



## Major article

## Structure for prevention of health care–associated infections in Brazilian hospitals: A countrywide study



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**Background:** Minimal structure is required for effective prevention of health care–associated infection (HAI). The objective of this study was to evaluate the structure for prevention of HAI in a sample of Brazilian hospitals. **Methods:** This was a cross-sectional study from hospitals in 5 Brazilian regions ( $n = 153$ ; total beds: 13,983) classified according to the number of beds; 11 university hospitals were used as reference for comparison. Trained nurses carried out the evaluation by using structured forms previously validated. The evaluation of conformity index (CI) included elements of structure of the Health Care–Associated Prevention and Control Committee (HAIPCC), hand hygiene, sterilization, and laboratory of microbiology. **Results:** The median CI for the HAIPCC varied from 0.55–0.94 among hospital categories. Hospitals with >200 beds had the worst ratio of beds to sinks (3.9;  $P < .001$ ). Regarding alcoholic product for handrubbing, the worst ratio of beds to dispensers was found in hospitals with <50 beds (6.4) compared with reference hospitals (3.3;  $P < .001$ ). The CI for sterilization services showed huge variation ranging from 0.0–1.00. Reference hospitals were more likely to have their own laboratory of microbiology than other hospitals.

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**Conclusion:** This study highlights the need for public health strategies aiming to improve the structure for HAI prevention in Brazilian hospitals.

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A minimal structure is required for effective prevention of health care–associated infection (HAI), mainly the presence of an active Health Care–Associated Infection Prevention and Control Committee (HAIPCC).<sup>1</sup> Appropriate resources for hand hygiene, medical devices sterilization, and microbiologic analysis of clinical specimens are also among the core components of a good structure for HAI prevention and control.<sup>2</sup> Developing countries have higher HAI rates compared with developed nations, mainly because of their lack of resources and scarcity of expertise in epidemiology and infection control.<sup>3</sup> This raises an important concern regarding patient safety worldwide; therefore, high priority should be given for infection prevention strategies in low and middle-income countries.<sup>3,4</sup>

In the last decade, Brazil has experienced a significant improvement in its socioeconomic condition. However, until now, there has been a lack of information regarding the structure for prevention of HAI in hospitals within country. The knowledge of the actual structure for HAI prevention in Brazilian hospitals will support public policies aiming at overcoming deficiencies and defining priorities. To fulfill this need, a national study was proposed to identify the main features of HAI prevention resources in the country with a multidisciplinary team of researchers, called Project IRAS-Brazil. This study aimed to evaluate the structure for prevention of HAI in a sample of Brazilian hospitals.

## MATERIALS AND METHODS

### *Design and settings*

A cross-sectional study was carried out from August 2011–August 2013. Hospitals located in the 5 Brazilian regions were evaluated.

### *Sampling*

A list of all acute care hospitals in the country was obtained from the free-access national database of health care facilities (CNES: <http://cnes.datasus.gov.br/>). The sample size included 10 out of 26 Brazilian states (Ceará, Goiás, Minas Gerais, Pará, Paraná, Paraíba, Pernambuco, Rio Grande do Sul, Rio de Janeiro, and São Paulo). These states were selected by convenience; nevertheless, they host about two-thirds of all health care facilities within the country. A cluster sampling technique was used, and clusters were defined by state and number of hospital beds. The hospitals were chosen at random in the study base (from the 10 states) within 3 categories according to the number of beds: 10–49 beds, 50–199 beds, and  $\geq 200$  beds. Eleven university hospitals which harbored the teams that conducted the study were included by convenience and were used as reference for comparison purposes.

### *Data collection*

Teams of nurses experienced in infection control were trained to carry out the evaluation by using structured forms previously validated.<sup>5</sup> They visited each one of the randomized facilities and reference hospitals and performed the evaluation through direct observation, inspection of documents, and interviews. Written guidelines were developed to avoid dissimilarities in data collection procedures. For each state under investigation, a coordinator

hosted in the reference hospitals was in charge to manage operational issues of data collection and to ensure homogeneity along the investigation procedures. Evaluation was focused on 4 essential areas: HAIPCC, sterilization service (SS), hand hygiene resources, and laboratory of microbiology. These areas were selected considering their impact in HAI prevention. Each area was evaluated according to their main components: for HAIPCC, components included operational structure, guidelines, HAI surveillance, and activities for preventions. For SS, components included cleaning, preparing-wrapping, and sterilization-storage. Hand hygiene resources included structural conditions for handwashing and antiseptic handrubbing with alcohol. The ratio of beds to sinks, beds to alcohol dispensers, patients to sinks, and patients to alcohol dispensers was calculated counting the resources available at the point of care. Elements of functionality and cleanliness of hand hygiene resources were also evaluated. Laboratories of microbiology were only visited if they were located within hospital premises; the 10 following components were evaluated: human resources, technical guidelines, management programs, environmental structure, decontamination and waste, automation, culture media and water quality, quality control, susceptibility tests, and typing procedures. Each component was further detailed in several elements to be evaluated. Elements were evaluated in regard to their presence, with no attempt to further evaluate their quality details. A conformity index (CI) was composed by the overall sum of elements in a given area to be evaluated, and the final CI was considered as the proportion of the number of elements which were in conformity in a given component evaluated. A CI of  $\geq 0.75$  (or 75%) was considered a good level of quality in structure for infection prevention and control.

A summary of data collection tool is available on request from the author.

### *Statistics*

The databank was fed in each state and sent by electronic means to a central coordination located in São Paulo, where data consolidation and analysis were performed.

The 11 university hospitals were used as reference when performing comparison among categories. The rationale of choosing these hospitals as reference was not related to the excellence in infection prevention, but rather to the presence of well-established infection control teams with tradition in research in this field. Spearman coefficient ( $\rho$ ) was used to identify correlation in the CI among the components evaluated. Linear regression models were used to identify correlations between the CI (dependent variables) and hospital categories and country regions (independent variables). Mid-*P* correction of the Fisher exact test was used for comparison of ratio of sinks or alcohol dispensers per patients or beds. In all tests, significance was assumed if  $P < .05$ . Statistics tests were performed using OpenEpi (Emory University, Atlanta, GA), Epi Info 3.5 (Centers for Disease Control and Prevention, Atlanta, GA), and SPSS 19.0 (IBM, Armonk, NY).

### *Ethics*

The research project was approved by the Committee of Ethical Research of the Federal University of São Paulo (protocol no. 0119/

**Table 1**

Distribution of the number of hospitals, total number of beds, and median beds per hospital (range) according to the hospital categories, Brazil, 2011–2013

Hospital Category/ Region	Hospitals (n)	Total no. of beds	Median beds per hospital (range)
Reference	11	4,747	462 (144–984)
Southeast	4	1,298	486 (144–812)
Northeast	3	1,476	250 (242–984)
Midwest	1	302	302 (NA)
North	1	377	377 (NA)
South	2	1,294	647 (641–653)
≥200 beds	8	2,247	280 (223–386)
Southeast	5	1,398	286 (234–316)
Northeast	1	386	386 (NA)
Midwest	0	NA	NA (NA)
North	1	223	223 (NA)
South	1	240	240 (NA)
50–199 beds	55	4,910	79 (50–181)
Southeast	22	1,902	74 (51–181)
Northeast	10	997	99 (50–159)
Midwest	3	237	83 (66–88)
North	3	281	96 (70–115)
South	17	1,493	77 (60–165)
<50 beds	79	2,079	24 (10–49)
Southeast	31	894	30 (10–49)
Northeast	5	177	30 (10–40)
Midwest	22	526	21 (10–42)
North	6	188	25 (10–49)
South	15	294	24 (10–33)
Total	153	13,983	45 (10–984)

NA, not applicable.

11) and by board committees from all of the other 10 reference hospitals.

## RESULTS

The distribution of the number of hospitals and beds among the sample is shown in Table 1. The intended sample was 270 hospitals (6.8% of all hospitals in the studied states; 4.3% of the total number in Brazil). However, there was sample loss for the following reasons: (1) relevant incongruity between CNES (official registry) data and actual hospital data (type of health care facility did not fit the inclusion criteria; inexistence of health care facility, lack of inpatient units, or other); (2) no answer from the hospital to the research team after ≥3 contact attempts; (3) refusal to participate; (4) refusal or lack of signature in the official ethical form approval; and (5) difficulties in hospital access because of geographic reasons (no road access; regional flood at the time of data collection). Public hospitals comprised 73% of the reference hospitals, 75% of the large hospitals (>200 beds), 33% of the medium-sized hospitals (50–199 beds), and 38% of the small hospitals (<50 beds). The other remaining hospitals were private or not-for-profit, and most of them were partially dependant on public funding.

### HAI Prevention and Control Committee

We found a large variation in the CI for the HAIPCC. Smaller hospitals had a lower CI compared with reference hospitals ( $P < .001$ ) (Table 2). Regional diversity influences this variation; the Midwest region was most likely to have a poor CI in their HAIPCC. Taking into account the hospital categories and regions, we found that the South and Southeast regions were more likely to have a better CI when compared with the others. Smaller hospitals had a significantly lower CI regardless of the region (Table 2). The lack of professionals dedicated to the HAIPCC was one of the most frequent flaws observed in smaller hospitals. Written guidelines for essential issues on infection prevention, such as those for germicides

**Table 2**

Distribution of percentiles of the conformity index for the Health Care–Associated Infection Prevention and Control Committee and  $P$  values (linear regression) according to categories of hospitals and geographic region ( $n = 153$ ), Brazil, 2011–2013

	Minimum	25%	50%	75%	Maximum	Crude $P$ value	Adjusted $P$ value*
Hospital category							
Reference hospitals <sup>†</sup>	0.69	0.90	0.94	0.98	1.00	Reference	Reference
≥200 beds	0.67	0.95	0.96	0.99	1.00	.20	.90
50–199 beds	0.06	0.70	0.88	0.96	1.00	<.001	.09
<50 beds	0.00	0.23	0.55	0.84	1.00	<.001	<.001
Country region							
Southeast	0.00	0.67	0.88	0.95	1.00	Reference	Reference
Northeast	0.00	0.33	0.76	0.94	1.00	.07	.001
Midwest	0.00	0.23	0.43	0.64	0.98	<.001	.001
North	0.00	0.15	0.76	0.95	1.00	.09	.04
South	0.00	0.60	0.85	0.97	1.00	.90	.90

\*Adjusted  $P$  value to country region and hospital category.

<sup>†</sup>Eleven university hospitals.

standardization and use, environmental cleaning, and devices sterilization, were not found in most hospitals. Routine surveillance activities were demonstrated; nevertheless, surprisingly, many HAIPCCs did not use the national standard definitions (CI variation among hospital categories: 0.40–0.89), and most hospitals actually did not base their preventive efforts on the surveillance data (CI variation among hospital categories: 0.37–0.74). The preventive activities were usually well documented regarding wards, intensive care, and neonatal care but are poorly documented regarding other services, such as emergence departments, blood donation, and laboratories (CI variation among hospital categories: 0.23–0.94). The worst CI for each component was observed in hospitals with <50 beds. We detected positive correlations in the CI among all 4 components of the HAIPCC ( $P < .001$ ). We observed slightly smaller values of  $\rho$  regarding the component of HAI prevention activities compared with other components (Fig 1).

### Sterilization services

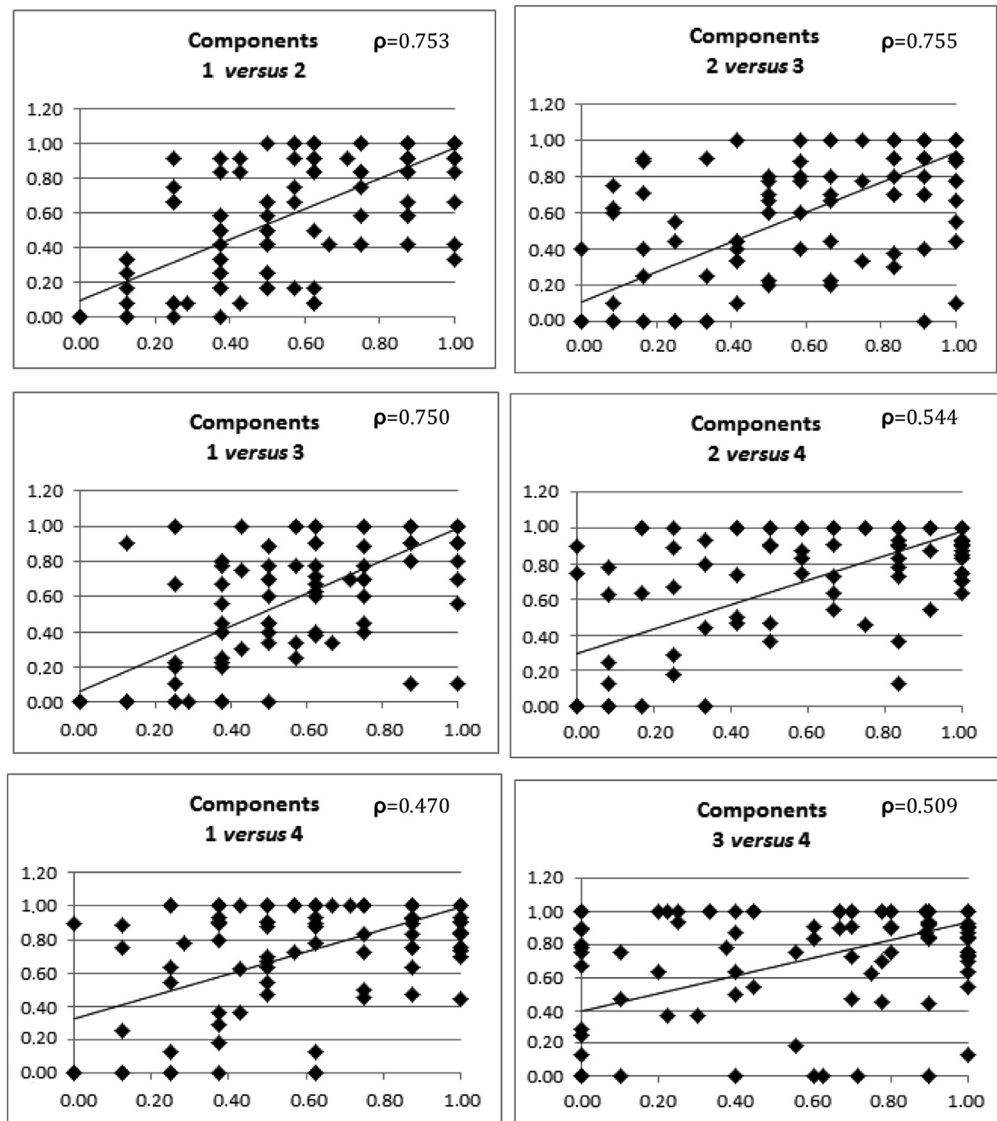
Overall, SIs showed low CIs, with best results in hospitals with ≥200 beds. Among those with <50 beds, the CI found was <0.70, up to percentile 75%, which may be considered a worrisome situation for this category of hospitals. The best CIs for SI were observed in the regions of the Southeast (CI = 0.64, at percentile 50%) and South (CI = 0.71, at percentile 50%) ( $P < .003$ ), but in this case, it does not matter the category of hospital. Both cleaning and preparing-wrapping components have shown lower CIs compared with the sterilization-storage component, mainly in smaller hospitals. Positive correlation was found among CIs observed in the 3 components evaluated. We also identified overall positive correlation for the CI between HAIPCC and SI ( $\rho = 0.669$ ;  $P < .001$ ) (Table 3).

### Hand hygiene

The ratios of hand hygiene resources per bed and per inpatient are demonstrated in Table 4. Poor CI for sinks means that even when present, sinks and other resources for hand hygiene lacked functionality or cleanliness (Table 4).

### Microbiology laboratories

The final sample corresponded to 90.9% of laboratories in reference hospitals and 21.1% of other remaining hospitals categories because these health care settings were mainly supported by outsourced laboratories, which could not be evaluated. Among



**Fig 1.** Correlation curves (Spearman  $\rho$ ) of the conformity index among the 4 components of Health Care–Associated Infection Prevention and Control Committee in Brazilian hospitals ( $n = 153$ ), Brazil, 2011–2013. The Health Care–Associated Infection Prevention and Control Committee evaluated operational structure, guidelines, HAI surveillance, and activities for prevention. Each and every correlation was significant at the  $P < .001$  level. 1, operational structure; 2, guidelines; 3, HAI surveillance; 4, activities for prevention.

laboratories visited, the CI ranged from 0.30–0.87. The quality control for culture media, such as Muller-Hinton, showed to have the worst conformity (CI = 0.30), followed by the quality control for other culture media and water (CI = 0.42).

## DISCUSSION

Brazil is a highly populated country (192 million) with approximately 6,266 hospitals (2012 data) spread in a large territory, posing a challenge to countrywide studies aiming at driving governmental strategies for prevention and control of HAI.<sup>6</sup> To our knowledge, this study presents the first scaled evaluation of structure for HAI prevention in the country.

Despite being mandatory by law since 1997,<sup>7</sup> the HAIPCC is still not fully compliant with all legal and recommended issues. This is particularly true for smaller hospitals, both public and private, which may deal with lack of economic support to provide even minimal resources for HAI prevention. We believe economic issues may account significantly for the very poor CI

of SIs among smaller hospitals because physical structure, equipment, instruments, and supplies are usually expensive. This is an even more stringent situation regarding localities outside the Southeast and South regions. Of note, the index of human development is higher in states in the Southeast and South regions (United Nations Development Program: <http://www.pnud.org.br>).

The detection of such variation in HAI prevention structure at hospitals is intimately linked to the Brazilian health care system model, which provides a certain level of autonomy to the states.<sup>6</sup> The Brazilian Unified Health System works at the municipal, state, and federal levels by direct management or by agreements or contracts with private health care units. For its part, the private sector (supplementary health care services) organizes itself by health care plans or by direct reimbursement of health care costs to the users. First, this raises questions about the efficiency and safety of small-sized hospitals (<50 beds) in the country. These types of hospitals represent 62% of hospital units, accounting for approximately 18% of beds in the Brazilian health care system.<sup>8</sup> In many



**Table 3**

Distribution of percentiles of the conformity index for sterilization services and *P* values (linear regression) according to categories of hospitals and geographic region (*n* = 153), Brazil, 2011–2013

	Minimum	25%	50%	75%	Maximum	Crude <i>P</i> value	Adjusted <i>P</i> value*
Hospital category							
Reference hospital <sup>†</sup>	0.51	0.58	0.63	0.79	0.92	Reference	Reference
≥200 beds	0.48	0.56	0.80	0.91	0.99	.50	.50
50–199 beds	0.00	0.54	0.74	0.86	0.99	.90	.50
<50 beds	0.00	0.37	0.51	0.64	0.95	.01	.005
Country region							
Southeast	0.30	0.56	0.64	0.82	0.99	Reference	Reference
Northeast	0	0.34	0.56	0.76	0.87	.02	.002
Midwest	0.20	0.36	0.45	0.53	0.76	<.001	<.001
North	0	0.29	0.49	0.56	0.99	.008	.003
South	0	0.54	0.71	0.85	0.97	.60	.50

\*Adjusted *P* value to country region and hospital category.

<sup>†</sup>Eleven university hospitals.

**Table 4**

Ratio of beds to sinks, patients to sinks, beds to alcoholic product dispensers, and patients to alcoholic product dispensers and the conformity index in Brazilian hospitals (*n* = 153), Brazil, 2011–2013

Hospital category	Beds to sinks*	Patients <sup>†</sup> to sinks	CI	Beds to alcoholic product dispensers	Patients <sup>‡</sup> to alcoholic product dispensers	CI
Reference hospital <sup>†</sup>	3.34	2.54	0.65	3.27	2.47	0.83
≥200 beds	3.91 <sup>§</sup>	3.12 <sup>§</sup>	0.59 <sup>§</sup>	3.49	2.79 <sup>§</sup>	0.84
50–199 beds	3.14	2.01 <sup>§</sup>	0.50 <sup>§</sup>	3.39	2.17 <sup>§</sup>	0.75 <sup>§</sup>
<50 beds	3.08	1.47 <sup>§</sup>	0.43 <sup>§</sup>	6.43	3.06 <sup>§</sup>	0.76 <sup>§</sup>

CI, conformity index, which includes elements of functionality and cleanliness of hand hygiene resources.

\*Includes all resources for handwashing: sinks, soap, and paper towels.

<sup>†</sup>Number of inpatients at the moment of visiting for evaluation.

<sup>‡</sup>Eleven university hospitals.

<sup>§</sup>*P* < .05.

situations, small-sized hospitals are filling the gap of a deficient primary care system, with more than half of them the only option for inpatient treatment in many municipalities.<sup>8</sup> As a consequence, most of these hospitals have low complexity of care. Therefore, it seems irrational to spend technologic resources, such as surgical equipment and invasive devices, instead of concentrating them in larger reference hospitals. Second, there is an urgent need for strong investments at the state level to improve the structure for HAI prevention. In a similar political system regarding the autonomy of states, in 2009 the United States designated \$40 million for the Centers for Diseases Control and Prevention to support states.<sup>9</sup> Along with this initiative, all states were required to take their amount of responsibility in the prevention chain, including dealing with epidemiologic data and actions plans to promote HAI reduction.<sup>9</sup>

We did not explore in deep detail the time dedication or qualifications for infection control preventionists related to their activities as others researchers did.<sup>10–12</sup> That type of research could help understand the reasons for the HAIPCC failing to use their own data to drive the infection control program because it could be related to difficulties to deal with epidemiologic information. As previously mentioned, many infection preventionists only work as data collectors and do not move toward leadership for improvement intervention.<sup>13</sup> Most importantly, the primary purpose of surveillance is reducing nosocomial infections at the hospital level; therefore, the use of data must be greatly beyond providing information to the Brazilian authorities.

A few studies evaluated the structure for HAI prevention in groups of hospitals by means of using criteria inspired or adapted from the Study on the Efficacy of Nosocomial Infection Control project. In general, those studies looked mainly at infection control personnel, prevention activities, and surveillance.<sup>10,12,14–17</sup> The use of a mailed or electronic questionnaire was more frequent than in locus visiting.<sup>10–12,15–18</sup> A Korean study also included the evaluation of resources for hand hygiene,<sup>11,14</sup> but they only evaluated hospitals with >300 beds. Others tried to identify the influence of characteristics and size of hospitals with adverse events rates or issues of the HAI program, with heterogeneous results.<sup>10,19,20</sup>

The results from this study showed that the HAIPCC tend to have a balanced level of compliance between the 4 main components of the program. The findings that hospitals that are more compliant with HAIPCC tend to have also high compliant SSs may be explained by the mutual influence between nurses in SSs and the HAIPCC. Simply, this also can only reflect an overall quality of the hospital or accreditation status,<sup>5,16,17</sup> which was not the focus of our study.

Brazilian regulations determine the use of alcoholic product at the point of care.<sup>21</sup> However, as demonstrated in other studies, the infrastructure for hand hygiene is not fully implemented.<sup>22</sup>

Besides this, our data reinforce the information from a previous Brazilian study regarding the weakness of structure and process of laboratories of microbiology linked to hospitals.<sup>23</sup>

A major strength of our study was the on-site collection of data carried out by trained personnel, minimizing bias and contributing to greater accuracy of the survey. This was implied in an enormous effort from the research team to provide operational and logistic background for all of these visits. The comparison of the reference hospitals with other categories has highlighted differences that may be useful when defining public policies applicable not only in Brazil but in other developing countries with similar characteristics. Among the limitations of our study, we should point out the infeasibility of including all 26 states in our sample. The selection of 10 states was a relevant pragmatic decision taking into consideration operational difficulties to perform such a study in Brazil, which is a federative nation with large geographic dimensions and limited resources. These states harbored 3,964 hospitals in 2012, corresponding to 63.3% of all hospitals in Brazil. Even though Brazil has many differences among regions, states in a same region are relatively homogeneous. Although randomization was used, several hospitals declined to participate in the evaluation, which may have introduced bias in our study. Furthermore, during the data collection, we found difficulties to get undoubted information regarding the number of professionals enrolled in the directed health care assistance.

## CONCLUSIONS

The findings from this study have major implications in national policies in promoting patient safety. A national plan should be driven to strengthen the main structures in HAI prevention, HAIPCC, SS, and laboratories of microbiology, giving high priority for the Midwest, North, and Northeast regions.

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