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Performance evaluation of hospitals that provide care in the public health system, Brazil

ABSTRACT

OBJECTIVE: To analyze if size, administrative level, legal status, type of unit and educational activity influence the hospital network performance in providing services to the Brazilian Unified Health System.

METHODS: This cross-sectional study evaluated data from the Hospital Information System and the *Cadastro Nacional de Estabelecimentos de Saúde* (National Registry of Health Facilities), 2012, in Sao Paulo, Southeastern Brazil. We calculated performance indicators, such as: the ratio of hospital employees per bed; mean amount paid for admission; bed occupancy rate; average length of stay; bed turnover index and hospital mortality rate. Data were expressed as mean and standard deviation. The groups were compared using analysis of variance (ANOVA) and Bonferroni correction.

RESULTS: The hospital occupancy rate in small hospitals was lower than in medium, big and special-sized hospitals. Higher hospital occupancy rate and bed turnover index were observed in hospitals that include education in their activities. The hospital mortality rate was lower in specialized hospitals compared to general ones, despite their higher proportion of highly complex admissions. We found no differences between hospitals in the direct and indirect administration for most of the indicators analyzed.

CONCLUSIONS: The study indicated the importance of the scale effect on efficiency, and larger hospitals had a higher performance. Hospitals that include education in their activities had a higher operating performance, albeit with associated importance of using human resources and highly complex structures. Specialized hospitals had a significantly lower rate of mortality than general hospitals, indicating the positive effect of the volume of procedures and technology used on clinical outcomes. The analysis related to the administrative level and legal status did not show any significant performance differences between the categories of public hospitals.

DESCRIPTORS: Hospital Services. Health Services Evaluation. Indicators of Health Services. Hospital Units. Unified Health System.

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INTRODUCTION

An aging population and the adoption of nonsubstitutable technology in health are the reason for continuous spending increases in this sector.[a] Despite these increases in spending, there is an large gap between the best existing practices and the treatment that the patient actually receives.[11] Despite these spending increases, the resources directed towards the health system are limited, and the population will not accept increasing taxes as the only way to finance this system.

Despite the emphasis given towards reorganizing the health care model in the Brazilian Unified Health System (SUS), the main focus of care remains on the hospitals. The hospital sector performs virtually all hospitalizations in Brazil and is also responsible for a quarter of outpatient consultations and almost 80.0% of cases of patients requiring emergency or immediate medical attention.[b] This sector accounts for an estimated 67.0% of all spending in health care.[6] Hospitals meets the demands of higher hierarchy, but also serves as an important point for health care access and follow-up. Performance evaluation has been growing in recent years as a result of the high cost and the possible opportunity to reallocate savings to other parts of the system.[c]

Data from international literature show that mean inefficiency stands at between 13.0% and 59.0%.[2,19] A study from the United States estimated that approximately 3.0% of the Gross Domestic Product of the Country was wasted due to inefficiency in the hospital network.[7] Despite significant amounts having been spent on inpatient activities in Brazil, there do not seem to have been any reflected improvement in results regarding the population's health when it is compared to other countries that have spent similar amounts, in some cases they are even poorer. The Performance Assessment Tool for Quality Improvement in Hospitals project recommends that hospital performance be evaluated considering dimensions such as clinical effectiveness, patient safety and focus, efficiency, training for health professionals and clinical governance.[17] However, hospital performance is difficult to measure due to the lack of data referring to conditions prior to hospitalization and, therefore, performance assessment usually revolves around studying variables related to patient movement and hospital bed use.[14]

The objective of this study was to examine whether size, administrative level, legal status, unit type or educational activity have any influence on the hospital network's performance in providing services to the health system.

METHODS

Data from the state of Sao Paulo, Southeastern Brazil, from January to December 2012 were analyzed during this cross-sectional study, based on information available from the Hospital Information System of the SUS (SIH-SUS) and from the *Cadastro Nacional de Estabelecimentos de Saúde* (CNES – Brazilian National Registry of Health Facilities). The SIH-SUS provided information regarding the Hospital Admission Authorization (HAA) such as hospital outputs, external transfers, number of inpatient days, deaths, and HAA value paid. The CNES provided information pertaining to December 2012 regarding human resources, hospital beds and characteristics of the health care facilities.

The scope of these databases is suitable for hospital performance assessment and for decision-making guidance in health.[8] However, the possibility of data being added or deleted, possible under-reporting and high percentage of non-reporting, the possibility of errors made during data collection and the inaccurate or incomplete completion of information are among the main limitations present when handling these databases.[3] In addition, the HAA instrument need to be more rigorously epidemiological due to it having been conceived for billing purposes. These databases do not provide access to internal characteristics or information regarding the hospitals, and there is a shortage of clinical data that could make better comparisons of results among hospital providers possible.[8]

The main chosen indicators are related above all to the following structure and processes: percentage of specialized beds; ratio of hospital staff per bed; proportion of high complexity hospital outputs; mean HAA value paid; bed occupancy rate; mean length of stay; bed turnover index; hospital output percentage by external transfer; and hospital mortality rate.

Bed availability in the SUS was used as a reference to calculate indicators related to the quantity of beds, which made it possible to cross-check current SIH-SUS information, both for private and public hospitals that eventually allocated part of their facilities to private care. As regards the hospital staff per bed indicator, the ratio between the total number of professionals and available hospital beds were considered, which was due to the impossible task of determining the exact availability of each professional involved in the SUS.

[a] Towers Watson. 2010 Health Care Cost Survey: Workforce Health: new deal, new dividend: 21st annual U.S. results report. [cited 2015 Feb 8]. Available from: http://www.towerswatson.com/en/Insights/IC-Types/Survey-Research-Results/2010/02/2010-Health-Care-Cost-Survey
[b] Instituto Brasileiro de Geografia e Estatística. Estatísticas da saúde: Pesquisa de Assistência Médico-sanitária. Rio de Janeiro (RJ); 2009.
[c] Wolff LDG. Um modelo para avaliar o impacto do ambiente operacional na produtividade dos hospitais brasileiros. [thesis]. Florianópolis (SC): Universidade Federal de Santa Catarina; 2005.

More detailed analysis was performed on the main selected hospital indicators, which was achieved by examining the calculation method and any possible limitations.

The percentage of specialized beds demonstrates the high complexity and resolvability (intensive care, intermediaries and isolation) in the area of available beds.[d] By aggregating the different types of beds under the same nomenclature, extreme values for one of these categories can determine disparate values for the indicator.

Regarding the indicator hospital staff per bed, institutions with a lower hospital staff per bed ratio are generally more productive.[18] However, this may in turn indicate a lower quality in care. This indicator may be influenced by the level of technology employed, the outpatient care burden and dehospitalization programs.[12,18] Among the calculation limitations for the indicators are the possible imprecise nature of information from the CNES and its wide variety of records, which might include outsourced labor or not, and the liberal nature of the relationship with doctors at certain institutions.

The percentage of high complexity hospital outputs makes it possible to compare hospitals according to the complexity of the diagnoses and treatments provided. The complexity of the patient is generally influenced by gender, age group, primary and secondary diagnoses, admission and output type and the need to perform surgical procedures.[3] The complexity of the procedures performed, considered for this study, were only those as stated by the SUS Table of Procedures, Medicines, Orthotics, Prosthetics, and Special Materials.

The mean HAA value paid represents the mean cost of each hospitalization. Despite being recognized as an important payment mechanism, the HAA value does not always have a direct relationship to costs incurred during health service provision.[6] Having a robust information system that could properly determine costs would be indispensable in Brazil.

The bed occupancy rate represents the degree to which available beds are used, thus, very low values are generally associated with lower efficiency levels. However, high rates may indicate a high prevalence of comorbidities, low resolvability, low emergency resource reserve or an imbalance between supply and demand.[e] Furthermore, as indicators regarding bed utilization are closely related to each other, bed occupancy rate can be influenced by mean length of stay and the bed turnover index.[f]

The mean length of stay represents the time spent hospitalized.[g] This indicator usually varies according to the diagnosis and profile of the patient, technological development, and payment mechanisms.[3] Payments per procedure generally encourage stay periods to be reduced, an opposite situation to when it is paid for on a per day basis. Theoretically, the higher the mean stay length, the greater the consumption of resources and the lower the productivity.[f] Longer periods can be associated with hospital infections, as well as social factors and administrative issues – delays in implementing procedures and lack of additional or spare beds. However, shorter hospitalization periods can be associated with early discharges, early external transfers, unexpected deaths and low resolvability that result in early patient discharge.[e]

The bed turnover index represents the extent to which the capacity of which is being used, expressed by the number of hospitalizations per bed in a given period. Although this may be considered one of the main indicators for productivity and efficiency, high values may indicate rehospitalizations, unnecessary hospitalizations or early discharges.[e]

The hospital output percentage by external transfer indicates the percentage of hospital outputs that are a result of referrals to other institutions.[g] High values usually point to low resolvability and a lack of structure that is necessary for appropriate patient treatment.

The hospital mortality rate measures the proportion of patients who die during hospitalization.[g] This indicator reflects the patient's general state, complexity of the cases, resolvability and quality of care provided.[15] The hospital mortality rate can also be associated with hospital reservation access and rates, admission type (emergency or voluntary), early discharges and severe cases being transferred to other institutions. The inverse relationship between volume of procedures and deaths is recognized, which suggests the benefits of specializing in a small number of diagnostics and using determined technologies regarding the clinical outcome.[1] However, one limitation of this study was that standardizing the indicator according to demand characteristics and social factors was not possible, which is a required procedure in possible developments of this study.

[d] Ministério da Saúde, DATASUS. Cadastro Nacional de Estabelecimentos de Saúde – CNES. Notas técnicas. Brasília (DF); s.d [cited 2015 Jun 11]. Available from: http://tabnet.datasus.gov.br/cgi/cnes/%5CNT_Estabelecimentos.htm

[e] Marinho A, Moreno AB, Cavalini LT. Texto para discussão n° 848. Avaliação descritiva da rede hospitalar do Sistema Único de Saúde (SUS). Instituto de Pesquisa Econômica Aplicada. Rio de Janeiro (RJ); 2001.

[f] Rotta C. Utilização de indicadores de desempenho hospitalar como instrumento gerencial [thesis]. São Paulo (SP): Faculdade de Saúde Pública da Universidade de São Paulo; 2004.

[g] Ministério da Saúde, Secretaria de Assistência à Saúde, Departamento de Sistemas e Redes Assistenciais. Padronização da nomenclatura do censo hospitalar. 2.ed. rev. Brasília (DF); 2002 [cited 2015 Jun 11]. (Série A. Normas e Manuais Técnicos). Available from: http://bvsms.saude.gov.br/bvs/publicacoes/padronizacao_censo.pdf

Five hundred and thirty three (533) hospitals in Sao Paulo that had beds available to the SUS that had HAA in 2012 were included in the selection process of this study. Facilities that were only open for daytime practice were excluded. The defined study categories based on information from the National Registry of Health Facilities were as follows:

- Hospital size: small-sized (up to 50 beds), medium-sized (51 to 150 beds), large-sized (151 to 500 beds), and special-sized (up to 500 beds);

- Administrative level: state, municipal and private;

- Type of unit: specialized hospital and general hospital;

- Legal status: direct administration, indirect administration, private for-profit and private non-profit; and

- Educational activity: educational activity present (university unit, isolated upper school unit and educational aid unit) and no educational activity present.

Descriptive statistical data were presented according to mean and standard deviation for continuous and proportional variables. Normal distribution was proven by the Shapiro-Wilkinson test. The comparison of the differences between the means, which involved two or more groups, was performed using analysis of variance (ANOVA), while observing the equality of variances premise (Bartlett test). The differences between the means in the groups were evaluated while considering the Bonferroni correction, since multiple tests were performed to test each pair of means in the subgroups.

Statistical analysis was performed in the Stata, version 12.1 software (StataCorp, TX, USA).

RESULTS

The mean number of beds in hospitals in Sao Paulo that provided care for the SUS was 140.9. Around 6.9% of these beds were classified as additional, and the ratio of hospital staff per bed was 2.1. The mean bed occupancy rate was 52.2%, a result that is associated with a 7.2-day mean length of stay and a turnover rate of 39.1 outputs per bed in that year. The mean HAA value paid showed no association with the proportion of high complexity hospital outputs (adjusted $R^2 = 0.0302$). The mean hospital mortality rate was 3.7%. The mortality rate showed no association with productivity indicators such as bed occupancy rate (adjusted $R^2 = 0.0018$) and bed turnover index (adjusted $R^2 = 0.0090$), indicating that greater efficiency is not related with poor quality.

Hospital structure indicators showed higher results (mean number of beds, percentage of specialized beds, greater complexity outputs, mean HAA value paid and ratio of hospital staff per bed) at larger facilities. Higher

bed occupancy rate and mean length of stay were associated with large-sized hospitals. Bed occupancy rate was significantly lower in small hospitals (33.1%) than in medium (51.5%), large (69.5%) and special-sized (76.0%) hospitals. Hospitals with up to 50 beds had a mean length of stay of 3.7 days. Medium (6.9), large (10.6), and special-sized (13.6) facilities had a considerably longer mean length of stay. No differences were found between large and special-sized hospitals for most of the indicators selected, which indicates possible homogeneity (Table 1).

Municipal and private hospitals were classified mostly as small (38.5% and 34.0% respectively) and medium (32.1% and 38.5%), whereas state hospitals were mostly large (60.3%).

Private hospitals had less available human resources per bed than public hospitals; no significant difference was observed between municipal and state hospitals.

State hospitals had the highest bed occupancy rate (65.7%) and mean length of stay (9.8 days). Part of this longer stay can be explained by the lower level of referrals to other institutions and the increased complexity of the procedures performed. The turnover rate for the administrative level did not vary (Table 2).

Private hospitals had a lower hospital mortality rate than public hospitals. It was not possible to identify any differences between state and municipal hospitals (Table 2).

No significant differences were observed between hospitals with direct or indirect administration for indicators regarding the percentage of additional beds, percentage of highly complex procedures, mean HAA value paid, ratio of hospital staff per bed, bed occupancy rate, mean length of stay, bed turnover index and hospital mortality rate (Table 3).

Nonprofit hospitals had a shorter length of stay (6.5 *versus* 19.0 days), a higher bed turnover index (39.8 *versus* 15.0) and higher hospital mortality rate (3.7% *versus* 0.6%) than for-profit hospitals. No significant difference was found in the percentage of additional beds, percentage of high complexity outputs, mean HAA value paid, ratio of hospital staff per bed, and bed occupancy rate among the private groups (Table 3).

Educational activities were most present in large-sized hospitals (56.5%). The mean number of beds in these hospitals was 278.8, which is considerably higher than the mean number of beds in hospitals that have not developed educational activities (114.7). Hospitals that developed these activities also had a higher percentage of additional beds, higher proportion of high complexity hospital outputs (9.7% *versus* 1.6%), a higher mean HAA value paid, and higher ratio of hospital staff per bed (Table 4).

Table 1. Hospital indicators by size. Sao Paulo, SP, Southeastern Brazil, 2012.

Hospital indicators	Small size	Medium size	Large size	Special size	Total	p
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	
Number of hospitals	161	193	164	15	533	–
Indicators						
Mean number of hospital beds	32.9 (11.1)	91.7 (28.0)	244.4 (77.8)	801.3 (286.1)	140.9 (156.0)	< 0.001
Percentage of specialized beds (%)	1.5 (4.4)	6.9 (9.6)	11.2 (9.5)	16.5 (17.8)	6.9 (9.6)	< 0.001*
Proportion of high complexity outputs (%)	1.1 (5.7)	1.1 (5.7)	4.7 (8.9)	17.4 (19.4)	2.9 (8.0)	< 0.001
Mean HAA value paid (R$)	827.55 (4,969.16)	841.77 (1,130.46)	1,439.09 (1,434.73)	2,587.20 (1,684.23)	1,070.39 (2,955.75)	0.032
Ratio of hospital staff per bed	2.0 (2.8)	1.9 (1.4)	2.5 (1.8)	3.5 (2.4)	2.1 (2.1)	0.001*
Ratio of hospital staff per occupied bed	14.9 (59.5)	11.8 (72.1)	4.9 (10.0)	5.0 (3.4)	10.4 (54.7)	0.392
Bed occupancy rate (%)	33.1 (20.4)	51.5 (25.0)	69.5 (21.1)	76.0 (18.9)	52.2 (26.7)	< 0.001*
Mean length of stay	3.7 (3.1)	6.9 (7.8)	10.6 (9.2)	13.6 (9.7)	7.2 (7.9)	< 0.001*
Bed turnover index	38.7 (26.1)	40.9 (20.5)	38.3 (21.0)	29.4 (15.7)	39.1 (22.4)	0.228
Percentage of external transfers (%)	4.7 (4.7)	2.7 (2.7)	1.6 (1.8)	1.2 (1.2)	2.9 (3.4)	< 0.001*
Hospital mortality rate (%)	3.5 (3.5)	3.5 (2.8)	4.1 (3.1)	3.6 (2.5)	3.7 (3.1)	0.229

HAA: Hospital Admission Authorization
* There was no significant observed difference between the large and special-sized facilities for this indicator (p > 0.05) during this group analysis (Bonferroni).

Table 2. Hospital indicators for the administrative level. Sao Paulo, SP, Southeastern Brazil, 2012.

Hospital indicators	State	Municipal	Private	Total	p
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	
Number of hospitals	78	78	377	533	–
Indicators					
Mean number of hospital beds	249.2 (219.4)	106.2 (89.4)	125.7 (141.5)	140.9 (156.0)	< 0.001[a]
Percentage of specialized beds (%)	12.7 (12.7)	8.4 (8.6)	5.3 (8.5)	6.9 (9.6)	< 0.001
Proportion of high complexity outputs (%)	6.2 (11.8)	0.8 (2.9)	2.6 (7.6)	2.9 (8.0)	< 0.001[a]
Mean HAA value paid (R$)	1,223.03 (1,029.75)	613.04 (250.34)	1,133.42 (3,475.48)	1,070.39 (2,955.75)	0.326
Ratio of hospital staff per bed	3.1 (1.6)	3.5 (2.0)	1,6 (2,0)	2.1 (2.1)	< 0.001[b]
Ratio of hospital staff per occupied bed	5.3 (3.7)	9.2 (13.0)	11.8 (64.7)	10.4 (54.7)	0.620
Bed occupancy rate (%)	65.7 (19.3)	54.2 (26.0)	49.0 (27.3)	52.2 (26.7)	< 0.001[a]
Mean length of stay	9.8 (8.5)	4.6 (2.4)	7.3 (8.3)	7.2 (7.9)	< 0.001
Bed turnover index	38.5 (21.5)	43.7 (18.0)	38.5 (21.5)	39.1 (22.4)	0.145
Percentage of external transfers (%)	1.7 (1.7)	5.0 (5.6)	2.7 (2.9)	2.9 (3.4)	< 0.001
Hospital mortality rate (%)	3.8 (2.8)	4.8 (3.0)	3.5 (3.2)	3.7 (3.1)	0.004[b]

HAA: Hospital Admission Authorization
[a] There was no significant observed difference between the municipal and private facilities for this indicator (p > 0.05) during this group analysis (Bonferroni).
[b] There was no significant observed difference between the municipal and state facilities for this indicator (p > 0.05) during this group analysis (Bonferroni).

Even a higher bed occupancy rate (63.3%) and a higher bed turnover index (43.6) were observed in hospitals that had educational activity. But we found no significant differences between the groups for the mean length of stay and hospital mortality rates (Table 4).

The bed occupancy rate was higher in specialized hospitals (75.2%) compared with general hospitals. However, the turnover rate of these was lower (24.3) due to the greater length of stay (18.4 days) at the specialized institutions (Table 5).

Table 3. Hospital indicators by legal status. Sao Paulo, SP, Southeastern Brazil, 2012.

Hospital indicators	Direct administration	Indirect administration	Non-profit status	For-profit status	Total	p
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	
Number of hospitals	124	32	355	22	533	–
Indicators						
Mean number of hospital beds	160.4 (133.0)	244.9 (298.4)	119.8 (138.3)	220.4 (161.8)	140.9 (156.0)	< 0.001[b]
Percentage of specialized beds (%)	10.1 (11.4)	12.6 (9.6)	5.3 (7.9)	6.1 (15.1)	6.9 (9.6)	< 0.001[a,b,c]
Proportion of high complexity outputs (%)	3.1 (8.7)	4.8 (10.0)	2.5 (7.0)	4.2 (13.8)	2.9 (8.0)	0.354
Mean HAA value paid (R$)	873.17 (717.98)	1,091.89 (1,083.08)	1,068.28 (3,488.08)	2,184.69 (3,153.72)	1,070.39 (2,955.75)	0.299
Ratio of hospital staff per bed	3.2 (1.8)	3.6 (1.7)	1.7 (2.0)	1.0 (1.9)	2.1 (2.1)	< 0.001[a,c]
Ratio of hospital staff per occupied bed	7.7 (10.8)	5.5 (2.7)	8.3 (40.9)	67.8 (207.8)	10.4 (54.7)	< 0.001[a,b]
Bed occupancy rate (%)	57.2 (23.8)	70.5 (19.7)	48.3 (26.2)	59.7 (41.4)	52.2 (26.7)	< 0.001[a,c]
Mean length of stay	7.4 (7.1)	6.5 (4.9)	6.5 (7.5)	19.0 (11.9)	7.2 (7.9)	< 0.001[a,b]
Bed turnover index	39.4 (20.5)	47.5 (16.3)	39.8 (22.9)	15.0 (15.2)	39.1 (22.4)	< 0.001[a,b]
Percentage of external transfers (%)	3.3 (4.6)	3.7 (3.7)	2.8 (3.0)	0.8 (1.1)	2.9 (3.4)	0.009[a,b]
Hospital mortality rate (%)	4.1 (3.0)	4.9 (2.9)	3.7 (3.2)	0.6 (1.1)	3.7 (3.1)	< 0.001[a,b]

HAA: Hospital Admission Authorization
[a] There was no significant observed difference between the direct and indirect administration facilities for this indicator (p > 0.05) during this group analysis (Bonferroni).
[b] There was no significant observed difference between the direct administration and the non-profit facilities for this indicator (p > 0.05) during this group analysis (Bonferroni).
[c] There was no significant observed difference between the for-profit and non-profit facilities for this indicator (p > 0.05) during this group analysis (Bonferroni).

The hospital mortality rate was considerably lower in the specialized hospitals (0.9% *versus* 4.4% in general hospitals). This result proved to be consistent despite the higher percentage of high complexity hospitalizations and lower percentage of external transfers at such facilities (Table 5).

DISCUSSION

Most Brazilian hospitals are known for being small-sized and located in Brazil's countryside.[16] These hospitals are considered inefficient, despite their decentralized and regionalized position.[6] Many small-sized facilities operate on the descending part of the mean cost curve, which allows them increased returns of scale and the leeway to reduce their fixed costs with increased volume of patients.[h]

In contrast, large-sized hospitals have greater returns of scale as a result of their higher volume of patients and lesser uncertainty that is inherent to resource provision.[4] These hospitals have higher occupancy rates and require less reservations for busy periods. In addition, these hospital are in a stronger position in relation to

bargaining power with suppliers, and are often more efficient through their specialization in certain diagnoses and procedures.[4] However, hospitals that are even larger experience diseconomies of scale, as hospitals that have already reduced their fixed costs and increased their number of patients may result in higher spending and reduced efficiency.[h]

In this study, bed movement indicators highlighted the relevance of the scale effect for operational performance, meaning that medium and large-sized hospitals have the best results for these process indicators. Large and special-sized hospitals were similar regarding the selected indicators, which indicates a possible homogeneity between these groups. To have benefits from economies of scale, hospitals must operate with an ideal number of between 100 and 450 beds. The cost curve for hospitals is "U" shaped, in which the intermediate level, with approximately 230 beds, tends to be the most efficient.[2] Thus, small-sized hospitals are always having to redefine their practices. Ministerial policies encourage bed closures that give priority to standing care and encouraging referral and counter-referral practices according to the level of complexity.[16] Establishing

[h] Proite A, Souza MCS. Eficiência técnica, economias de escala, estrutura da propriedade e tipo de gestão no sistema hospitalar brasileiro. In: Anais do Encontro Nacional de Economia da Associação Nacional de Centros de Pós-Graduação em Economia; dez. 2004; João Pessoa (PB). 32.

Table 4. Hospital indicators for educational activity. Sao Paulo, SP, Southeastern Brazil, 2012.

Hospital indicators	Educational activity	No educational activity	Total	p
	Mean (SD)	Mean (SD)	Mean (SD)	
Number of hospitals	85	448	533	–
Indicators				
Mean number of hospital beds	278.8 (254.4)	114.7 (11.8)	140.9 (156.0)	< 0.001
Percentage of specialized beds (%)	14.6 (11.0)	5.4 (8.5)	6.9 (9.6)	< 0.001
Proportion of high complexity outputs (%)	9.7 (12.7)	1.6 (5.9)	2.9 (8.0)	< 0.001
Mean HAA value paid (R$)	2,291.59 (6,840.40)	838.68 (1,125.79)	1,070.39 (2,955.75)	< 0.001
Ratio of hospital staff per bed	3.4 (1.8)	1.9 (2.0)	2.1 (2.1)	< 0.001
Ratio of hospital staff per occupied bed	19.9 (104.7)	8.6 (38.4)	10.4 (54.7)	0.082
Bed occupancy rate (%)	63.3 (24.3)	50.1 (26.7)	52.2 (26.7)	< 0.001
Mean length of stay	6.8 (5.3)	7.3 (8.3)	7.2 (7.9)	0.581
Bed turnover index	43.6 (20.1)	38.3 (22.7)	39.1 (22.4)	0.043
Percentage of external transfers (%)	1.6 (2.1)	3.2 (3.6)	2.9 (3.4)	< 0.001
Hospital mortality rate (%)	4.2 (3.2)	3.6 (3.1)	3.7 (3.1)	0.114

HAA: Hospital Admission Authorization

Table 5. Hospital indicators by type of unit. Sao Paulo, SP, Southeastern Brazil, 2012.

Hospital indicators	General hospital	Specialized hospital	Total	p
	Mean (SD)	Mean (SD)	Mean (SD)	
Number of hospitals	430	103	533	–
Indicators				
Mean number of hospital beds	130.0 (157.1)	186.3 (143.1)	140.9 (156.0)	0.001
Percentage of specialized beds (%)	7.5 (9.7)	4.3 (8.4)	6.9 (9.6)	0.002
Proportion of high complexity outputs (%)	2.4 (6.7)	4.8 (11.8)	2.9 (8.0)	0.006
Mean HAA value paid (R$)	879.14 (1,249.92)	1,868.80 (6,180.44)	1,070.39 (2,955.75)	0.002
Ratio of hospital staff per bed	2.2 (2.0)	1.8 (2.1)	2.1 (2.1)	0.042
Ratio of hospital staff per occupied bed	11.7 (60.4)	5.0 (13.5)	10.4 (54.7)	0.262
Bed occupancy rate (%)	46.7 (23.7)	75.2 (26.4)	52.2 (26.7)	< 0.001
Mean length of stay	4.6 (3.7)	18.4 (10.5)	7.2 (7.9)	< 0.001
Bed turnover index	42.7 (21.5)	24.3 (19.8)	39.1 (22.4)	< 0.001
Percentage of external transfers (%)	3.4 (3.6)	0.9 (1.3)	2.9 (3.4)	< 0.001
Hospital mortality rate (%)	4.4 (2.9)	0.9 (2.4)	3.7 (3.1)	< 0.001

HAA: Hospital Admission Authorization

inter-municipal health partnerships between small municipalities can lead to agreements to construct regional systems.[9]

In addition to potential economies of scale related to the size and the number of patients, there is a direct relation between volume of procedures and quality of care. Hospitals that perform certain procedures with more often and employ certain technologies have lower mortality rates.[1] This study showed that the 'type of unit' group was most closely associated with hospital mortality rate. These results were observed to be significantly lower than in specialized hospitals compared with general hospitals, despite the higher percentage of high complexity hospitalizations and the lower percentages of transfers than other facilities.

Type of unit can also affect the operational result. The bed occupancy rate was higher for specialized hospitals. However, due to the longer lengths of stay at these institutions, the turnover rate was considerably lower. Excessive treatment and high mean staying periods in specialized hospitals, which may impact performance,

is common.[i] In contrast, general hospitals usually provide emergency or immediate medical attention that negatively affect performance, which is due to the seriousness of the cases and the larger number of deaths.[h] In addition, general hospitals are often unable to provide appropriate therapies for diverse specialties and are required to refer patients to other institutions.[h] Thus, there must be an optimum level of expertise associated with higher performance levels.[h]

The administrative level also has a relationship with performance. Public hospitals tend to maximize the social benefit of the services provided while private hospitals tend to maximize profit.[10] For-profit private hospitals also tend to become more and more specialized, particularly regarding high-cost procedures, as they are better remunerated by the system.[h] However, this study found no significant difference between mean HAA value paid to public or private hospitals. Moreover, no association between mean HAA value paid and the proportion of high complexity outputs were found. Statistical analysis showed that the groupings used in this study do not adequately explain the results from the mean HAA value paid indicator. Other factors must be related to the health system's remuneration of procedures.

Authors affirm that the competition between health providers is associated with better performance.[13] However, the SUS establishes physical and financial ceilings for hospitals, according to size and historical care production information.[c] This can prevent certain hospital from increasing the volume of the services it provides and reaching a high level of productivity. As a result, competition only usually exists for certain more profitable services, albeit only occasionally.[c]

Education usually has an impact on hospital performance.[j] Facilities that provide education usually have a high ratio of professionals to beds, principally because of the medical teachers and resident doctors. Having residents at a hospital can have negative effects on efficiency, since medical training requires the time and dedication of other medical professionals at the hospital, in addition to requiring more tests and procedures.[5] The group characterized by educational activities had the greatest association with the hospital staff per bed indicator during this study. However, education was related to better operational performance that was expressed by a higher bed occupancy rate and higher bed turnover index. The mean length of stay and hospital mortality rates showed no significant difference when comparing hospitals that had no educational activity.

This study pointed to the importance of the scale effect for efficiency, which reinforces findings from the literature in that larger hospitals display a superior performance when compared to facilities with fewer beds.[4] Hospitals that provide education also display greater operational efficiencies expressed by the process indicators, albeit also having been associated with the importance of using human resources and highly complex structures. Specialized hospitals have a hospital mortality rate that is significantly lower than that in general hospitals, indicating the positive effect of the procedure volume and technology employed concerning clinical outcome. Finally, the analysis related to the administrative level and legal status did not show any significant performance differences between the categories of public hospitals.

[i] Agrell J, Bogetoft P. Should health regulators use DEA? Frederiksberg: Department of Economics; 2001 [cited 2015 Jun 11]. Available from: http://www.researchgate.net/profile/Per_Agrell/publication/267566933_SHOULD_HEALTH_REGULATORS_USE_DEA_/links/546926a20cf20dedafd0d70c.pdf

[j] Marinho A, Façanha LO. Hospitais universitários: avaliação comparativa de eficiência técnica. Rio de Janeiro: Instituto de Pesquisa Econômica Aplicada; 2001 [cited 2015 Jun 11]. (Texto para Discussão, 805). Available from: http://www.ipea.gov.br/portal/index.php?option=com_content&view=article&id=4057

REFERENCES

1. Birkemeyer JD, Siewers AE, Finlayson EV, Stukel TA, Lucas FL, Batista I, et al. Hospital volume and surgical mortality in the United States. *N Engl J Med.* 2002;346(15):1128-37. DOI:10.1056/NEJMsa012337

2. Byrnes P, Valdmanis V. Analyzing technical and allocative efficiency of hospitals. In: Charnes A, Cooper WW, Lewin AY, Seiford LM, editors. Data envelopment analysis: theory, methodology, and applications. London: Kluwer; 1994. p. 129-44.

3. Escrivão Júnior A. Uso da informação na gestão de hospitais públicos. *Cienc Saude Coletiva.* 2007;12(3):655-66. DOI:10.1590/S1413-81232007000300015

4. Grannemann T, Brown R, Pauly M. Estimating Hospital Costs: A Multiple-Output Analysis. *J Health Econ.* 1986;5:107-27.

5. Kooreman P. Nursing home care in the Netherlands: a nonparametric efficiency analysis. *J Health Econ.* 1994;13:301-16.

6. La Forgia GM, Couttolenc BF. Hospital performance in Brazil: the search for excellence. Washington (DC): The World Bank Publications; 2008.

7. Lins ME, Lobo MSC, Silva ACM, Fizman R, Ribeiro VJP. O uso da Análise Envoltória de Dados (DEA) para avaliação de hospitais universitários brasileiros. *Cienc Saude Coletiva.* 2007;12(4):985-98. DOI:10.1590/S1413-81232007000400020

8. Lobo MSC, Bloch KV, Fiszman R, Oliveira MR, Ribeiro VJP. Sistema de informações dos hospitais universitários (SIHUF/MEC): um banco de dados administrativo. *Cad Saude Coletiva.* 2006;14(1):149-62.

9. Neves LA, Ribeiro JM. Consórcios de saúde: estudo de caso exitoso. *Cad Saude Publica.* 2006;22(10):2207-17. DOI:10.1590/S0102-311X2006001000027

10. Pauly MV. Nonprofit firma in medical markets. *American Economic Review.* 1987;77:2757-262.

11. Porter ME, Teisberg EO. Repensando a saúde: estratégias para melhorar a qualidade e reduzir os custos. Porto Alegre: Bookman; 2007.

12. Ramos MCA, Cruz LP, Pollara WN. Desenvolvimento e aplicação de metodologia para o dimensionamento do corpo clínico em um hospital de ensino do município de São Paulo. *Rev Adm Saude.* 2012;14(54):3-10.

13. Register CA, Bruning ER. Profit incentives and technical efficiency in the production of hospital care. *Southern Economic Journal.* 1987;28(4):899-914.

14. Schout D, Novaes HMD. Do registro ao indicador: gestão da produção da informação assistencial nos hospitais. *Cienc Saude Coletiva.* 2007;12(4):935-44. DOI:10.1590/S1413-81232007000400015

15. Travassos C, Noronha JC, Martins M. Mortalidade hospitalar como indicador de qualidade: uma revisão. *Cienc Saude Coletiva.* 1999;4(2):367-381. DOI:10.1590/S1413-81231999000200011

16. Ugá MAD, López EM. Os hospitais de pequeno porte e sua inserção no SUS. *Cienc Saude Coletiva.* 2007;12(4):915-28. DOI:10.1590/S1413-81232007000400013

17. Veillard J, Champagne F, Klazinga N, Kazandjian V, Arah OA, Guisset AL. A performance assessment framework for hospitals: the WHO Regional Office for Europe PATH project. *Int J Qual Health Care.* 2005;17(6):487-96. DOI:10.1093/intqhc/mzi072

18. Zucchi P, Bittar OJNV. Funcionários por leito: estudo em alguns hospitais públicos e privados. *Rev Adm Saude.* 2002;4(14):1-7.

19. Zuckerman S, Hadley J, Iezzoni L. Measuring hospital efficiency with frontier cost functions. *J Health Econ.* 1994;13:255-80.