Device-associated infection rates in intensive care units of Brazilian hospitals: findings of the International Nosocomial Infection Control Consortium

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ABSTRACT

Objectives.   *To measure device-associated infection (DAI) rates, microbiological profiles, bacterial resistance, extra length of stay, and attributable mortality in intensive care units (ICUs) in three Brazilian hospitals that are members of the International Nosocomial Infection Control Consortium (INICC).*

Methods.   *Prospective cohort surveillance of DAIs was conducted in five ICUs in three city hospitals in Brazil by applying the definitions of the U.S. Centers for Disease Control and Prevention National Nosocomial Infections Surveillance System (CDC-NNIS).*

Results.   *Between April 2003 and February 2006, 1 031 patients hospitalized in five ICUs for an aggregate 10 293 days acquired 307 DAIs, a rate of 29.8% or 29.8 DAIs per 1 000 ICU-days. The ventilator-associated pneumonia (VAP) rate was 20.9 per 1 000 ventilator-days; the rate for central venous catheter-associated bloodstream infections (CVC-BSI) was 9.1 per 1 000 catheter-days; and the rate for catheter-associated urinary tract infections (CAUTI) was 9.6 per 1 000 catheter-days. Ninety-five percent of all* Staphylococcus aureus *DAIs were caused by methicillin-resistant strains. Infections caused by* Enterobacteriaceae *were resistant to ceftriaxone in 96.7% of cases, resistant to ceftazidime in 79.3% of cases, and resistant to piperacillin-tazobactam in 85.7% of cases.* Pseudomonas aeruginosa *DAIs were resistant to ciprofloxacin in 71.3% of cases, resistant to ceftazidime in 75.5% of cases, and resistant to imipenem in 27.7% of cases. Patients with DAIs in the ICUs of the hospitals included in this study presented extra mortality rates of 15.3% (RR 1.79, P = 0.0149) for VAP, 27.8% (RR 2.44, P = 0.0004) for CVC-BSI, and 10.7% (RR 1.56, P = 0.2875) for CAUTI.*

Conclusion.   *The DAI rates were high in the ICUs of the Brazilian hospitals included in this study. Patient safety can be improved through the implementation of an active infection control program comprising surveillance of DAIs and infection prevention guidelines. These actions should become a priority in every country.*

Key words   Bacterial infection; cross infection/epidemiology; drug resistance, bacterial; hospitals; infection control; infection control practitioners; intensive care units; length of stay; mortality; Brazil.

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Surveillance of healthcare-associated infections (HAI), particularly in the high-risk hospital setting found in intensive care units (ICU), has allowed United States hospitals to improve infection control and health care quality (1). Surveillance has proved effective in preventing HAI, as documented in the U.S. Centers for Disease Control and Prevention (CDC) Study of the Efficacy of Nosocomial Infections Control (SENIC) (2). As a result of this evidence, standards for HAI surveillance and infection control have been developed and adopted in several industrialized countries (3).

There is increasing scientific evidence that HAIs are a major cause of patient morbidity and mortality in the industrialized world (4). Device-associated infections (DAIs), particularly ventilator-associated pneumonia (VAP), central venous catheter-related bloodstream infection (CVC-BSI), and catheter-associated urinary tract infection (CAUTI) pose the greatest threat to ICU patients (5–7).

Surveillance of DAIs has become uniform thanks to the introduction of the CDC's National Nosocomial Infection Surveillance System (NNIS), which provides clear, unambiguous definitions for DAIs (8). Calculating DAI rates per 1 000 device-days and implementing targeted surveillance allows for effective comparative assessment of health care facilities, and provides a comprehensive overview of problems to be solved at specific institutions.

Most studies addressing ICU-acquired infection have been published about health care in industrialized countries (9), but there is a lack of scientific data showing DAI rates in developing countries. Uniform definitions are needed to close this gap and to improve health care standards (10–15).

Brazil is the largest country in Latin America, and has the fifth largest population in the world. Health care facilities are beset with common health problems. These include, but are not limited to, deficiencies in infrastructure and a shortage of well-trained health care workers. Health facilities suffer from the widespread occurrence of multidrug-resistant *Staphylococcus aureus* and gram-negative bacteria.

Beginning in 1983, the Brazilian Ministry of Health has worked to establish a nation-wide program to control healthcare-associated infections (16). In 1994, the Ministry conducted a national study to evaluate how measures implemented for HAI control had affected HAI rates. The study concluded that there was a median incidence of 15.5% for HAI and that 42.5% of hospitals were engaged in appropriate infection control activities. The health sector was highly receptive to the HAI control program and the study reported an increase in the number of infection control committees in health facilities from 7% in 1992 to 43% in 1993 (17, 18).

Largely as a result of these initiatives, data for infection control conditions and HAI rates from Brazil are available (19). A study made in 1992 of a hospital in Belo Horizonte, Brazil, concluded that the global prevalence rate of HAI was 14.0%. It also revealed that pneumonia and surgical-site infections (SSI) were responsible for 19.5% and 19.2% of HAIs, respectively (20). A group of hospitals, also in Belo Horizonte, that applied CDC-NNIS methods from January 1991 to June 1995 reported that the mean rate of HAI was 5.1% or 9.7 HAI per 1 000 patient-days (21).

The objective of this study is to update data detecting DAI rates, microbiological profile, bacterial resistance, extra length of stay, and attributable mortality from a multi-center study carried out in three urban hospitals in Brazil.

METHODS

Setting

The International Nosocomial Infection Control Consortium (INICC) is a nonprofit organization founded in 1998 with the aim to prevent and reduce DAIs in hospitals in developing countries by collecting surveillance data on these infections. Hospitals that are INICC members provide general medical and surgical services to adults and children hospitalized in their intensive care units. INICC applies standardized protocols for data collection (8, 22).

This study was conducted from April 2003 to February 2006 in five ICUs of three INICC member hospitals in São Paulo, Porto Alegre, and Rio de Janeiro, Brazil. Identity of the participating hospitals remains confidential.

The infection control team at each hospital was comprised of a physician, an infection control practitioner-surveillance (ICP) nurse, and support personnel. The person responsible for DAI surveillance in each institution had an average of six years experience in infection control (see Table 1). Every hospital maintained a clinical microbiology laboratory that provided standardized *in vitro* susceptibility testing of clinical isolates. Patients occupied beds in a common ward. The ICU nurse-to-patient ratio was one to three.

The research study protocol was approved by the Institutional Review Board at each health care facility. Patient confidentiality was protected by coding the recorded information, with patient identities known only to the institutional infection control team.

Surveillance

Each month, rates of CVC-BSI, CAUTI, and VAP were recorded, using definitions established by the CDC National Nosocomial Infections Surveillance System (NNIS) (8, 22).

Definitions

The following DAI definitions are adapted from those established by the CDC National Nosocomial Infections Surveillance System (NNIS) as reported in Garner et al. (8).

Ventilator-associated pneumonia (VAP). VAP is indicated in a mechanically ventilated patient with a chest radiograph that shows new or progressive infiltrates, consolidation, cavitation, or pleural effusion. The pa-

TABLE 1. Features of three International Nosocomial Infection Control Consortium member hospitals in Brazil, April 2003 to February 2006

Variable	Hospital A	Hospital B	Hospital C	Total
Hospitals (number)	1	1	1	3
Academic teaching	0	1	0	1
Public	1	0	0	1
Private community	0	0	1	1
Hospital beds (number)	750	480	180	1 410
Experience of infection control practitioners (years)	6	14	9	6–14
Intensive care units (ICUs) (number)	3	1	1	5
ICU type	Medical-surgical	Medical-surgical	Medical-surgical	Medical-surgical
ICU beds (number)	35	14	9	58
Surveillance period	10/03 to 10/04	4/03 to 6/03	6/04 to 2/06	4/03 to 2/06
Patients studied (number)	705	142	184	1 031
Total ICU days	7 942	673	1 678	10 293
Male (%)	55.3	52.8	50.5	54.1
Mean age of patient (years)	53.6	55.7	68.1	56.5
Mean ASIS[a]	3.59	2.57	3.90	3.51
Device utilization (DU)[b]				
Ventilator-days	5 344	424	734	6 502
Ratio of ventilator use	0.67	0.63	0.44	0.63
Central venous catheter-days	7 648	620	1 226	9 494
Ratio of central venous catheter use	0.96	0.92	0.73	0.92
Urinary catheter-days	6 768	619	1 430	8 817
Ratio of urinary catheter use	0.85	0.92	0.85	0.86

[a] ASIS = average severity-of-illness score.

[b] Device utilization (DU): DU ratios were calculated by dividing the total number of device-days by the total number of patient-days. Device-days are the total number of days of exposure to the device (ventilator, central venous catheter, or urinary catheter) by all of the patients in the selected population during the selected time period. Patient-days are the total number of days that patients are in the ICU during the selected time period.

tient must also meet at least one of the following criteria: new onset of purulent sputum or change in character of sputum; organism cultured from blood; or isolation of an etiologic agent from a specimen obtained by tracheal aspirate, bronchial brushing or bronchoalveolar lavage, or biopsy.

Laboratory-confirmed central venous catheter-associated bloodstream infection (CVC-BSI). Central venous catheter-associated bloodstream infection is laboratory-confirmed when a patient with a CVC has a recognized pathogen that is isolated from one or more percutaneous blood cultures after 48 hours of vascular catheterization and is not related to an infection at another site. The patient also has at least one of the following signs or symptoms: fever (temperature ≥ 38 °C), chills, or hypotension. With skin commensals (for example, diphtheroids, *Bacillus* spp., *Propionibacterium* spp., coagulase-negative staphylococci, or micrococci), the organism is cultured from two or more blood cultures.

Clinically suspected central venous catheter-associated bloodstream infection (CVC-BSI). Central venous catheter-associated bloodstream infection is clinically suspected when a patient with a CVC has at least one of the following clinical signs with no other recognized cause: fever (temperature ≥ 38 °C), hypotension (systolic blood pressure ≤ 90 mmHg), or oliguria (≤ 20 mL/h).

Catheter-associated urinary tract infection (CAUTI). For the diagnosis of catheter-associated urinary tract infection, the patient must meet one of two criteria. The first criterion is satisfied when a patient with a urinary catheter has one or more of the following symptoms with no other recognized cause: fever (temperature ≥ 38 °C), urgency, or suprapubic tenderness. The urine culture is positive for 10^5 colony-forming units (CFU) per mL or more, with no more than two microorganisms isolated. The second criterion is satisfied when a patient with a urinary catheter has

at least two of the following criteria with no other recognized cause: positive dipstick analysis for leukocyte esterase or nitrate and pyuria (≥ 10 leukocytes/mL).

Culture techniques

In all cases, standard laboratory methods were used to identify microorganisms, and a standardized susceptibility test was performed (23). The following are culture techniques for VAP, CVC-BSI, and CAUTI.

VAP. In most cases, a deep tracheal aspirate from the endotracheal tube was cultured aerobically and gram-stained.

CVC-BSI. Central venous catheters were removed aseptically and the distal 5 cm of the catheter was amputated and cultured using a standardized, semiquantitative method (24). Concomitant blood cultures were drawn percutaneously in nearly all cases.

CAUTI. A urine sample was aseptically aspirated from the sampling port of the urinary catheter and cultured quantitatively.

Forms, training, adjudication, and data feedback

Surveillance data were prospectively and actively collected using forms that were specially designed to allow adjudication of DAIs. Data forms were based on the new onset of fever, beginning of antibiotic therapy, performance of cultures, and presentation of hypotension 48 hours after admission. At each ICU, a patient had a check-off for every clinical and microbiologic criterion for each type of DAI. This allowed the hospital epidemiologist or other senior infection control officer reviewing completed data forms in the participating hospital to confirm that in each case adequate criteria for infection were met. Additionally, the original patient data form could be further assessed at the INICC headquarters in Buenos Aires before the reported infection was registered in the consortium database (10).

Data on patient demographics, age, gender, severity of illness score, and hospital location were gathered at the beginning of hospitalization. Each day, the infection control practitioner (ICP) prospectively and actively collected data on mechanical ventilation, placement of CVC and urinary catheters, fever, blood pressure, antibiotic use, and the results of cultures on each patient admitted to the ICU. At the end of hospitalization, if the patient had acquired a DAI, the ICP recorded the date of onset, site of infection, infecting microorganisms, and their antimicrobial susceptibilities.

The average severity-of-illness score (ASIS) was recorded by applying the CDC Nosocomial Infections Surveillance System criteria. Points were ascribed to patients as follows: 1 point for postoperative patients requiring routine postoperative observation; 2 points for physiologically stable patients requiring prophylactic overnight observation; 3 points for patients requiring nursing and monitoring; 4 points for physiologically unstable patients requiring intensive nursing and medical care with the need for frequent reassessment and adjustment of therapy; and 5 points for physiologically unstable patients in coma or shock, who require cardiopulmonary resuscitation, or who need intensive medical and nursing care with frequent reassessment (22).

At each member hospital, researchers received training about surveillance procedures from the INICC Chairman (VDR). A support team at INICC headquarters in Buenos Aires answered questions from the investigators in Brazilian facilities within 24 hours; these responses were in turn reviewed by the INICC Chairman (10).

Each month the completed surveillance forms from participating hospital were sent to INICC headquarters in Buenos Aires. To ensure that criteria for DAIs met those established by CDC NNIS, each form was assessed in terms of registered signs (fever, blood pressure), cultures, device use, and consumption of antibiotics (8, 22).

The DAIs reported by the hospitals were adjudicated, i.e., scrutinized to ensure that sufficient criteria had been met to record them as DAIs. This included examination of data for putatively uninfected patients to detect any unreported DAIs. When discrepancies were encountered, the INICC contacted the hospital research teams via electronic mail; the judgement of the principal investigator and ICP of the participating hospital was final. Adjudication is a unique feature of the INICC outcome surveillance component and is considered essential not only to maximize the accuracy of surveillance data, but also to continually assess the capacity of the ICP and principal investigator at each hospital.

Each month, the INICC team prepared individual reports for each participating hospital. These reports contained updated data, presented in charts and tables, showing the hospitals' DAI rates, microbiological profile, bacterial resistance, extra mortality by type of DAI, extra length of stay (LOS), hand hygiene compliance, and CVC and urinary catheter care compliance.

Statistical analysis

Outcomes measured during the surveillance period included the incidence density rate of CVC-BSI, CAUTI, and VAP. The DAI rates per 1 000 device-days were calculated by dividing the total number of DAIs by the total number of specific device-days and multiplying the result by 1 000 (22).

Device utilization (DU) ratios were calculated by dividing the total number of device-days by the total number of patient-days. Device-days are the total number of days of exposure to the device (central line, ventilator, or urinary catheter) by all of the patients in the selected population during the selected time period. Patient-days are the total number of days that patients are in the ICU during the selected time period.

Chi square analyses for dichotomous variables and t-test for continuous variables were used to analyze baseline differences among rates. Relative risk (RR) ratios, 95% confidence intervals (CIs), and *P*-values were determined for all primary and secondary outcomes.

The crude excess mortality was calculated as the difference between the crude mean case-fatality of patients with a device-associated infection and the crude case-fatality of patients hospitalized in the ICU during the same period who did not acquire a device-associated infection. The extra length of stay (LOS) is the difference between the length of stay of patients with a DAI and the length of stay of patients hospitalized in the ICU during the same period who did not acquire a DAI.

EpiInfo® version 6.04b (CDC, Atlanta, Georgia) was used to conduct data analysis.

RESULTS

During the study period (April 2003 to February 2006), surveillance data were collected prospectively on 1 031 patients hospitalized for an aggregate of 10 293 ICU-days in five ICUs in three hospitals in Brazil. The features of each ICU, the number of patients enrolled, ICU-days, and the average

TABLE 2. DAIs[a] per 1 000 device-days in ICUs[a] of three Brazilian International Nosocomial Infection Control Consortium member hospitals, April 2003 to February 2006

Infection	Device type	Device-days	DAIs (n)	Distribution of DAIs (%)	Rate per 100 patients (%)	Rate per 1 000 device-days (%)[b]
VAP[a]	MV[a]	6 502	254	44.3	13.2	20.9
CVC-BSI[a]	CVC[a]	9 494	26	28.0	8.3	9.1
CAUTI[a]	UC[a]	8 817	27	27.7	8.2	9.6

[a] DAI: Device-associated infection; ICU: intensive care unit; VAP: ventilator-associated pneumonia, CVC-BSI: central vascular catheter-associated blood stream infection; CAUTI: catheter-associated urinary tract infection; MV: mechanical ventilator; UC: urinary catheter.
[b] Rate per 1 000 device-days: Rates were calculated by dividing the total number of DAIs by the total number of specific device-days by all of the patients in the selected population during the selected time period and multiplying the result by 1 000.

severity-of-illness score (ASIS) are shown in Table 1 (24). Mean patient ASIS was 3.51.

Patients acquired 307 DAIs for a mean rate of 29.8% or 29.8 infections per 1 000 ICU-days. CVC-associated BSI represented 28.0%, VAP represented 44.3%, and CAUTI represented 27.7% of all DAIs (Table 2).

TABLE 3. Microbiological profile of DAIs[a] in the ICUs[a] of three International Nosocomial Infection Control Consortium member hospitals in Brazil, April 2003 to February 2006

Pathogen	Proportion of cases (%)
Enterobacteriaceae	22.8
Pseudomonas spp.	22.6
Candida spp.	15.9
Acinetobacter spp.	14.6
Staphylococcus aureus	11.3
Coagulase-negative staphylococci	8.4
Enterococcus spp.	2.5
Stenotrophomonas spp.	0.8
Streptococcus spp.	0.8

[a] DAI: Device-associated infection; ICU: intensive care unit.

Device utilization ratio

Device utilization ratio presented a wide range: mechanical ventilation utilization ratio ranged from 0.44 to 0.67 (mean, 0.63); CVC utilization ratio ranged from 0.73 to 0.96 (mean, 0.92); and urinary catheter utilization ratio ranged from 0.85 to 0.92 (mean, 0.86) (Table 1). Distribution by type of device-associated infection and device utilization are shown in Table 2.

VAP

The rates of VAP ranged from 16.3 to 21.9 per 1 000 ventilator-days, with a mean rate in the five ICUs of 20.9 per 1 000 ventilator-days (Table 2). Crude mortality of patients with VAP was 34.5%, with an extra mortality of 15.3%, (RR 1.79, 95% CI 1.11–2.89, P = 0.0149). The LOS of patients without DAI was 5.8 days, and the LOS of patients with VAP was 16.8 days, yielding an extra length of stay of 11.0 days (RR 2.91, 95% CI 2.72–3.13, P < 0.001).

CVC-associated BSI

The rates of BSI varied widely, from 8.1 to 25.8 per 1 000 catheter-days, with a mean rate of 9.1 per 1 000 catheter-days (Table 2). The crude mortality of patients with BSI was 47.1%, with an extra mortality of 27.8% (RR 2.44, 95% CI 1.46–4.09, P = 0.0004). The LOS of patients with CVC-BSI was 13.0 days, yielding an extra length of stay of 7.3 days (RR 2.26, 95% CI 2.05–2.49, P < 0.001).

CAUTI

The rates of CAUTI ranged from 4.8 to 11.1 per 1 000 catheter-days, with a mean rate of 9.6 per 1 000 catheter-days (Table 2). Crude mortality of patients with CAUTI was 30.0%, with extra mortality of 10.7% (RR 1.56, 95% CI 0.69–3.52, P = 0.2875). The LOS of patients with CAUTI was 14.1 days, yielding an extra length of stay of 8.3 days (RR 2.44, 95% CI 2.17–2.76, P < 0.001).

Bacterial profile and resistance

The most common agents that caused DAIs were Enterobacteriaceae (22.8%), *Pseudomonas* spp (22.6%), *Candida* spp. (15.9%), and *Acinetobacter* spp. (14.6%). *Staphylococcus aureus* (11.3%) and coagulase-negative staphylococci (8.4%) were also significant (see Table 3). The drug resistance of these pathogens to antibiotics is illustrated in Table 4.

DISCUSSION

Healthcare-associated infections (HAIs) continue to be a major cause of patient morbidity and attributable mortality (4). In addition, health care costs are significantly increased by HAIs (4, 25–27). It should be noted that the incidence of HAIs can be reduced by as much as 30%, which would result in a substantial decline in health care costs. This is supported by studies conducted in U.S. hospitals where integrated infection control programs, including targeted surveillance of

TABLE 4. Resistance of pathogens in the ICUs[a] of three International Nosocomial Infection Control Consortium member hospitals in Brazil, April 2003 to February 2006

Bacteria	Antibiotic used	Percentage resistance
Enterobacteriaceae	Ceftriaxone	96.7
Enterobacteriaceae	Ceftazidime	79.3
Enterobacteriaceae	Piperacillin-tazobactam	85.7
Enterococci	Vancomycin	0.0
Pseudomonas aeruginosa	Ciprofloxacin	71.3
Pseudomonas aeruginosa	Ceftazidime	75.5
Pseudomonas aeruginosa	Imipenem	27.7
Pseudomonas aeruginosa	Piperacillin-tazobactam	100
Staphylococcus aureus	Methicillin	95.7

[a] ICU: Intensive care unit.

device-associated infections, have been implemented (2).

In INICC member hospitals, surveillance is conducted by the use of forms specially designed to gather patient data, including patients with and without DAIs. These forms provide the ICPs with prompts at every stage of treatment, and enable them to detect the occurrence of DAIs. The data contained in the forms include patient's temperature, blood pressure, exposure to invasive devices, cultures done, and antibiotic use, providing for an uninterrupted and comprehensive picture of the patient's condition in the ICU. The forms make it possible to compare patients in terms of age, gender, underlying diseases, service (medical or surgical), severity-of-illness score, time of year, and exposure to invasive devices. INICC uses this information to calculate the added length of stay (LOS) and resulting hospitalization costs and attributable mortality (10, 12–15, 26–29).

The INICC's initial efforts have focused on surveillance in ICUs because of the extensive use of invasive devices where patients are exposed to higher rates of DAIs (3). External adjudication applied by the INICC results in increased accuracy regarding infections reported. In most cases, DAIs in ICUs as defined by the CDC-NNIS System and the INICC databases are based on positive cultures. Therefore, it is reasonable to assume that the difference between the surveillance methodology implemented by the CDC-NNIS and the INICC in their ability to detect the majority of DAIs is not significant.

Hand hygiene resources and compliance showed significant variation in INICC member hospitals and ICUs, ranging from 20% to 70% (30). The mean rate of hand hygiene compliance in a recent study carried out in the participating ICUs of all INICC member hospitals was 50% (30). This was similar to results of recent research studies conducted in the United States and Europe (31). Significant variation was also found in the use of sterile dressings on CVC insertion sites in Peruvian INICC member hospitals. Among the major obstacles to be overcome at

hospitals with limited resources are: poor hand hygiene compliance, the ineffective isolation of patients, protracted use of invasive devices, and the incorrect positioning of the urine collection bag (32).

We compared DAI rates in this study of five ICUs in INICC member hospitals in Brazil with pooled rates for DAIs in the ICUs of U.S. hospitals included in the CDC's National Healthcare Safety Network (CDC-NHSN) survey results for 2005–2006 (1). In the five ICUs in INICC member hospitals in Brazil, the mean rate for CVC-BSI was 9.1 per 1 000 catheter-days compared with a rate of 2.4 per 1 000 CVC-days reported in the CDC-NHSN study; the mean rate for VAP was 20.9 per 1 000 ventilator-days in the Brazilian study compared with a rate of 3.6 per 1 000 ventilator-days reported in the CDC-NHSN study; the rate for CAUTI was 9.6 per 1 000 catheter days in the Brazilian study compared with the CDC-NHSN rate of 3.4 per 1 000 catheter-days (1).

In the Brazilian INICC ICUs, crude mortality from VAP was 34.5%, with an extra mortality of patients with VAP of 15.3%, significantly higher than patients without DAI. The crude mortality of patients with BSI was 47.1%, with extra mortality of 27.8%, also significantly higher than patients without DAI. However, the extra mortality of patients with CAUTI was 10.7%, which shows no significant difference when comparing patients without DAI. These results are similar to the findings of Clec'h et al. who conducted a study from 1995 to 2007 and analyzed data of 298 patients with CAUTI. After matching patients with and without CAUTI, it was determined that CAUTI was not associated with increased mortality (33).

There was a high rate of resistance to most antibiotics commonly used in ICUs (Table 4). This may be the result of inadequate infection control programs as well as clonal spread of resistance among patients. Control of antibiotic resistance requires more restrictive use of anti-infective agents, isolation of patients, and more effective DAI control (34). Additionally,

control of antibiotic resistance might involve active surveillance of admitted patients, as some DAIs are community-acquired infections which colonize in patients and become institutionalized (34).

Some of the factors affecting high DAI rates in Brazilian ICUs included in this study have been addressed in other studies conducted in developing countries (20, 21). First, it should be taken into account that most developing countries lack the legal framework or standards governing the implementation of infection control programs. In the few cases where infection control standards are in force, compliance is lacking. Additionally, hospital accreditation and national infection control surveillance are not compulsory. Second, hand hygiene compliance in most health care facilities presents highly variable rates (30, 35, 36). Third, the great majority of hospitals in developing countries receive limited financial or administrative support, resulting in a scarcity of necessary funds to deal with infection control (37). Fourth, the low nurse-to-patient staffing ratio in hospitals in developing countries compared with hospitals in industrialized countries is one of the factors contributing to the high DAI rates in ICUs (38). This situation is exacerbated by the fact that wards are over-crowded, nurses lack experience, there is a shortage of trained personnel, and supplies are lacking.

DAI surveillance is the first measure to be taken to reduce the threat of DAIs in hospitalized patients (2). Next, basic infection control should be practiced for effective prevention of DAIs (39, 40). There is evidence that significant improvement occurs in health facilities where efforts are made to impart awareness and knowledge about the problem of DAIs in their ICUs. Feedback programs for hand hygiene compliance show substantially lowered rates in healthcare-associated infections. In several of the INICC member hospitals there is evidence that attention to the use of CVC and urinary catheters has brought about significant declines in the incidence of DAIs (28, 35, 36, 41-44).

Limitations

This study has several limitations. First, the data collected during the three-year study are not generally representative of all of Brazil's health care facilities. They do represent, however, comprehensive surveillance of five ICUs in three hospitals in three cities, so the study's findings are useful for the design of infection control strategies. Second, APACHE severity-of-illness scores were not used because there were not enough resources for the labor-intensive calculation of this score. Finally, similar to other cohort studies, hospitals initiated clinical surveillance at different periods and surveillance was suspended at certain times, resulting in the lack of simultaneously collected data from all hospitals enrolled in this study.

Conclusion

Healthcare-associated infections pose a huge and under-recognized threat to patient safety in developing countries. It is hoped that interventions such as the surveillance of DAIs described in this study, together with simple and inexpensive infection prevention measures already being implemented, will lead to broad acceptance of infection control programs in all INICC member hospitals. This would significantly reduce all types of DAIs, particularly those acquired in ICUs.

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RESUMEN

Tasa de infecciones asociadas a aparatos en unidades de cuidados intensivos de hospitales brasileños: datos de la Comunidad Científica Internacional de Control de Infecciones Nosocomiales

Objetivos. Determinar las tasas de infección asociadas a aparatos (IAA), los perfiles microbiológicos, la resistencia bacteriana, la estancia hospitalaria adicional y la mortalidad atribuible en las unidades de cuidados intensivos (UCI) de tres hospitales brasileños miembros de la Comunidad Científica Internacional de Control de Infecciones Nosocomiales (INICC).

Métodos. Se realizó una vigilancia prospectiva de cohorte de las IAA en cinco UCI de tres hospitales urbanos de Brasil, según las definiciones del Sistema Nacional de Vigilancia de Infecciones Nosocomiales de los Centros para el Control y la Prevención de Enfermedades (CDC-NNIS) de los Estados Unidos de América.

Resultados. Entre abril de 2003 y febrero de 2006 se hospitalizaron 1 031 pacientes en las cinco UCI estudiadas, con un total de 10 293 días en los que se adquirieron 307 IAA, para una tasa de 29,8% (29,8 IAA por 1 000 días-UCI). Las tasas fueron: de 20,9 casos por 1 000 días-ventilador en neumonía asociada a respiradores (NAR); de 9,1 por 1 000 días-catéter en infecciones circulatorias asociadas con cateterismo venoso central (IC-CVC); y de 9,6 por 1 000 días-catéter en infecciones urinarias asociadas con el uso de catéteres (IUAC). De las IAA causadas por *Staphylococcus aureus*, 95% se debieron a cepas resistentes a la meticilina. De las infecciones causadas por Enterobacteriaceae, 96,7% fueron resistentes a la ceftriaxona, 79,3% a la ceftazidima y 85,7% a la combinación piperacilina-tazobactam. De las IAA causadas por *Pseudomonas aeruginosa*, 71,3% resultaron resistentes a la ciprofloxacina, 75,5% a la ceftazidima y 27,7% al imipenem. Los pacientes con IAA en las UCI estudiadas presentaron tasas de mortalidad adicional de 15,3% (riesgo relativo [RR] = 1,79; $P = 0,0149$) por NAR, 27,8% (RR = 2,44; $P = 0,0004$) por IC-CVC y 10,7% (RR = 1,56; $P = 0,2875$) por IUAC.

Conclusiones. Las tasas de IAA en las UCI de los hospitales brasileños estudiados fueron elevadas. Se puede mejorar la seguridad de los pacientes mediante la implementación de un programa de control activo de las infecciones, que contemple la vigilancia de las IAA y directivas para la prevención de las infecciones. Estas acciones deben ser una prioridad en todos los países.

Palabras clave Infecciones bacterianas, infección hospitalaria/epidemiología, farmacorresistencia bacteriana, hospitales, control de infecciones, profesionales para control de infecciones, unidades de terapia intensiva, tiempo de internación, mortalidad, Brasil.