Journal of Hospital Infection 96 (2017) 139–144

Available online at www.sciencedirect.com

Journal of Hospital Infection

journal homepage: www.elsevierhealth.com/journals/jhin

Multi-state survey of healthcare-associated infections in acute care hospitals in Brazil☆

C. Magno Castelo Branco Fortaleza[a,*], M.C. Padoveze[b], C.R. Veiga Kiffer[c], A.L. Barth[d], Irna C. do Rosário Souza Carneiro[e], H.I. Garcia Giamberardino[f], J.L. Nobre Rodrigues[g], L. Santos Filho[h], M.J. Gonçalves de Mello[i], M. Severino Pereira[j], P. Pinto Gontijo Filho[k], M. Rocha[l], E.A. Servolo de Medeiros[c], A.C. Campos Pignatari[c]

[a] Faculdade de Medicina de Botucatu, Botucatu, São Paulo State, Brazil
[b] Escola de Enfermagem (School of Nursing), Universidade de São Paulo (USP), City of São Paulo, São Paulo State, Brazil
[c] Escola Paulista de Medicina (São Paulo School of Medicine), Universidade Federal de São Paulo (UNIFESP), City of São Paulo, São Paulo State, Brazil
[d] Universidade Federal do Rio Grande do Sul (UFRGS), City of Porto Alegre, State of Rio Grande do Sul, Brazil
[e] Universidade Federal do Pará (UFPA), City of Belém, Pará State, Brazil
[f] Hospital Pequeno Príncipe (HPP), City of Curitiba, State of Paraná, Brazil
[g] Universidade Federal do Ceará, City of Fortaleza, State of Ceará, Brazil
[h] Universidade Federal da Paraíba (UFPB), City of João Pessoa, State of Paraíba, Brazil
[i] Instituto Medicina Integral Prof. Fernando Figueira (IMIP), City of Recife, State of Pernambuco, Brazil
[j] Pontifícia Universidade Católica (PUC) – Goiás, City of Goiânia, State of Goiás, Brazil
[k] Universidade Federal de Uberlândia (UFU), City of Uberlândia, State of Minas Gerais, Brazil
[l] Fundação Instituto Oswaldo Cruz (FiOCruz), City of Rio de Janeiro, Rio de Janeiro State, Brazil

ARTICLE INFO

Article history:
Received 17 November 2016
Accepted 21 March 2017
Available online 23 March 2017

Keywords:
Healthcare-associated infections
Epidemiology
Prevalence survey
Brazil

SUMMARY

Background: Healthcare-associated infections (HCAIs) challenge public health in developing countries such as Brazil, which harbour social inequalities and variations in the complexity of healthcare and regional development.
Aim: To describe the prevalence of HCAIs in hospitals in a sample of hospitals in Brazil.
Methods: A prevalence survey conducted in 2011–13 enrolled 152 hospitals from the five macro-regions in Brazil. Hospitals were classified as large (≥200 beds), medium (50–199 beds) or small sized (<50 beds). Settings were randomly selected from a governmental database, except for 11 reference university hospitals. All patients with >48 h of admission to the study hospitals at the time of the survey were included. Trained epidemiologist nurses visited each hospital and collected data on HCAIs, subjects' demographics, and invasive procedures. Univariate and multivariate techniques were used for data analysis.
Findings: The overall HCAI prevalence was 10.8%. Most frequent infection sites were pneumonia (3.6%) and bloodstream infections (2.8%). Surgical site infections were found in

☆ Preliminary results were presented in the International Conference on Prevention & Infection Control (ICPIC), Geneva, Switzerland, June 25th to 28th, 2013.

* Corresponding author. Address: Faculdade de Medicina de Botucatu, Doencas Tropicais, Distrito de Rubiao Junior, S/N, Botucatu, São Paulo State 18618-970, Brazil. Tel.: +55 14 38152312; fax: +55 14 38159898.
E-mail address: cmfortaleza@uol.com.br (C.M.C.B. Fortaleza).

http://dx.doi.org/10.1016/j.jhin.2017.03.024

1.5% of the whole sample, but in 9.8% of subjects who underwent surgical procedures. The overall prevalence was greater for reference (12.6%) and large hospitals (13.5%), whereas medium- and small-sized hospitals presented rates of 7.7% and 5.5%, respectively. Only minor differences were noticed among hospitals from different macro-regions. Patients in intensive care units, using invasive devices or at extremes of age were at greater risk for HCAIs.

Conclusion: Prevalence rates were high in all geographic regions and hospital sizes. HCAIs must be a priority in the public health agenda of developing countries.

Introduction

There is compelling evidence that the burden of healthcare-associated infections (HCAIs) is greater in developing countries [1,2]. However, a recent systematic review pointed out that the quality of data from those settings is often poor [2]. One could add to this scenario the scarcity of national surveillance systems and of comprehensive prevalence surveys conducted in poor and middle-income countries [3].

In previous decades, prevalence surveys have been carried out in several countries, with the objective of providing a 'snapshot' picture of HCAIs in an extensive area [4–6]. Their main advantage over prospective surveillance systems lies in the possibility of accurate and comprehensive collection of data. It is even possible to employ trained teams for active data collection, thus avoiding heterogeneity in the accuracy of local surveillance. Therefore, prevalence surveys may provide information that is consistent and reliable [7].

In Brazil, the only previous multi-state prevalence survey was conducted in the early 1990s by Prade *et al*. and included 99 tertiary-care hospitals [8]. Those authors found the overall prevalence of HCAIs to be 15.5%. In spite of the importance of these findings, that survey did not assess the burden of HCAIs in middle or small-sized hospitals. It is worth noting that most hospitals in Brazil have <50 beds [9]. Even though those hospitals care for less complex diseases, they perform many surgical and obstetric procedures [10]. Since those procedures pose infection risks, small hospitals must be addressed in infection control surveillance and policies.

In this study, we describe the results of a prevalence survey conducted throughout 18 months during 2011–13, enrolling hospitals with different sizes from 10 states located in the five macro-regions in Brazil. The study grew out of a project aimed at identifying the burden of HCAIs and the resources for infection control in Brazilian hospitals (Project 'IRAS-Brasil').

Methods

Study design and settings

A prevalence survey was conducted from November 2011 through April 2013 (an 18-month period), enrolling a sample of hospitals from 10 states in Brazil. There was an attempt to include states from the five Brazilian macro-regions: North, one state (Pará); Northeast, three (Ceará, Paraiba, and Pernambuco); Midwest, one (Goiás); Southeast, three (Minas Gerais, Rio de Janeiro, and São Paulo); South, two (Paraná and Rio Grande do Sul).

Eleven 'reference hospitals' (two in São Paulo and one in each of the above 10 states) were enrolled and co-ordinated the study in each state. A further 141 acute care hospitals were randomly selected from the national registry of healthcare settings [Cadastro Nacional de Estabelecimentos de Saúde (CNES), http://cnes.datasus.gov.br]. The total number of hospitals from the study states recorded in that database was 4176. The study enrolled public, private, and non-profit hospitals.

The selection of hospitals was based on the proportionality among states and size categories. Hospitals were classified as large (≥200 beds), medium (50–199 beds) or small (<50 beds). Briefly, a database containing every hospital in the study states was generated. The sample for each state was calculated according to its representativeness in the total number of hospitals, and stratification within that sample was performed according to the proportionality of size categories (large, medium or small hospitals) in that state. The participation of hospitals in the study was voluntary. Whenever a hospital declined to participate, another hospital from the same state and size category was randomly selected and included in the study.

Data collection and definitions

Data were collected by a team of nurses with experience in infection control and surveillance of HCAIs. That team was constituted uniquely for the purpose of this research and did not include local infection control professionals from study hospitals. All these nurses were submitted to additional training on surveillance definitions and methods, as well as to supervision by the study co-ordination, regarding operational procedures and results. A written guideline with strict procedures for data collection was developed.

The survey was performed in visits to each hospital on Tuesdays, Wednesdays, and Thursdays, in order to avoid bias due to concentration of severe cases near weekends [11]. Visits and data collection in individual hospitals took from one to nine days, according to hospital size and complexity. The study was strictly observational, and no intervention for infection control (e.g. education, provision of resources) was performed by the research team in the hospitals before or during the survey.

Data were obtained from patients' charts, laboratory files, and – when necessary – through direct examination of the patient. All patients who were admitted for two days before the visit were included in the study. The collected data comprised demographics, comorbidities, procedures, invasive devices, and use of antimicrobials, as well as the presence of HCAIs.

Table I
Prevalence of HCAIs according to regions in Brazil

Region	Subjects	Total HCAI	Patients with HCAI	Pneumonia	BSI	SSI	UTI	SST	Other
Southeast [reference]	2722	11.7	10.2	3.8	3.2	1.6 [8.2]	1.8	0.6	0.8
Northeast	1517	9.8	9.3	3.4	3.3	0.9 [7.8]	0.8*	0.4	1.0
Midwest	257	13.2*	11.3	4.3	1.5	3.1 [24.2]*	0.8	1.2	2.3*
North	672	12.5	12.2	4.3	2.2	1.9 [17.1]*	1.5	1.6*	0.9
South	1352	8.7*	8.3	2.7	2.2	1.4 [10.7]	1.3	0.4	0.7
Total	6520	10.8	9.9	3.6	2.8	1.5 [9.8]	1.4	0.6	0.9

HCAI, healthcare-associated infections; BSI, bloodstream infections; UTI, urinary tract infections; SSI, surgical site infections; SST, skin or soft tissue infections.
All data are percentages of total subjects. Numbers in brackets represent SSI prevalence when calculated only for subjects submitted to surgical procedures.
*Significantly different ($P < 0.05$) from the reference.

HCAIs were defined according to the guidelines from Agência Nacional de Vigilância Sanitária (ANVISA, Brazil's National Agency for Sanitary Surveillance) [12]. Those guidelines were largely based on definitions from the National Healthcare Safety Network [13]. However, ANVISA guidelines expand the definition of bloodstream infections (BSIs) to include patients with clinically defined sepsis without laboratory confirmation.

Statistics

Data were entered and stored in a web-based (MySQL) environment specifically developed for the project's purpose. Descriptive statistics were performed using SPSS 19 (IBM, Armonk, NY, USA). The chi-square test was applied to compare overall proportions for hospital categories or regions. Whenever applicable, multivariate analysis using single-step logistic regression models was used.

Results

The study comprised 152 hospitals. Table I presents the distribution among macro-regions and hospital size categories. A total of 6520 patients admitted to the surveyed hospitals met inclusion criteria. The subjects were distributed as follows: reference hospitals: 2750; other large hospitals: 1211; medium-sized hospitals: 2147; small-sized hospitals: 412.

The prevalence rates for overall HCAIs and patients with HCAIs were 10.8% [95% confidence interval (CI): 10.1—11.6%] and 9.9% (95% CI: 9.1—10.6%). Most case patients (92%) presented HCAI in one site. Two or three simultaneous HCAIs were found in 7% and 1%, respectively. The most frequent infectious syndromes were pneumonia (overall prevalence, 3.6%), BSI (2.9%), surgical site infection (SSI, 1.5%), and urinary tract infection (UTI, 1.4%). The prevalence rate for SSI was 9.8%, when calculated for a baseline population restricted to patients who had undergone surgical procedures. Other infectious sites detected in the study (e.g. gastrointestinal tract, peritoneum and central nervous system) had an aggregated prevalence of 0.9%. Tables I and II present results stratified for Brazil's macro-regions and for hospital size, respectively. Differences for macro-regions were generally small. The South presented lower overall HCAI rate, but did not differ from other regions in rates of patients with HCAI. Results stratified for age categories are presented in Table III. Higher prevalence of most infectious syndromes was found among neonates, infants and elderly subjects.

Our study also focused on the prevalence of use of invasive devices. The device use prevalence was 16.3% for central venous catheter, 14.7% for urinary catheter, and 7.3% for mechanical ventilation. Among study subjects, 15.0% had undergone surgery during admission. Stratified results are presented in Table IV.

Patients in intensive care units (ICUs) and high-risk nurseries presented higher prevalence rates for overall HCAIs: 29.1% and 16.8%, respectively (Table V). Neonates and critically ill patients were more likely to develop HCAIs (and specifically pneumonia or BSI) in multivariate models (Table VI). Other significant predictors for infection were age >65 years (for pneumonia and UTI), previous surgery (pneumonia, bloodstream infections), and central venous catheter (for all

Table II
Prevalence of HCAIs according to hospital size

Size category	Subjects	Total HCAIs	Patients with HCAI	Pneumonia	BSI	SSI	UTI	SST	Other
Reference hospitals*	2750	12.6	11.5	3.7	3.9	2.0 [10.7]	1.3	0.6	1.2
≥200 beds	1211	13.5	12.8	4.6	3.6	1.7 [14.3]	1.8	0.7	1.0
50—199 beds	2147	7.7*	6.9*	3.2	1.6*	0.84 [6.7]*	1.2	0.1*	0.3*
10—49 beds	412	5.5*	5.6*	0.2*	0.7*	0.49 [4.3]*	1.5	0.2	1.7
Total	6520	10.8	9.9	3.6	2.9	1.5 [9.8]	1.4	0.6	0.9

HCAI, healthcare-associated infection; BSI, bloodstream infection; SSI, surgical site infection; UTI, urinary tract infection; SST, skin or soft tissue infection.
All data are percentages of total subjects. Numbers in brackets represent SSI prevalence when calculated only for subjects submitted to surgical procedures.
*Significantly different ($P < 0.05$) from the reference.

Table III
Prevalence of HCAI stratified for age categories

Age category	Subjects	Total HCAIs	Patients with HCAI	Pneumonia	BSI	SSI	UTI	SST	Other
Newborn (<28 days)	454	18.5*	18.3*	4.4*	9.7*	0.9 [20.0]	0.0	0.0	3.5*
Infant (28 days to 1 year)	516	13.4*	13.0*	2.5*	7.0*	0.6 [4.6]	0.6	0.6	2.1*
1–5 years	389	6.4	6.4	3.1	1.0	0.8 [7.7]	0.8	0.3	0.5
6–9 years	153	8.5	8.5	2.6	3.9	2.0 [18.8]	0.0	0.0	0.00
10–19 years	459	8.3	8.1	3.1	1.5	1.5 [8.8]	0.4	0.7	1.1
20–49 years (reference)	1717	8.1	7.5	2.5	1.9	1.8 [8.2]	1.1	0.5	0.4
50–64 years	1131	10.0	8.8	3.1	2.0	1.7 [9.6]	1.8	0.7	0.7
≥65 years	1701	13.1*	11.2*	5.4*	2.1	1.5 [13.9*]	2.6*	0.9*	0.5

HCAI, healthcare-associated infection; BSI, bloodstream infection; SSI, surgical-site infection; UTI, urinary tract infection; SST, skin or soft tissue infection.
All data are percentages of total subjects. Numbers in brackets represent SSI prevalence when calculated only for subjects submitted to surgical procedures.
*Significantly different ($P < 0.05$) from the reference.

syndromes). Few regional differences were identified, but subjects from the Midwest region were more likely to present overall higher HCAI or, specifically, SSI prevalence. Finally, when adjusted for other variables, hospital size was associated only with overall HCAI rates.

Discussion

Since the SENIC study, several countries have attempted to measure the burden and determinants of HCAI [14,15]. Surveillance systems have been developed and refined, but adherence and reliability of data are major challenges for developing countries [2,3]. In this setting, prevalence surveys are especially useful.

Our results agree with previous studies reporting a high burden of HCAIs in acute-care hospitals from low- and middle-income countries [2]. Our overall prevalence of HCAIs (10.8%) was higher than that reported for the USA (4.0%) and Europe (7.1%) [16,17]. It was also higher than values reported in China (3.6%), Cuba (7.3%), and Vietnam (7.8%) [18–20]. Comparing our results to those reported in Allegranzi *et al.*'s meta-analysis, our prevalence was similar to the overall rate (10.1%) [2]. It was also lower than the prevalence arising from studies that were classified as 'high quality' in that meta-analysis (15.5%). Nevertheless, differences in methods for hospital sampling, data collection and HCAI definitions are important limitations for direct comparisons.

Similarly to most previous surveys, the lower respiratory tract ranked first among infection sites [2,16,17]. However, focused analysis of subjects who underwent surgical procedures allowed us to acknowledge a significant burden of SSI, even in small hospitals. Given the international and local evidence that most SSI occur after discharge, this finding may be underestimated due to loss of post-discharge cases [21,22]. This underscores a relevant public health problem, since even small hospitals in Brazil are characterized by predominant surgical activity [10]. These findings are also relevant to the current World Health Organization campaign focusing on prevention of SSI [23].

On the other hand, gastrointestinal infections were rare in our prevalence study. This is in contrast to findings from the USA and Europe [16,17]. It is possible that our results may have been influenced by scarcity of resources for diagnosis of *Clostridium difficile* diarrhoea [24]. However, our study employed active data collection, and this should have prevented us from missing cases of nosocomial diarrhoea. This aspect requires further investigation.

Even though there are important differences in mortality indices and access to health care among Brazilian macro-regions, only minor differences in HCAI prevalence were found [25]. Differences in prevalence of overall HCAIs and of specific infections among different size categories were also smaller than we expected, and declined after adjusting for other factors. The use of invasive devices in small hospitals was

Table IV
Use of invasive devices and prevalence of post-surgical patients in the study hospitals

Category	Urinary catheter	Central venous catheter	Mechanical ventilation	Surgery
Reference hospitals	13.7%	18.8%	8.3%	18.2%
≥200 beds[a]	15.8%	16.2%	8.0%	11.4%*
50–199 beds	16.8%*	15.2%*	6.8%*	12.0%*
<50 beds	7.1%*	4.9%*	0.9%*	12.0%*
Total	14.7%	16.3%	7.3%	15.0%

Comparisons made using chi-square test for overall proportions.
*Rates differed significantly from the reference ($P < 0.05$).
[a] This group includes all hospitals with ≥200 beds, except the reference hospitals.

Table V
Survey results for intensive care units and high risk nurseries

Parameter	Intensive care units	High risk nurseries
No. of subjects	691	382
Central venous catheter	34.4%	22.3%
Mechanical ventilation	26.7%	11.3%
Urinary catheter	34.6%	0
Overal HCAIs	29.1%	16.8%
Pneumonia	10.3%	2.7%
Bloodstream infections	4.8%	10.5%
Urinary tract infections	11.8%	0

HCAI, healthcare-associated infection.

Table VI
Multivariate analysis (logistic regression) of predictors for overall HCAIs and specific sites of infections

Predictors	OR (95% CI)				
	Overall HCAIs	Pneumonia	BSI	SSI[a]	UTI
Region					
Southeast (reference)	—	—	—	—	—
Northeast	1.08 (0.85—1.37)	1.06 (0.73—1.53)	1.07 (0.73—1.57)	0.84 (0.43—1.62)	0.55 (0.29—1.06)
Midwest	1.59 (1.01—2.51)*	1.76 (0.88—3.53)	0.47 (0.16—1.42)	5.07 (1.99—12.93)*	0.58 (0.14—2.44)
North	1.20 (0.90—1.61)	1.02 (0.64—1.64)	0.54 (0.30—0.97)*	2.83 (1.37—5.83)*	1.01 (0.49—2.10)
South	0.78 (0.60—1.01)	0.66 (0.44—1.01)	0.64 (0.41—1.02)	1.36 (0.73—2.52)	0.77 (0.44—1.35)
Hospital size category					
Reference hospitals	—	—	—	—	—
≥200 beds	1.33 (1.04—1.69)*	1.15 (0.78—1.71)	1.12 (0.75—1.69)	1.50 (0.82—2.72)	0.91 (0.53—1.76)
50—199 beds	0.63 (0.50—0.80)*	0.72 (0.51—1.03)	0.55 (0.36—0.84)	0.62 (0.33—1.14)	0.71 (0.41—1.21)
10—49 beds	0.67 (0.42—1.07)	0.37 (0.13—1.02)	0.28 (0.08—0.92)	0.41 (0.09—1.81)	1.27 (0.51—3.14)
Intensive care unit	1.45 (1.09—1.92)*	2.46 (1.24—4.89)*	2.44 (1.54—3.87)*	0.52 (0.23—1.18)	0.69 (0.35—1.36)
High risk nursery	1.41 (0.91—2.17)	0.73 (0.31—1.70)	2.80 (1.61—4.88)*	0.12 (0.01—1.63)	0
Age category					
Newborns (<28 days)	2.97 (2.01—4.39)*	2.46 (1.24—4.89)*	3.22 (1.74—5.96)*	2.57 (0.62—10.71)	0
Infants (28 days to 1 year)	1.72 (1.20—2.46)*	0.93 (0.47—1.84)	2.48 (1.43—4.30)*	0.40 (0.11—1.44)	0.58 (0.17—2.05)
1—5 years	1.92 (0.63—1.64)	1.46 (0.73—2.96)	0.51 (0.17—1.49)	0.61 (0.16—2.27)	0.89 (0.26—3.11)
6—9 years	1.52 (0.80—2.88)	1.20 (0.40—3.65)	2.29 (0.90—5.83)	2.94 (0.75—11.57)	0
10—19 years	1.15 (0.77—1.73)	1.31 (0.68—2.51)	075 (0.32—1.75)	1.06 (0.44—2.57)	0.44 (0.10—1.90)
20—49 years (reference)	—	—	—	—	—
50—64 years	1.07 (0.79—1.44)	1.06 (0.66—1.73)	0.88 (0.51—1.54)	0.97 (0.51—1.83)	1.50 (0.78—2.87)
≥65 years	1.36 (1.05—1.77)*	1.80 (1.23—2.65)*	0.80 (0.48—1.33)	1.63 (0.90—2.95)	2.04 (1.15—3.64)*
Male gender	1.28 (1.07—1.53)*	1.22 (0.92—1.62)	1.13 (0.83—1.53)	1.51 (0.96—2.37)	1.15 (0.75—1.76)
Urinary catheter	1.72 (1.34—2.20)*	1.80 (1.23—2.65)*	0.94 (0.59—1.50)	0.83 (0.45—1.52)	2.96 (1.76—1.90)*
Mechanical ventilation	1.51 (1.13—2.02)*	2.27 (1.53—3.36)*	1.29 (0.83—2.01)	1.26 (0.54—2.90)	0.91 (0.44—1.90)
Central venous catheter	3.85 (3.09—4.79)*	3.34 (2.32—4.80)*	4.88 (3.36—7.07)*	2.83 (1.60—5.04)*	2.71 (1.59—4.64)*
Previous surgery	3.34 (2.71—4.12)*	1.57 (1.11—2.22)*	1.55 (1.06—2.29)*	—*	1.57 (0.95—2.59)

HCAI, healthcare-associated infection; OR, odds ratio; CI, confidence interval; BSI, bloodstream infection; SSI, surgical site infection; UTI, urinary tract infection.
*$P < 0.05$.
[a] Only subjects who had undergone previous surgery were included in the analysis of predictors for SSI.

not negligible. We feel that risk definition solely based on the number of hospital beds is not sufficient to guide public policies.

In a previous countrywide study, we found significant differences of conformity indices for infection control programmes and for sterilization services among different macro-regions and size categories [26]. Curiously, differences in prevalence of HCAIs were smaller than differences in the structure for prevention. Our hypothesis is that poor infection control practices and resources in less complex hospitals are counterbalanced by the fact that they care for less severely ill patients.

Other findings are mostly coherent with reports from other countries [2,16,17]. They point to patients in ICUs and high-risk nurseries, at extremes of ages, and with invasive devices as those requiring special attention for preventing the occurrence of HCAIs.

From a temporal perspective, it is worth noting that we found lower prevalence than that reported by Prade *et al.* for Brazilian tertiary hospitals in the 1990s [8]. Even if we restrict our results to reference and large hospitals, the overall rates (12.6% and 13.5%) were lower than Prade *et al.*'s (15.5%). Importantly, our study included subjects admitted for more than two days, whereas the previous survey's criterion was more than one day of admission. Since that study allowed more patients at low risk in the denominator, those results are underestimated in comparison with ours. A reduction in prevalence rates may be due to public policies directed at controlling HCAIs implemented in the gap between those studies [27]. It should be noted, however, that Prade *et al.* used HCAI definitions issued by the US Centers for Disease Control and Prevention (CDC) in 1988, whereas our study employed more recent definitions [12,13]. Difference in definitions limits the possibility of strict comparisons [28].

Limitations of our study include those inherent to the cross-sectional design, such as lack of subjects' follow-up and impossibility of detecting post-discharge HCAIs (mainly SSI). Also, the geographic extent of Brazil prevented us from including hospitals from all 26 states. On the other hand, there were also strengths: random selection of study hospitals; direct collection of data performed by trained nurses; and hospital visits on days of maximum occupation (Tuesday to Thursday) to prevent concentration of high-risk subjects. Finally, the inclusion of hospitals from all macro-regions allowed us a wide view of the burden of HCAIs in Brazil.

In conclusion, HCAIs are highly prevalent in Brazil, presenting a challenge for public health authorities. Pneumonia and SSIs stand out among risks for people admitted to acute-care hospitals. The risk for HCAIs is widely distributed both geographically and among hospitals of different sizes, so that any policy directed at reducing their occurrence and impact must be at once comprehensive and directed at more vulnerable subjects. From a global perspective, our study contributes to the knowledge of the worldwide burden of HCAIs. Also, our results emphasize the importance of conducting methodologically rigorous surveys to estimate the burden of HCAIs in developing countries.

Conflict of interest statement

None declared.

Funding sources

This study was funded by the National Council for Scientific and Technological Development (CNPq: 563225/2010-6) in partnership with the Ministry of Health of Brazil, under the call MCT/CNPq/CT-Saúde/MS/SCTIE/DECIT N° 40/2010.

References

[1] Pittet D, Allegranzi B, Storr J, Bagheri Nejad S, Dziekan G, Leotsakos A, et al. Infection control as a major World Health Organization priority for developing countries. J Hosp Infect 2008;68:285—92.
[2] Allegranzi B, Bagheri Nejad S, Combescure C, Graafmans W, Attar H, Donaldson L, et al. Burden of endemic health-care-associated infection in developing countries: systematic review and meta-analysis. Lancet 2011;377:228—41.
[3] Nogueira Junior C, Mello DS, Padoveze MC, Boszczowski I, Levin AS, Lacerda RA. Characterization of epidemiological surveillance systems for healthcare-associated infections (HAI) in the world and challenges for Brazil. Cad Saude Publica 2014;30:11—20.
[4] Vaqué J, Rosselló J, Trilla A, Monge V, García-Caballero J, Arribas JL, et al. Nosocomial infections in Spain: results of five nationwide serial prevalence surveys (EPINE Project, 1990 to 1994). Nosocomial Infections Prevalence Study in Spain. Infect Control Hosp Epidemiol 1996;17:293—7.
[5] Gastmeier P, Sohr D, Rath A, Forster DH, Wischnewski N, Lacour M, et al. Repeated prevalence investigations on nosocomial infections for continuous surveillance. J Hosp Infect 2000;45:47—53.
[6] Sohn AH, Garrett DO, Sinkowitz-Cochran RL, Grohskopf LA, Levine GL, Stover BH, et al. Prevalence of nosocomial infections in neonatal intensive care unit patients: results from the first national point-prevalence survey. J Pediatr 2001;139:821—7.
[7] Gastmeier P, Kampf G, Hauer T, Schlingmann J, Schumacher M, Daschner F, et al. Experience with two validation methods in a prevalence survey on nosocomial infections. Infect Control Hosp Epidemiol 1998;19:668—73.
[8] Prade SS, Oliveira ST, Rodriguez R, Nunes FA, Martins Netto E, Félix JQ, et al. Estudo brasileiro da magnitude de infecções hospitalares em hospitais terciários. Revista do Controle de Infecção Hospitalar 1995;2:11—24.
[9] Ugá MA, López EM. Os hospitais de pequeno porte e sua inserção no SUS. Cien Saude Colet 2007;12:915—28.
[10] Padoveze MC, Assis DB, Freire MP, Madalosso G, Ferreira SA, Valente MG, et al. Surveillance Programme for Healthcare Associated Infections in the State of São Paulo, Brazil. Implementation and the first three years' results. J Hosp Infect 2010;76:311—5.
[11] Rosselló-Urgell J, Vaqué-Rafart J, Armadans-Gil LL, Vaquero-Puerta JL, Elorza-Ricart JM, Quintas-Fernández JC, et al. The importance of the day of the week and duration of data collection in prevalence surveys of nosocomial infections. J Hosp Infect 2004;57:132—8.
[12] Agência Nacional de Vigilância Sanitária (ANVISA). Critérios diagnósticos de infecções relacionadas à assistência à saúde. 1st ed. Brasília, Brazil: ANVISA; 2013.
[13] Horan TC, Andrus M, Dudeck MA. CDC/NHSN surveillance definition of health care-associated infection and criteria for specific types of infections in the acute care setting. Am J Infect Control 2008;36:309—32.
[14] Haley RW, Culver DH, White JW, Morgan WM, Emori TG, Munn VP, et al. The efficacy of infection surveillance and control programs in preventing nosocomial infections in US hospitals. Am J Epidemiol 1985;121:182—205.
[15] World Health Organization. Report on the burden of endemic health care-associated infection worldwide. Geneva: WHO; 2011.
[16] Magill SS, Edwards JR, Bamberg W, Beldavs ZG, Dumyati G, Kainer MA, et al. Multistate point-prevalence survey of health care-associated infections. N Engl J Med 2014;370:1198—208.
[17] Zarb P, Coignard B, Griskeviciene J, Muller A, Vankerckhoven V, Weist K, et al. The European Centre for Disease Prevention and Control (ECDC) pilot point prevalence survey of healthcare-associated infections and antimicrobial use. Euro Surveill 2012;17. pii: 20316.
[18] Li C, Wen X, Ren N, Zhou P, Huang X, Gong R, et al. Point-prevalence of healthcare-associated infection in China in 2010: a large multicenter epidemiological survey. Infect Control Hosp Epidemiol 2014;35:1436—7.
[19] Izquierdo-Cubas F, Zambrano A, Frómeta I, Gutiérrez A, Bastanzuri M, Guanche H, et al. National prevalence of nosocomial infections. Cuba 2004. J Hosp Infect 2003;68:234—40.
[20] Thu TA, Hung NV, Quang NN, Archibald LK, Thuy le TT, Harun-Or-Rashid, et al. A point-prevalence study on healthcare-associated infections in Vietnam: public health implications. Infect Control Hosp Epidemiol 2011;32:1039—41.
[21] Petherick ES, Dalton JE, Moore PJ, Cullum N. Methods for identifying surgical wound infection after discharge from hospital: a systematic review. BMC Infect Dis 2006;6:170.
[22] Gomes AE, Cavalcante RD, Pavan EC, Freitas ED, Fortaleza CM. Predictive factors of post-discharge surgical site infections among patients from a teaching hospital. Rev Soc Bras Med Trop 2014;47:235—8.
[23] World Health Organization. WHO guidelines for safe surgery 2009: safe surgery saves lives. Geneva: WHO; 2009.
[24] Pires RN, Monteiro AA, Carneiro LC, Baethgen LF, Tavares R, Lincho CS, et al. Clostridium difficile infection in Brazil: a neglected problem? Am J Infect Control 2014;42:459—60.
[25] Viacava F, Bellido JG. Health, access to services and sources of payment, according to household surveys. Cien Saude Colet 2016;21:351—70.
[26] Padoveze MC, Fortaleza CM, Kiffer C, Barth AL, Carneiro IC, Giamberardino HI, et al. Structure for prevention of health care-associated infections in Brazilian hospitals: a countrywide study. Am J Infect Control 2016;44:74—9.
[27] Padoveze MC, Fortaleza CM. Healthcare-associated infections: challenges to public health in Brazil. Rev Saude Publica 2014;48:995—1001.
[28] Garner JS, Jarvis WR, Emori TG, Horan TC, Hughes JM. CDC definitions for nosocomial infections. Am J Infect Control 1988;1988(16):128—40.