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Nosocomial Bacterial Infections and Their Antimicrobial Resistance Patterns in University Hospitals of Hamedan, Iran

Seyyed Hamid Hashemi[a], Mojgan Mamani[*a], Shirin Jamal-Omidi[b], Amin Niayesh[b]

[a]*Department of Infectious Diseases, Hamedan University of Medical Sciences, Hamedan, Iran*
[b]*Student Research Center, Hamedan University of Medical Sciences, Hamedan, Iran*

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Corresponding author:

Mamani M. (MD)

Tel: +98 811 8274192

Fax: +98 811 8269808

E-mail addresses:

mamanimojgan@yahoo.com

ABSTRACT

Background: Nosocomial infections constitute a global health problem, leading to a high rate of morbidity and mortality. The aim of this study was to determine the frequency and antimicrobial resistance patterns of nosocomial infections in educational hospitals of Hamadan, western Iran.

Methods: During a 1-year period from April 2006 to March 2007, all patients with culture-proven nosocomial infections from educational hospitals in Hamedan, western Iran were included. Nosocomial infections were defined as a culture-proven infection, which occurred more than 48h after admission in the hospital. Antimicrobial susceptibility testing of isolated bacteria was performed by disc diffusion method.

Results: A total of 170 cases of culture-proven nosocomial infections were diagnosed. Most cases were in intensive care units (ICUs) (57.4%). The common sites of infection were lower respiratory tract (51.8%) and urinary tract (31.9%). *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, and *Escherichia coli*, were the most prevalent pathogens (32.7%, 22.9%, and 14.8% respectively). Most enterobacteriacea isolates were resistant to third generation cephalosporins. The resistant rates to ceftriaxone were 75.5% for *K. pneumoniae*, and 76% for *E. coli*. Among *P. aeruginosa* isolates, 26.5% were resistant to ceftazidim, and 36% to ciprofloxacin. Among *S. aureus* isolates, 80% were methicillin-resistant.

Conclusion: The patients in the ICUs are at a higher risk of nosocomial infections. The high prevalence of antimicrobial resistance in the hospitals highlights the need of further infection control activities and surveillance programs.

Introduction

Nosocomial infections (NIs) constitute a global health problem, leading to long-term hospital residences, increased use of antibiotics, increased economic burden, and a high rate of morbidity and mortality. The frequency of NIs varies depending on the study population, the hospital environment, patient care practices, the type of medical procedures, and invasive techniques. Several studies have reported that the prevalence of NIs vary from 4% in some parts of Europe to 18.6% in Africa and developing countries [1-5].

The most common types of NIs are surgical wound, urinary tract, and lower respiratory tract infections. The World Health Organization studies, and others, have shown that the highest prevalence of NI occurs in ICUs and in acute surgical and orthopedic wards. Infection rates are higher among patients with increased susceptibility because of old age, underlying disease, or chemotherapy [6].

Although it seems impossible to eradicate nosocomial infections, about one-third of them are reported to be preventable through infection control programs [5, 7]. These programs require a thorough knowledge of the NI rate, the prevalent pathogens, and their antimicrobial resistance. The distribution of bacterial pathogens and their susceptibility patterns change with time and vary among hospitals. In this manner, we aimed to ascertain the frequency and antimicrobial resistance patterns of NIs in educational hospitals of Hamadan, Iran.

Materials and Methods

During a 1- yr period from April 2006 to March 2007, all inpatients with culture-proven NI were included. The study was carried out in four educational hospitals in Hamadan, west of Iran. The hospitals included 16 unites (4 surgical, 9 medical, and 3 ICUs).

NI was defined as a culture-proven infection, which occurs more than 48 h after admission in hospital. Fallowing criteria were used for definitions of the various types of NIs:

Lower respiratory tract infection

Appearing of two of the following signs during hospitalization: a) cough, b) purulent sputum or endotracheal tube secretions c) new infiltrate on chest radiograph consistent with infection.

Urinary tract infection

Pyuria with at least 10^5 bacteria/ml in urine culture.

Surgical wound infection

Any purulent discharge, abscess, or spreading cellulitis at the surgical site during the month after the operation.

Bloodstream infection

Fever or rigors and at least one positive blood culture [6].

The identification of bacteria and their susceptibility to various antibiotics was in accordance with the National Committee for Clinical Laboratory Standards recommendations. Antimicrobial susceptibility testing of isolated bacteria was performed by disc diffusion method as described by Kirby-Bauer [8]. According to the type of isolated bacteria, a number of antibiotic discs were selected from twelve antibiotics including ceftizoxime, cefotaxime, ceftazidime, cefixime, oxacillin amikacin, gentamicin, carbenicillin, ciprofloxacin, cotrimoxazole, imipenem, and vancomycin (Padtan Teb, Tehran, Iran).

Patients' data including demographic characteristics, clinical course, site of infection, and laboratory results were recorded in a questionnaire. Data were analyzed using SPSS version 15.

Results

During the study period, 170 patients with culture-proven nosocomial infection were included. The mean age of the patients was 38.4±21.1 yr (range, 1-85 yr); 72% were male and 27% were female.

A total of 223 bacterial pathogens were isolated from 170 patients, out of whom 12 had more than one infected site and 41 had polymicrobial cultures. The most frequently isolated microorganism was *K. pnumoniae* (32.7%) followed by *P. aeruginosa* (22.9), *E. coli* (14.8), and *S. aureus* (11.2%).

Table 1 shows the distribution of nosocomial infections by ward. Most of the patients were admitted in ICUs (57.4%). The rest included surgery (10.2%), neurosurgery (9.1%), and other wards (23.3%). The common sites of infection were lower respiratory tract (51.5%), urinary tract (31.9), and surgical wounds (12.1%). The distribution of nosocomial isolates by site is shown in Table 2. *K. pnumoniae* was the most commonly isolated organism from all sites of infection.

Most enterobacteriacea isolates were resistant to third generation cephalosporins. The resistance rates were 15.5% for *K. pneumoniae*, 76% for *E. coli*. Among *P. aeruginosa* isolates, 26.5% were resistant to ceftazidim, and 36% to ciprofloxacin (Table 3). Among *S. aureus* isolates, 80% were methicillin-resistant, 69.2% resistant to cotrimoxazole and 16.6% resistant to imipenem and vancomycin.

Table 1: Frequency of isolated pathogens according to different wards

Pathogens	ICU	Surgery	Neurosurgery	Other wards	Total
K. pneumoniae	47(32)	6(37.5)	8(38.1)	12(30.7)	73(32.7)
P. aeruginosa	40(27.2)	4(25)	5(23.8)	2(5.1)	51(22.9)
E. coli	18(12.2)	1(6.2)	2(9.6)	12(30.8)	33(14.8)
S. aureus	16(10.9)	4(25)	1(4.7)	4(10.2)	25(11.2)
Seratia spp.	12(8.1)	1(6.2)	2(9.6)	0	15(6.7)
Proteus spp.	8(5.4)	0	1(4.7)	2(5.1)	11(4.9)
Enterobacter spp.	3(2)	0	0	0	3(1.3)
S. pneumonia	1(0.7)	0	1(4.7)	1(2.6)	3(1.3)
Hafnia alvei	1(0.7)	0	1(4.7)	0	2(0.9)
Citrobacter spp.	1(0.7)	0	0	0	1(0.5)
S. epidermidis	0	0	0	5(12.8)	5(2.2)
Edvardsiella tarda	0	0	0	1(2.6)	1(0.5)
Total	147	16	21	39	223

Table 2: Frequency of isolated pathogens according to different sites

Pathogens	Lower respiratory	Urinary tract	Surgical wound	Blood stream	Others
K. pneumoniae	37(31.8)	24(33.8)	9(35.7)	1(25)	2(33.33)
P. aeruginosa	32(27.3)	11(14.7)	6(21.4)	0	2(33.33)
E. coli	12(10)	19(26.6)	2(7.1)	0	0
S. aureus	10(9.1)	9(13.2)	3(10.7)	1(25)	2(33.33)
Seratia spp.	10(9.1)	2(2.9)	2(7.1)	1(25)	0
Proteus spp.	7(6.4)	3(4.4)	1(3.6)	0	0
Enterobacter spp.	1(0.9)	0	1(3.6)	1(25)	0
S. pneumonia	2(1.8)	0	1(3.6)	0	0
Hafnia alvei	2(1.8)	0	0	0	0
Citrobacter spp.	1(0.9)	0	0	0	0
S. epidermidis	1(0.9)	3(4.4)	1(3.6)	0	0
Edvardsiella tarda	0	0	1(3.6)	0	0
Total	115	71	27	4	6

Table 3: Frequency of antimicrobial resistance of enterobacteriaceae isolated from NIs (%)

	CT	CTX	CAZ	CFM	AN	GM	CB	CP	SXT
E. coli	68	76	-	92.8	-	72	-	66.6	71.4
Proteus spp.	85.7	85.7	-	57.4	57.4	71.4	-	33.3	77.7
Seratia spp.	92.3	85.7	-	66.6	66.6	91.6	-	90.9	90.9
P. aeruginosa	-	-	26.5		40.9	52.2	71.4	36	-
K. pneumoniae	75	75.5	-	96.5	50.9	90.9	-	80.5	75.5

CT: Ceftizoxime, CTX: Cefotaxime, CAZ: Ceftazidime, CFM: Cefixime, AN: Amikacin, GM: Gentamycin, CB: Carbenicillin, CP: Ciprofloxacin, SXT: Cotrimoxazole

Discussion

In this study, the most frequency of NIs was observed in ICUs. Previous studies have also reported the higher frequency in ICUs [9-12]. ICU patients are at higher risk of NI because of the increased severity of disease, duration of admission, and use of invasive procedures.

In our study, the most common site of infection was respiratory tract, while nosocomial pneumonia has been reported to be the second leading type of NI and accounts for 13% to 18% of all such infections in most studies [13]. This high prominence may be due to infection-control related risk factors including a lack of hand hygiene and glove-use practices and use of contaminated respiratory equipment. In addition, the common use of ventilator support is perhaps a great risk factor for the development of nosoco-

mial pneumonia. In the minority of previous studies, pneumonia was the most frequent NI: 38% in Turkey, and 65% in Oman [14-15].

The most frequent microbial agents of NIs in our study were *K. pneumoniae*, *P. aeruginosa*, and *E. coli*. Other studies have also reported similar results [5, 16]. More than 75% of K. *pneumonia* and *E. coli* isolates were resistant to third generation cephalosporins. Similar results have been reported in another study of NIs in Iran [16]. This (such a high resistance) may be due to extensive use of cephalosporins for hospitalized patients in our region. In this manner, it has been uncertain to use third-generation cephalosporins for empirical therapy for NIs.

Resistance of *P. aeruginosa* isolates to ceftazidime (26.5%) and ciprofloxacin (36%) highlights proper use of theses drugs because of increased potency of rapid resistance of *P. aeruginosa* to currently used antibiotics.

In our study, methicillin-resistant *S. aureus* (MRSA) represented a high proportion of all *S.aureus* isolates (80%) and vancomycin resistance was observed in 16.65% of isolates. These proportions are higher than those of other countries [2-5, 17]. This finding emphasizes the need to tailor control programs and to develop screening, labeling and isolation precautions particularly for MRSA carriers in high-risk wards such as ICU.

The use of disc diffusion method for detection of antimicrobial susceptibilities of isolated bacteria may be considered as a limitation of our study. Dilution test as a quantitative or E-test as a semi-quantitative method for detection of minimum inhibitory concentrations of bacteria are more reliable for identification of antimicrobial susceptibilities. However, because these methods are expensive and time wasting, the disc diffusion method is used routinely in our laboratories. Therefore, we determined the antimicrobial resistance patterns according to this method.

Conclusion

The high prevalence of NIs in ICUs and antimicrobial resistance in our hospitals highlight the need for further infection-control activities and antimicrobial resistance surveillance programs that may help for utilizing more proper empirical therapy for NIs.

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