DEVICE-ASSOCIATED NOSOCOMIAL INFECTION RATES IN INTENSIVE CARE UNITS OF ARGENTINA

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ABSTRACT

BACKGROUND: Nosocomial infections are an important public health problem in many developing countries, particularly in the intensive care unit (ICU) setting. No previous data are available on the incidence of device-associated nosocomial infections in different types of ICUs in Argentina.

METHODS: We performed a prospective nosocomial infection surveillance study during the first year of an infection control program in six Argentinean ICUs. Nosocomial infections were identified using the Centers for Disease Control and Prevention National Nosocomial Infections Surveillance System definitions, and site-specific nosocomial infection rates were calculated.

RESULTS: The rate of catheter-associated bloodstream infections in medical–surgical ICUs was 30.3 per 1,000 device-days; it was 14.2 per 1,000 device-days in coronary care units (CCUs). The rate of ventilator-associated pneumonia in medical–surgical ICUs was 46.3 per 1,000 device-days; it was 45.5 per 1,000 device-days in CCUs. The rate of symptomatic catheter-associated urinary tract infections in medical–surgical ICUs was 18.5 per 1,000 device-days; it was 12.1 per 1,000 device-days in CCUs.

CONCLUSION: The high rate of nosocomial infections in Argentinean ICUs found during our surveillance suggests that ongoing targeted surveillance and implementation of proven infection control strategies is needed in developing countries such as Argentina (*Infect Control Hosp Epidemiol* 2004;25:251-255).

Standards for routine surveillance of nosocomial infections have been a fixture in U.S. hospitals since the role of surveillance in reducing rates of infection among hospitalized patients was demonstrated in the Study on the Efficacy of Nosocomial Infection Control (SENIC) project.[1] Similar standards for infection control surveillance have been adopted in other developed countries.[2] Unfortunately, the implementation of nosocomial infection surveillance programs has not gained widespread acceptance in many developing countries, despite a growing body of literature suggesting that nosocomial infections are an increasingly important cause of patient morbidity and mortality in these countries.[3-10]

Surveillance data regarding nosocomial infections in hospitals in developing countries are limited. This is especially true in Argentina, where there is no national program for monitoring hospital-acquired infections. As a result, we undertook a 1-year prospective surveillance study of selected nosocomial infections in six intensive care units (ICUs) in three Buenos Aires hospitals of different sizes.

METHODS

Setting

Location. This study was conducted in three hospitals in Buenos Aires, Argentina. Each hospital had recently started to work with an infection control team composed of a physician (with formal education and background in internal medicine, infectious diseases, and hospital epidemiology), an infection control nurse, and support personnel. Each team had informatics and daily microbiologic support available within the institution.

Center Descriptions (Table 1). Hospital A is a public 250-bed hospital situated in the province of Buenos Aires with one medical–surgical ICU (10 beds) and one coronary care unit (CCU) (10 beds). Nosocomial infection surveillance was performed from July 1998 to June 1999. Hospital B is a private 150-bed hospital situated in the province of Buenos Aires with one medical–surgical ICU (17 beds) and one CCU (15 beds). Nosocomial infection surveillance was performed from April 1999 to March 2000. Hospital C is a private 180-bed hospital situated in the city of Buenos Aires with 1 medical–surgical ICU (10 beds) and 1 CCU (10 beds). Nosocomial infection surveillance was performed from September 2000 to August 2001. All ICUs in the observed centers operate at a tertiary-care level of complexity, caring for patients who have undergone heart, neurosurgical, and orthopedic surgery as well as patients with severe medical illness.

Human Resources. Eighty percent to 90% of the nursing employees are nurse assistants in our hospitals.

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TABLE 1
FEATURES OF THE HOSPITALS

Hospital	No. of Hospital Beds	Hospital Facilities	Type of ICU	No. of ICU Beds	No. of Patients	Patient-Days	ASIS
A	250	Public	MS-ICU	10	318	2,801	3.13 (SD, 1.10)
			CCU	10	285	1,991	2.26 (SD, 0.61)
B	150	Private	MS-ICU	17	556	2,659	2.43 (SD, 1.12)
			CCU	15	773	3,613	2.48 (SD, 0.48)
C	180	Private	MS-ICU	10	626	3,901	2.89 (SD, 1.00)
			CCU	10	761	2,687	2.32 (SD, 1.05)
Total	580			72	3,319	17,652	

ICU = intensive care unit; ASIS = average severity of illness score; MS-ICU = medical–surgical intensive care unit; CCU = coronary care unit; SD = standard deviation.

The nurse-to-patient ratio varies from 1:4 to 1:6 even when a patient is receiving mechanical ventilation. The degree of administrative support was assessed by (1) participation in infection control committee meetings; (2) willingness to meet with infection control representatives; (3) willingness to finance improvements in the existing environment, such as installation of additional sinks; (4) evaluation and approval of submitted infection control policies in a timely manner; and (5) active participation in the performance feedback process. With the use of these criteria, administrative support in hospital A was judged to be low (0 of 5 criteria met), whereas support in hospitals B and C was judged to be good (4 to 5 of 5 criteria met).

Materials. Antiseptic soap and disposable paper towels were intermittently available during the first 2 months of surveillance at all study centers. Study centers used tape and gauze for vascular catheter securement rather than transparent sterile adhesive dressings. Open rather than closed infusion systems were used for delivery of fluids and medications for all patients admitted to the study centers during the surveillance period. Open intravenous infusion systems are administered in a rigid glass or semi-rigid plastic fluid container, which must be externally vented to ambient air to allow complete fluid egress. This is in contrast to closed intravenous infusion systems used in most developed countries, which rely on the use of collapsible plastic bags that do not require external venting for complete drainage. Product sterility was not enforced by a pharmacist at any of the study centers and testing to evaluate the sterilization process was infrequent.

Infection Control Compliance. At the beginning of the surveillance study, compliance with handwashing was found to be only 16.5%,[11] whereas compliance with various aspects of vascular catheter site care ranged from 49% to 57%.[10]

Surveillance

An infection control program was implemented in each center during the first 12 months of surveillance. Rates of catheter-associated bloodstream infection, symptomatic catheter-associated urinary tract infection, and ventilator-associated pneumonia were obtained by an infection control nurse using standard Centers for Disease Control and Prevention (CDC) National Nosocomial Infections Surveillance (NNIS) System definitions.[12,13] The NNIS System criteria for defining nosocomial pneumonia were modified in January 2002; however, our study was completed before the release of these criteria and thus rates of ventilator-associated pneumonia in our study units were calculated using the older NNIS System criteria.[11] Data on surgical-site infections were excluded from this analysis. Surveillance data were collected prospectively in all three centers.

Date of onset of infection, site of infection, patient demographics, ventilator use, central venous catheter use, and urinary catheter use were collected by an infection control nurse for all patients admitted to each unit. The average severity of illness score was defined according to CDC criteria.[13] To calculate the average severity of illness score, points are ascribed to patients once a week on the basis of the classification scheme. One point is ascribed to postoperative patients requiring routine postoperative observation, 2 points to physiologically stable patients requiring prophylactic overnight observation, 3 points for 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 who are in a coma or shock or who require cardiopulmonary resuscitation or intensive medical and nursing care with the need for frequent reassessment. The average severity of illness score for each ICU was calculated by dividing the total number of points ascribed to patients by the total number of patients present on the unit on the days that the average severity of illness score was collected.

Epi-Info software (version 6.04b; CDC, Atlanta, GA) was used for data analysis. Device utilization rates were calculated by dividing the total number of devices used by the total number of patient-days. Rates of ventilator-asso-

TABLE 2
DEVICE USE

Device	Type of ICU*	No. of Device-Days	No. of Patient-Days	Device Utilization Rate
Mechanical	MS-ICU	2,917	9,361	0.31
ventilator	CCU	593	8,291	0.07
Central venous	MS-ICU	4,452	9,361	0.47
catheter	CCU	1,618	8,291	0.19
Urinary catheter	MS-ICU	6,549	9,361	0.69
	CCU	2,302	8,291	0.27

ICU = intensive care unit; MS-ICU: medical–surgical intensive care unit; CCU = coronary care unit.
*Data for each type of device were pooled from both types of ICUs in hospitals A, B, and C.

TABLE 3
DISTRIBUTION OF DEVICE-ASSOCIATED INFECTIONS

Infection	No.	%
Ventilator-associated pneumonia	162	34.5
Catheter-associated bloodstream infection	158	33.7
Catheter-associated urinary tract infection	149	31.8
Total	469	100

ciated pneumonia, catheter-associated bloodstream infection, and symptomatic catheter-associated urinary tract infection were calculated by dividing the total number of device-associated infections by the total number of device-days and then multiplying the result by 1,000.[13]

Definitions

Ventilator-Associated Pneumonia. Criterion 1 for ventilator-associated pneumonia was that a patient receiving mechanical ventilation had rales or dullness to percussion on physical examination of the chest and at least one of the following: 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 transtracheal aspirate, bronchial brushing, or biopsy.[12] Criterion 2 was that a patient receiving mechanical ventilation had a new or progressive infiltrate, consolidation, cavitation, or pleural effusion on chest radiograph and at least one of the following: new onset of purulent sputum or change in character of sputum; organism cultured from blood; isolation of an etiologic agent from a specimen obtained by transtracheal aspirate, bronchial brushing, or biopsy; isolation of virus from or detection of viral antigen in respiratory secretions; diagnostic single antibody titer (IgM) or fourfold increase in paired sera (IgG) for pathogen; or histopathologic evidence of pneumonia.[12]

Laboratory-Confirmed Catheter-Associated Bloodstream Infection. This was defined as a patient with a central venous catheter who had a recognized pathogen cultured from one or more percutaneous blood samples, after 48 hours of vascular catheterization, that was not related to an infection at another site and at least one of the following signs or symptoms: fever (≥ 38°C); chills; or hypotension. With common skin commensals (eg, diphtheroids, *Bacillus* species, *Propionibacterium* species, coagulase-negative staphylococci, or micrococci), the organism is cultured from two or more blood samples drawn on separate occasions.[12]

Clinically Suspected Catheter-Associated Bloodstream Infection. This was defined as a patient with a central venous catheter who had at least one of the following clinical signs with no other recognized cause: fever (≥ 38°C); hypotension (systolic blood pressure < 90 mm Hg); or oliguria (< 20 mL/h). However, blood cultures were not performed or no organisms were recovered from blood cultures. There was no apparent infection at another site and the physician instituted treatment.[12]

Symptomatic Catheter-Associated Urinary Tract Infection. Criterion 1 for symptomatic catheter-associated urinary tract infection was that a patient with a Foley urinary catheter had one or more of the following with no other recognized cause: fever (≥ 38°C); urgency; frequency; or suprapubic tenderness. A urine culture was positive for 10^5 or more colony-forming units per milliliter with no more than two microorganisms.[12] Criterion 2 was that a patient with a Foley urinary catheter had at least two of the following signs of infection with no other recognized cause: positive dipstick for leukocyte esterase, nitrate, or both; pyuria (≥ 10 white blood cells per milliliter); organisms are seen on Gram stain; physician diagnoses a urinary tract infection; or physician initiates appropriate therapy for a urinary tract infection.[12]

Culture Techniques

Decisions to remove catheters and obtain samples for cultures were made independently by each patient's attending physician. Central venous catheters were removed aseptically and the last 5 cm of the catheter tip was cultured using a semiquantitative method.[14] Specimens not immediately cultured were refrigerated at 4°C. All cultures were inoculated within 8 hours of catheter removal. Standard laboratory methods were used to identify microorganisms colonizing the tips of central venous catheters.[15,16]

RESULTS

The characteristics of the individual ICUs and the average severity of illness score[13] of patients residing in each unit are detailed in Table 1. A total of 17,652 device-days were observed among 3,319 patients in the 6 study units during the 12 months of surveillance (Table 1). The number of device-days for individual devices is highlighted in Table 2 according to type of unit.

A total of 469 device-associated infections occurred

TABLE 4
POOLED INCIDENCE DENSITIES FOR SPECIFIC DEVICE-ASSOCIATED INFECTIONS

Infection	Type of ICU	No. of Device-Days	No. of Nosocomial Infections	Rate Per 1,000 Device-Days
Ventilator-associated pneumonia	MS-ICU	2,917	135	46.28
	CCU	593	27	45.53
Central venous catheter–associated bloodstream infection	MS-ICU	4,452	135	30.32
	CCU	1,618	23	14.21
Catheter-associated urinary tract infection	MS-ICU	6,549	121	18.47
	CCU	2,302	28	12.14

ICU = intensive care unit; MS-ICU = medical–surgical intensive care unit; CCU = coronary care unit.

during the surveillance period. The devices resulted in equivalent numbers of infections (Table 3), but the risk of infection posed by each varied considerably when expressed per 1,000 device-days (Table 4). Although the two types of units were equivalent for risk of ventilator-associated pneumonia, the risk of catheter-associated bloodstream infection and catheter-associated urinary tract infection was higher in the medical–surgical ICUs as compared with the CCUs.

When the two types of units were combined, the rate of ventilator-associated pneumonia was 46.1 infections per 1,000 device-days, whereas it was 46.3 and 45.5 infections per 1,000 device-days in medical–surgical ICUs and CCUs, respectively. When the two types of units were combined, the rate of catheter-associated bloodstream infection was 26.0 infections per 1,000 device-days. The risk of infection was significantly higher in the medical–surgical ICUs compared with the CCUs (30.3 vs 14.2 infections per 1,000 device-days; risk ratio [RR], 2.1; 95% confidence interval [CI_{95}], 1.4 to 3.3; $P \leqslant .001$). When the two types of units were combined, the rate of catheter-associated urinary tract infection was 16.8 infections per 1,000 device-days. The risk of catheter-associated urinary tract infection appeared to be greater in the medical–surgical ICUs, although this did not reach statistical significance (18.5 vs 12.1 infections per 1,000 device-days; RR, 1.5; CI_{95}, 1.0 to 2.3; $P = .053$).

DISCUSSION

Nosocomial infections have been associated with increased patient morbidity and mortality[17-20] as well as significant incremental healthcare costs in many different countries[21,22]; similar associations have been demonstrated in Argentina.[9] Studies performed in the United States have demonstrated that an integrated infection control program that includes intensive surveillance can reduce the incidence of nosocomial infections by as much as 30%,[1] which can result in significant reductions in healthcare costs. Unfortunately, the up-front cost of implementing such programs has limited their development in resource-poor countries such as Argentina.

As a result of these limited resources, we chose to focus our surveillance on ICUs. Although the device utilization in our hospital ICUs was similar to the pooled mean reported for medical–surgical ICUs and CCUs by the NNIS System, we found that rates of selected nosocomial infections were considerably higher (often twofold to eightfold) than those reported by ICUs participating in the NNIS System.[23] We employed older NNIS System criteria when calculating rates of ventilator-associated pneumonia. These criteria may be less specific than those currently employed by NNIS System hospitals. However, our rates of ventilator-associated pneumonia were still much higher than those of U.S. hospitals prior to the use of the new criteria.

Several differences between U.S. and Argentinean hospitals help explain the marked disparity in rates of nosocomial infection. First, Argentina does not accredit hospitals or even require that hospitals have an infection control program. This lack of governmental oversight has resulted in an absence of infection control programs in most Argentinean hospitals. As a result, many nosocomial infections occur in healthcare facilities that lack practitioners familiar with published infection control guidelines. Second, many healthcare providers in Argentina are unaware of infection control procedures such as strict asepsis during central venous catheter insertion, head elevation for patients receiving mechanical ventilation, and maintenance of a closed drainage circuit in patients with a Foley catheter. Third, the general lack of knowledge regarding institutional rates of infection reduces the impetus for changing current hospital practices or compliance with basic practices of asepsis such as handwashing. Fourth, the nurse-to-patient ratio at our hospitals is considerably lower than that seen in most U.S. ICUs. Studies of catheter-associated bloodstream infection have consistently demonstrated a higher risk of infection with lower nurse-to-patient ratios and with nursing inexperience.[24,25] Finally, the use of outdated technology likely has a significant impact on the risk of infection in our patient population. For example, closed infusion systems have been a standard of care in the United States for nearly three decades; however, open infusion systems are used for the delivery of fluids to most patients in developing countries, a practice that is associated with a significant risk of infusate-related bloodstream infection.[26-28]

Surveillance of nosocomial infections is a necessary but insufficient step toward reducing the risk of infection among patients treated in Argentinean hospitals. It is hoped that knowledge of the magnitude of the problem will provide hospitals with the impetus for instituting change. There are signs that this may already be happening. For example, we have been able to demonstrate that the institution of performance feedback programs for handwashing[11] and central venous catheter care[10] can significantly reduce the risk of catheter-associated bloodstream infection. It is our hope that these successes, combined with other studies demonstrating the cost-effectiveness of preventing nosocomial infections,[29] will lead to broad acceptance of infection control practices among all Argentinean hospitals.

Nosocomial infections are common in Argentinean ICUs, with rates far higher than those seen in industrialized countries. Expanding surveillance among Argentinean hospitals and developing integrated infection control programs is necessary if a reduction in these rates is to be seen.

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