it also involved choosing a category to be reported in cases with more than one secondary diagnosis. One of the criteria for choosing a category may be related to requirements of the specific government legislation and/or for reimbursement of hospital care.

The frequency of screeners is directly associated to the quality of information reported, which probably contributes to underestimated results. Failure to adjust for risk factors of patients may have affected the results of the multivariate analysis. As there was no variable available describing patients' morbidity profile at admission it is difficult to discriminate between preexisting conditions and care-related complications, especially in the event of specific medical conditions such as cardiac arrest. However, this study was not designed to assess the validity of screeners of adverse outcomes as a measure of quality of care. It aimed to provide a detailed assessment of the quality of the care process.

The study showed only the frequency of potential adverse outcomes, and thus it was not possible to ascertain whether there was any adverse event, i. e., avoidable harm due care and not the patient's disease. According to Needleman et al[13] (2002) and Van Den Heede et al[19] (2006), screeners of adverse outcomes consist of conditions that are potentially sensitive to nursing care, suggesting an association between high levels of nursing care and reductions in the rates of deaths and adverse events. This study did not aim to assess this association, but it would be an important aspect to be evaluated in further studies with different data sources.

Some major aspects of the current study should be noted. A nationwide analysis was conducted including an array of hospital service providers within the Brazilian National Health System. This study adapted screeners of adverse outcomes to the ICD-10 and explored their use adjusted for patients' risk factors and care-related characteristics. Although the adaptation of screeners to the ICD-10 may require further refinement and expert validation it allow to promptly use the methodology tested[20] in information systems based on the ICD-10 diagnostic coding. Moreover, it is an innovative approach as there are few studies on adverse events in Brazil, especially based on administrative data. The current study explored the feasibility of using the SIH-SUS to assess adverse outcomes in health care and to measure their effects on patients.

It is well-known the extent, complexity, and incentive to administrative data production in more developed countries,[7,] which has allowed more comprehensive assessments of health systems. Quality of care and patient safety should be a priority in the political agenda of governments and academia, as well as professional training and retraining on the importance of reliable and complete recording of data in information systems in health, which would render them more reliable. Regular reassessments of information systems are needed for they can be used as effective mechanisms for measuring the performance and quality of services provided. These measures have an impact on public health services restructuring with a special emphasis on quality of care, in addition to reimbursement of services. In conclusion, despite the limitations of the current study approach and design, our findings point to the importance of this issue in Brazil and the need for further research and development of monitoring strategies and improvements targeted to patient safety and quality of care provided in public hospitals, as seen in other countries.

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