International Journal of Infectious Diseases 31 (2015) 31–34

Contents lists available at ScienceDirect

International Journal of Infectious Diseases

journal homepage: www.elsevier.com/locate/ijid

The impact of hospital-acquired infections with multidrug-resistant bacteria in an oncology intensive care unit

P. Cornejo-Juárez [a,*], D. Vilar-Compte [a], C. Pérez-Jiménez [a], S.A. Ñamendys-Silva [b], S. Sandoval-Hernández [a], P. Volkow-Fernández [a]

[a] Department of Infectious Disease, Instituto Nacional de Cancerología, Av. San Fernando No. 22, Col. Sección XVI, Tlalpan, 14080 México, D.F., Mexico
[b] Department of Critical Care Medicine, Instituto Nacional de Cancerología, Mexico City, Mexico

ARTICLE INFO

Article history:
Received 8 August 2014
Received in revised form 8 November 2014
Accepted 15 December 2014

Corresponding Editor: Eskild Petersen, Aarhus, Denmark

Keywords:
Cancer
Surveillance
Intensive care unit
Hospital-acquired infection
Multidrug-resistant bacteria
Mortality

SUMMARY

Objective: To describe overall site-specific hospital-acquired infection (HAI) rates and to describe the microbiological and antibiotic resistance profiles of infecting pathogens, together with their impact on multidrug-resistant (MDR) bacteria-associated mortality.
Methods: We conducted a 5-year retrospective descriptive study of HAI in patients in the intensive care unit (ICU) of a cancer center in Mexico from January 2007 to December 2011. The following information was collected: patient characteristics and comorbidities, data related to the neoplasm and its treatment, microbiology, and the resistance pattern of all isolates.
Results: During the study period, 1418 patients were admitted to the ICU; 134 of them developed 159 infections, with an incidence of 11.2/100 hospitalized patients and 32.2/per 1000 patient-days. Two hundred sixty-six microorganisms were isolated. The overall prevalence of MDR-HAI was 39.5%. The most frequent organisms were as follows: 54 (20%) *Escherichia coli* (94.4% of these were extended-spectrum beta-lactamase producers), 32 (12%) *Staphylococcus aureus* (90.6% of these were methicillin-resistant), 32 (12%) *Enterococcus faecium* (18.7% of these were vancomycin-resistant), and 20 (6%) *Acinetobacter baumannii* (all were MDR). Among patients admitted to the ICU, 252 (17.8%) died. Death was related to the HAI in 58 (23%) of these patients ($p < 0.001$) and 51 (88%) had a MDR organism isolated ($p = 0.05$).
Conclusions: The emergence of MDR bacteria poses a difficult task for physicians, who have limited therapeutic options. Critically ill cancer patients admitted to the ICU are at major risk of a bacterial MDR-HAI that will impact adversely on mortality.

1. Introduction

Hospital-acquired infections (HAI) have been recognized for over a century as a critical problem affecting the quality of healthcare, and they constitute a major source of adverse healthcare outcomes.[1,2] The emergence of multidrug-resistant bacteria (MDRB) has become a public health problem, creating a new burden on medical care in hospitals, particularly for patients admitted to intensive care units (ICU).[1] In critical care units, there is extensive antimicrobial use, which imposes a selection pressure and promotes the emergence of MDRB.[1] In addition to this, ICU patients have an increased risk of infection due to their underlying diseases or conditions, impaired immunity, and exposure to multiple invasive devices (mechanical ventilation, central venous catheters (CVC), and urinary tract catheters).[1,3,4] The incidence of ICU-HAI is 5–10-times higher than HAI rates in general wards.[5] HAI in the ICU has been associated with increased morbidity, mortality, and costs.[1,6,7]

The aim of this study was to describe the incidence of HAI in an oncology ICU and to describe the microbiological and antibiotic resistance profiles of infecting pathogens, together with their impact on MDRB-associated mortality.

2. Methods

The National Cancer Institute of Mexico (INCan), located in Mexico City, is a 135-bed referral and teaching hospital for adult patients with cancer, with an average 170 000 medical visits per

* Corresponding author.
E-mail address: patcornejo@yahoo.com (P. Cornejo-Juárez).

http://dx.doi.org/10.1016/j.ijid.2014.12.022

year. Each year 7500 hospital discharges, 1400 long-term indwelling CVC placements, 34 000 chemotherapy infusion sessions, and >3500 major surgery procedures are carried out. Efforts have been made to improve the outcome of cancer patients admitted to the six-bed medical and surgical ICU,[8] including better selection of patients and standardized care. Nonetheless, mortality trends have increased over the past years, in parallel with an increase in MDRB-HAI (Table 1).

We conducted a 5-year retrospective descriptive study of HAI in patients in the ICU, from January 2007 to December 2011. Data were obtained from ICU daily reports, infection control surveillance forms, microbiology laboratory reports, and patient medical charts. The following information was collected: patient characteristics and comorbidities, data related to the neoplasm and its treatment, microbiology, and the resistance pattern of all isolates. The Sequential Organ Failure Assessment (SOFA) score[9] at ICU admission and at detection of the infection, length of ICU stay, number of ventilator days, days of CVC placement, and urinary tract catheter days were also reviewed. HAI was defined using the Centers for Disease Control and Prevention criteria (CDC, 2008).[10]

Cultures were obtained from blood, urine, tracheo-bronchial secretions, and from any other site with a clinical suspicion of infection. Bacteria were cultured using standard microbiological methods. Antimicrobial susceptibility testing was performed using the automated BD Phoenix system (USA) and the Kirby–Bauer disk diffusion technique (Clinical Laboratory Standards Institute, CLSI).[11] Antimicrobial treatment was considered appropriate when the patient received an antibiotic to which the isolated bacteria were susceptible, during the first 24 h of clinical infection, and if the patient received this for ≥72 h.[12]

Infections occurring at more than one site in the same patient were reported as separate infection events, unless the same bacterium was isolated at the same time. The clinical outcome was assessed until hospital discharge or death. For the purposes of this investigation, death was classified as attributed to the HAI or as non-HAI infection-related according to the medical professional who certified the death, along with a clinical chart review by at least two of the authors of the current article.

MDRB included the following: methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant *Enterococcus faecium* (VRE), and extended-spectrum beta-lactamase (ESBL)-producing *Escherichia coli* and *Klebsiella spp*. *Pseudomonas aeruginosa*, *Acinetobacter spp*, and other Gram-negative bacteria were considered multidrug-resistant (MDR) if they showed resistance to fluoroquinolones, cephalosporins, and carbapenems.

Table 1
Hospital-acquired infections (HAI), overall mortality, and infection-related mortality in an intensive care unit (ICU)

Year	2007	2008	2009	2010	2011
HAI rate	8.6	8.9	11.5	9.5	17.4
Patients admitted to the ICU (*n*)	341	296	277	273	252
ICU overall mortality (%)	19	18	17	18	18
HAI mortality (%)	19	31	29	25	53
ICU stay, days, median (IQR)	4 (2–4)	2 (1–4)	2 (1–6)	3 (1–6)	4 (2–5)
Infection rate by site					
VAP	3.8	4.7	4.3	3.7	9.5
VAP/1000 ventilator-days	11.7	15.8	14.4	12.2	31.7
CA-UTI	2	3	3.9	3.7	2.6
CA-UTI/1000 catheter-day	3.4	5	6.6	6.1	3.6
CLABSI	0.8	0	0.4	0	0.8
SSI	0.3	1.3	1.8	1	2.1
Abdominal sepsis	0.6	1	1.1	2.2	2
Prevalence (%) MDR-HAI pathogens[a]	37.5	33.3	29.4	33.3	65.1

IQR, interquartile range; VAP, ventilator-associated pneumonia; CA-UTI, catheter-associated urinary tract infection; CLABSI, central line-associated bloodstream infection; SSI, surgical site infection; ESBL, extended-spectrum beta-lactamase; XDR, extensively drug-resistant; MRSA, methicillin-resistant *Staphylococcus aureus*; VRE, vancomycin-resistant Enterococcus.

[a] MDR, multidrug-resistant bacteria (ESBL *Escherichia coli*, MDR/XDR *Pseudomonas aeruginosa*, MDR *Acinetobacter baumannii*, MRSA, VRE).

2.1. Statistical analysis

Categorical variables were compared using the Chi-square test or Fisher's exact test, as appropriate. Continuous data were compared by means of the Mann–Whitney *U*-test or the Student *t*-test according to the data distribution. Odds ratios (OR) with 95% confidence intervals (95% CI) were calculated. *p*-Values of ≤0.05 were considered statistically significant. Device utilization ratios, site-specific incidence rates per 100 patients, and site-specific incidence densities per 1000 days at risk or per 1000 patient-days were calculated. Data were analyzed using Epi-Info (v. 7) and STATA (v. 12) statistical software.

3. Results

During the study period there were 1418 admissions to the ICU. There were 159 HAI in 134 patients (110 with one, 23 with two, and one with three HAI episodes). The overall incidence of HAI in the ICU was 11.2 per 100 patients and 32.2/1000 patient-days (Table 1).

The median patient age was 50 years; 65 patients (48.4%) were male. The most frequent causes of ICU admission were septic shock (43%), hypovolemic shock (25%), respiratory failure (15%), and postoperative care (10%). Other demographic and clinical characteristics are shown in Table 2.

Seventy-two patients (45.3%) had ventilator-associated pneumonia (VAP), 41 (25.8%) had a catheter-associated urinary tract

Table 2
Demographic and clinical characteristics in intensive care unit (ICU) patients with hospital-acquired infections (HAI) (2007–2011)

Characteristic, *n* (%)	Patients (*N* = 134)
Age, years, median (range)	50 (16–93)
Male	65 (48.5%)
Underlying oncological disease	
Genitourinary	32 (23.9)
Lymphoma	16 (11.9)
Acute leukemia	14 (10.4)
Esophagus and stomach	10 (7.5)
Colon and rectum	9 (6.7)
Breast	6 (4.5)
Status of cancer at ICU admission	
Recent diagnosis	83 (64)
Progression	11 (8.5)
Complete remission	16 (12.3)
Recurrence	12 (9.2)
Non-response	8 (6.1)
ICU admission diagnosis	
Septic shock	58 (43)
Hypovolemic shock	33 (25)
Respiratory failure	20 (14.9)
Postoperative surgical care	14 (10.4)
Other reasons	6 (4.4)
Chemotherapy within 2 months	26 (19.4)
Mechanical ventilation	131 (97.8)
Comorbidities	
No comorbidities	97 (72.4)
Hypertension[a]	17 (12.7)
Diabetes mellitus	14 (10.4)
Chronic renal failure	6 (4.5)
Other[b]	7 (5.2)

[a] Six patients had two co-morbidities.

[b] Four patients with systemic lupus erythematosus, one with fever and neutropenia, one with HIV, and one with deep venous thrombosis.