Device-associated nosocomial infection rates in intensive care units in four Mexican public hospitals

Ector Jaime Ramirez Barba,[a] Victor Daniel Rosenthal,[b] Francisco Higuera,[c] Martha Sobreyra Oropeza,[d] Hector Torres Hernández,[e] Martha Sánchez López,[f] Elia Lara Lona,[a] Pablo Duarte,[b] Javier Ruiz,[b] Raul Rojas Hernandez,[a] Amalia Chavez,[e] Irma Perez Cerrato,[f] Gloria Elena Ramirez Ramirez,[a] and Nasia Safdar[g]

México City and Guanajuato, Mexico; Buenos Aires, Argentina; and Madison, Wisconsin

Background: Routine surveillance of nosocomial infections has become an integral part of infection control and quality assurance in US hospitals.

Methods: As part of the International Nosocomial Infection Control Consortium, we performed a prospective nosocomial infection surveillance cohort study in 5 adult intensive care units of 4 Mexican public hospitals using the Centers for Disease Control and Prevention National Nosocomial Infections Surveillance system definitions. Site-specific nosocomial infection rates were calculated.

Results: The overall nosocomial infection rate was 24.4% (257/1055) and 39.0 (257/6590) per 1000 patient days. The most common infection was catheter-associated bloodstream infection, 57.98% (149/257), followed by ventilator-associated pneumonia, 20.23% (52/257), and catheter-associated urinary tract infection, 21.79% (56/257). The overall rate of catheter-associated bloodstream infections was 23.1 per 1000 device-days (149/6450); ventilator-associated pneumonia rate was 21.8 per 1000 device-days (52/2390); and catheter-associated urinary tract infection rate was 13.4 per 1000 device-days (56/4184).

Conclusion: Our rates are similar to other hospitals of Latin America and higher than US hospitals. (Am J Infect Control 2006;34: 244-7.)

Routine surveillance of nosocomial infections (NI) has become an integral part of infection control and quality assurance in US hospitals because its potential of reducing nosocomial infections has become evident in the Study on the Efficacy of Nosocomial Infection Control (SENIC).[1]

There is a growing body of literature suggesting that nosocomial infections are an increasingly important cause of patient morbidity and mortality in developing countries.[2,3] Surveillance for device-associated nosocomial infection has been well standardized by the Nosocomial Infection Surveillance System (NNIS) because there are well-accepted definitions for device-associated nosocomial infections.[4] Using device-utilization frequencies as the denominator allows comparing data with others from an infection control point of view. Although a national nosocomial infection surveillance system called *RHOVE* (Hospital Network for Epidemiological Surveillance) has been present in Mexico since 1997, it does not provide information on rates of device-associated infection.[5] We undertook a prospective surveillance study to determine device-associated nosocomial infection rates in 5 intensive care units (ICUs) in 4 Mexican public hospitals.

METHODS

Setting

An international project, the International Nosocomial Infection Control Consortium (INICC) led by one of the authors of this study (V.D.R.), has focused on determining the incidence of nosocomial infections at volunteer hospitals worldwide following NNIS methodology and definitions[4] and implementing cost-effective interventions to reduce associated morbidity, mortality, attributable length of stay, extra bacterial resistance, and antibiotic use. We have previously reported device-associated infection rates from Argentina, Brazil, Colombia, Mexico, Peru, India, Morocco, Italy, and Turkey.[3,6-11]

This portion of the INICC project was conducted in 5 ICUs of 4 public hospitals in Mexico. Each hospital had an infection control team composed of a medical

doctor and an infection control nurse and personnel support. The health care workers (HCWs) in charge of the nosocomial infection surveillance were the same as those collecting data for the national Mexican surveillance system (RHOVE), in place since 1997. Each team had access to patient electronic records and microbiologic support available within the hospital. The institutional review board at each center approved the study protocol. Patient confidentiality was protected by coding the recorded information and was only identifiable by the infection control team.

Center descriptions

Hospital A has 1151 beds, B has 480, C has 193, and D has 172. Participant ICUs were as follows: adult medical/surgical ICU (10 beds) and adult neurosurgical ICU (10 beds) at hospital A; adult medical/surgical ICU (6 beds) at hospital B; adult medical/surgical ICU (10 beds) at hospital C; and adult medical/surgical ICU (10 beds) at hospital D. All of them are public hospitals; A and B are situated in Mexico City; C in Irapuato City; and D in Celaya City. At hospital A, the HCWs in charge of collecting the data were intensive care physicians; at hospitals B, C, and D, the HCWs in charge of nosocomial infection surveillance were infection control nurses with at least 4 years of experience. The physician who validated the nosocomial infection diagnosis at hospital A was an infectious diseases specialist; at B, a physician with expertise in epidemiology; at C and D, a physician with specialization in public health. Nosocomial infection surveillance was performed from June 2002 to May 2003 at hospital A; from October 2003 to December 2004 at B; from November 2003 to November 2004 at C; and from November 2003 to July 2004 at D. All ICUs are tertiary care level III, caring for postsurgical and patients with severe medical illness.

Infection control practices at the study sites

The nurse-to-patient ratio varied from 1:3 to 1:5. The human resources for the intervention were those of the infection control program. Handwashing resources were limited. Sinks were not available in all ICUs. Antiseptic soap (10% povidone-iodine) and disposable paper towels were intermittently available at all study centers. Cloth, reusable towels were frequently used instead of disposable paper towels. Alcohol handrubs were not used. Regarding catheter care, the study centers utilized tape and gauze for vascular catheter care rather than transparent sterile adhesive dressings or sterile gauze. Open rather than closed infusion systems were used for delivery of fluids and medications on all patients admitted to the study centers during the surveillance period.

Table 1. Patients' features

Hospital	City	ICU	Patients	Patient days	ASIS
A	Mexico City	MS	248	1823	3.8
A	Mexico City	NS	222	1811	4.0
B	Mexico City	MS	238	681	3.43
C	Irapuato	MS	215	1571	4.83
D	Celaya	MS	132	704	2.34
Overall			1055	6590	2.74

ICU, intensive care unit; *ASIS*, average severity illness score; *MS*, medical surgical; *NS*, neurosurgical.

Surveillance

Rates of catheter-associated bloodstream infection (BSI), symptomatic catheter-associated urinary tract infection (CAUTI), and ventilator-associated pneumonia (VAP) were obtained by an infection control nurse utilizing standard Centers for Disease Control and Prevention (CDC)/National Nosocomial Infection Surveillance (NNIS) system definitions.[4,12] 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 on all patients admitted to each unit. The average severity of illness score was defined according to the Hospital Infections Program, Centers for Disease Control and Prevention criteria.[12]

Culture techniques

Decisions to remove catheters and obtain cultures were made independently by the patient's attending physicians. Central venous catheters were removed aseptically, and the last 5 cm of the catheter tip was cultured using a standardized semiquantitative method.[13] 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.

Statistical analysis

EpiInfo version 6.04b (version 1996; Centers for Disease Control and Prevention, 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 VAP, catheter-associated BSI, and symptomatic CAUTI were calculated by dividing the total number of device-associated infections by the total number of device-days and multiplying the result by 1000.[12]

RESULTS

At 5 ICUs of 4 public hospitals, we surveyed 1055 patients representing 6590 patient-days (Table 1). The

Table 2. Device use and pooled incidence densities for specific device-associated infections

Infection site	Device type	Device-days	Patient-days	Device utilization	NI	Distribution of device-associated NI (%)	Rate per 1000 device-days
VAP	MV	2390	6590	0.36	52	20.23	21.8
CA-BSI	CVC	6450	6590	0.98	149	57.98	23.1
CA-UTI	UC	4184	6590	0.63	56	21.79	13.4

ICU, intensive care unit; *MV*, mechanical ventilator; *CVC*, central vascular catheter; *UC*, urinary catheter; *NI*, nosocomial infection; *VAP*, ventilator-associated pneumonia; *CA-BSI*, central venous catheter-associated blood stream infection; *CA-UTI*, catheter-associated urinary tract infection.

characteristics of the individual ICUs and the average severity of illness score[12] of patients residing in each unit is shown in Table 1. The number of device-days and device usage according to unit type is presented in Table 2. We have shown the proportion by type of device-associated infection in Table 2. The overall rate of catheter-associated BSI was 23.1 per 1000 device days (149/6450); the VAP rate was 21.8 per 1000 device days (52/2390); and the CAUTI rate was 13.4 per 1000 device days (56/4184) (Table 2).

DISCUSSION

Nosocomial infections have been associated with increased patient morbidity and mortality[14] as well as significant incremental health care costs.[15] Similar associations have been demonstrated in Mexico and Argentina.[16-18] Studies performed in the United States have demonstrated that an integrated infection control program that includes targeted device-associated surveillance can reduce the incidence of nosocomial infection by as much as 30% and lead to reduced health care costs.[1]

Over the past years, one of the authors (V.D.R.) has visited many countries with differing health care systems and has found that all of them have similar issues with respect to infection control. In general, for many of the visited developing countries, the perception was that rates of nosocomial infections are low and that compliance with hand hygiene occurs universally. However, because there are no formal surveillance systems and no feedback, this perception is often erroneous. In the course of the last few years, we have reported infection rates in several developing countries, using NNIS methodology.[3,6-11] Our research has shown that rates of nosocomial infections are high, infection control measures are sporadically and inconsistently applied, and relatively inexpensive measures of prevention have great returns.

Our goals are to detect nosocomial infection rates and implement focused strategies for prevention. Identifying the existence of nosocomial infection rates in well-established medical centers worldwide, using rigorous scientific methodologies, and offering effective and economically acceptable ways of reducing these rates, we could improve the infection control practices and significantly reduce morbidity and mortality.[19-22]

The device-associated nosocomial infection rates found in our study are comparable with those found in recent smaller earlier studies reported from other Latin American countries: In 1 Brazilian hospital, the BSI rate was ranging from 0 to 32 per 1000 central vascular catheter-days, and the rate of VAP was 42 per 1000 ventilation-days[23]; in another Mexican hospital, the rates of nosocomial VAP and bacteremia/sepsis were 28 and 26 cases, respectively, per 1000 device-days.[24]

On the other hand, although the device utilization in our Mexican hospital ICUs is similar to the pooled mean reported for the NNIS system, we found that our rates of selected nosocomial infections were similar to those reported by other Latin American countries[3,6-8] and higher than those reported by ICUs participating in the American NNIS system.[25]

There are a number of possible explanations for our higher rates. Open infusion systems are widely used in Mexico, rather than the closed system that is the standard of care in most developed countries. Macias et al found bacterial correlation between contamination of infection ports and contamination of infusate and blood cultures in Mexico.[26] Other researchers as well as us have previously shown that open infusion systems are associated with high rates of BSI, and conversion to a closed system can reduce rates substantially.[27,28] Hand hygiene was sporadic and inconsistently applied in our study sites, which speaks to the limited funds and resources available in developing countries. A less desirable nurse-to-patient staffing ratio and limited availability of supplies all contribute to high rates of nosocomial infection. Studies of catheter-associated BSI have consistently demonstrated a higher risk of infection with lower nurse-to-patient ratios and nursing inexperience,[29] and the use of some outdated technology may have a significant impact on the risk of infection in our patient population.

Surveillance of nosocomial infections is a necessary first step toward reducing the risk of infection among patients treated in Mexican hospitals. The next step is to apply infection control practices that have been shown to prevent nosocomial infections.

References

1. 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.

2. Cevik MA, Yilmaz GR, Erdinc FS, Ucler S, Tulek NE. Relationship between nosocomial infection and mortality in a neurology intensive care unit in Turkey. J Hosp Infect 2005;59:324-30.

3. Rosenthal VD, Guzman S, Crnich C. Device-associated nosocomial infection rates in intensive care units of Argentina. Infect Control Hosp Epidemiol 2004;25:251-5.

4. Garner JS, Jarvis WR, Emori TG, Horan TC, Hughes JM. CDC definitions for nosocomial infections, 1988. Am J Infect Control 1988;16:128-40.

5. Conyer R. Nosocomial infections. Salud Publica Mex 1999;41(Suppl 1):3-4.

6. Salomao R, Blecher S, Maretti da Silva MA, Vilins M, Hilário da Silva E, Rosenthal VD. Device-associated nosocomial infection rates and extra length of stay in intensive care units of Brazil. SHEA meeting, 2005. April 9th to 12th. Los Angeles, CA; 2005.

7. Sussmann O, Olarte N, Valderrama A, Alvarez C, Garzon Agudelo JE, Rosenthal VD. National multi-center prospective study to evaluate device-associated nosocomial infection rates in intensive care units of Colombia: benchmark with NNIS American rates. SHEA meeting, 2004 April 17th to 20th; Philadelphia; 2004.

8. Cuellar L, Rosales R, Castillo Bravo L, Linares Caceres M, Fernández Maldonado E, Gamio Cárdenas Y, et al. Prospective study on intensive care units of Peru. Extra length of stay and device associated rates of nosocomial infections. Fifth Pan-American Congress Of Infection Control and Hospital Epidemiology, 2004. October 7th to 10th; Lima, Peru; 2004.

9. Leblebicioglu H, Özgültekin A, Özay A, Cetinkaya Sardan Y, Koksal I, Yalcin AN, et al. Extra length of stay and device-associated nosocomial infection rates in intensive care units (ICU) in nine hospitals of Turkey. ICAAC meeting, 2005. December 16 to 19. Washington DC; 2005.

10. Mehta Y, Sen N, Chakravarthy M, Rosenthal VD, Nair R, Pawar M, et al. Extra length of stay and device-associated nosocomial infection rates in intensive care units in three hospitals of India. ICAAC meeting, 2005. December 16 to 19. Washington DC; 2005.

11. Abouqal R, Madani N, Zeggwagh AA, Rosenthal VD. Extra length of stay and device-associated nosocomial infection rates in intensive care units in one hospital of Morocco. ICAAC meeting, 2005. December 16 to 19. Washington DC; 2005.

12. Emori TG, Culver DH, Horan TC, Jarvis WR, White JW, Olson DR, et al. National nosocomial infections surveillance system (NNIS): description of surveillance methods. Am J Infect Control 1991;19:19-35.

13. Maki DG, Weise CE, Sarafin HW. A semiquantitative culture method for identifying intravenous-catheter-related infection. N Engl J Med 1977;296:1305-9.

14. Jarvis WR. Selected aspects of the socioeconomic impact of nosocomial infections: morbidity, mortality, cost, and prevention. Infect Control Hosp Epidemiol 1996;17:552-7.

15. Haley RW. Measuring the costs of nosocomial infections: methods for estimating economic burden on the hospital. Am J Med 1991;91:S32-8.

16. Rosenthal VD, Guzman S, Migone O, Crnich CJ. The attributable cost, length of hospital stay, and mortality of central line-associated bloodstream infection in intensive care departments in Argentina: a prospective, matched analysis. Am J Infect Control 2003;31:475-80.

17. Higuera F, Rangel-Frausto MS, Rosenthal VD, Castanon J, Franco G, Tobal N, et al. The attributable cost, and length of hospital stay of central line associated blood stream infection in intensive care units in Mexico: a prospective, matched analysis. SHEA meeting, 2005. April 9th to 12th. Los Angeles, CA; 2005.

18. Rosenthal VD, Guzman S, Migone O, Safdar N. The attributable cost and length of hospital stay because of nosocomial pneumonia in intensive care units in 3 hospitals in Argentina: a prospective, matched analysis. Am J Infect Control 2005;33:157-61.

19. Rangel-Frausto MS, Higuera F, Martinez Soto J, Rosenthal VD. Cost effectiveness of switching from an open IV infusion system to a closed system on rates of central venous catheter-associated bloodstream infection in three Mexican hospitals. APIC meeting, 2005. June 19th to 23rd. Baltimore; 2005.

20. Rosenthal VD, Guzman S, Safdar N. Effect of education and performance feedback on rates of catheter-associated urinary tract infection in intensive care units in Argentina. Infect Control Hosp Epidemiol 2004;25:47-50.

21. Rosenthal VD, Guzman S, Pezzotto SM, Crnich CJ. Effect of an infection control program using education and performance feedback on rates of intravascular device-associated bloodstream infections in intensive care units in Argentina. Am J Infect Control 2003;31:405-9.

22. Higuera F, Rosenthal VD, Duarte P, Ruiz J, Franco G, Safdar N. The effect of process control on the incidence of central venous catheter-associated bloodstream infections and mortality in intensive care units in Mexico. Crit Care Med 2005;33:2022-7.

23. Lopes JM, Tonelli E, Lamounier JA, Couto BR, Siqueira AL, Komatsuzaki F, et al. Prospective surveillance applying the national nosocomial infection surveillance methods in a Brazilian pediatric public hospital. Am J Infect Control 2002;30:1-7.

24. Martinez-Aguilar G, Anaya-Arriaga MC, Avila-Figueroa C. Incidence of nosocomial bacteremia and pneumonia in pediatric units. Salud Publica Mex 2001;43:515-23.

25. National Nosocomial Infections Surveillance (NNIS) System Report, data summary from January 1992 through June 2004, issued October 2004. Am J Infect Control 2004;32:470-85.

26. Macias AE, Munoz JM, Herrera LE, Medina H, Hernandez I, Alcantar D, et al. Nosocomial pediatric bacteremia: the role of intravenous set contamination in developing countries. Infect Control Hosp Epidemiol 2004;25:226-30.

27. Rangel-Frausto MS, Higuera F, Martinez Soto J, Castañon J, Franco G, Tobal N, Sanchez Velazques LD, Ruiz J, Valenzuela A, Duarte P, Rosenthal VD. Prospective study of the impact of switching from an open IV infusion system to a closed system on rates of central venous catheter-associated bloodstream infection in Mexican hospitals. SHEA meeting, 2004. April 17th to 20th. Philadelphia; 2004.

28. Rosenthal VD, Maki DG. Prospective study of the impact of open and closed infusion systems on rates of central venous catheter-associated bacteremia. Am J Infect Control 2004;32:135-41.

29. Robert J, Fridkin SK, Blumberg HM, Anderson B, White N, Ray SM, et al. The influence of the composition of the nursing staff on primary bloodstream infection rates in a surgical intensive care unit. Infect Control Hosp Epidemiol 2000;21:12-7.