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Evaluation of Nosocomial Infections in a Teaching Hospital

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Background: Nosocomial infections (NIs) have increasingly resulted in death and patients have to bear high treatment costs. Healthcare personnel could play a prominent role in prevention and control of NIs.
Objectives: The aim of this study was to evaluate NIs in patients admitted to a teaching hospital in Ahvaz, southwest of Iran, during 2013.
Patients and Methods: The present study was a cross-sectional study conducted in Razi Hospital, Ahvaz during 12 months from March 2013 to March 2014. All patients hospitalized with no signs and symptoms of infection within 48 hours of admission and presenting signs and symptoms of infection after 48 hours of hospitalization were included in the study. Data about patients' age, sex, site of infection, ward of hospitalization and type of NIs were collected. Bacterial strains were isolated from various clinical samples of patients and identified by conventional methods.
Results: The incidence of NIs was low (i.e. < 2%). Among 16936 admitted patients in this hospital, 174 patients (79 males and 95 females) with a mean age of 51.7 ± 24.6 years (range, 5 to 90 years) were diagnosed with an NI. Incidence density of NIs were 3.18% in infectious diseases ward, 2.17% in intensive care unit (ICU), 2% in orthopedic ward, 0.68% in obstetrics and gynecology (OBGYN) ward and 0.278% in general surgery. Regarding the etiology of infection, coagulase-negative staphylococci in 23.69%, Bacillus in 21.05%, *Escherichia coli* was found in 18.42%, and coagulase-positive staphylococci in 13.16% of the cases. The results indicated that coagulase-negative staphylococci was the most frequent pathogen.
Conclusions: The frequency of NIs in this hospital was lower in comparison with other worldwide studies. However, low incidence of health care-associated infections in our study may be due to under diagnosis and underreporting of such infections by health care staff.

Keywords: Infections; Hospital; Nosocomial; Infections; Hospital; Nosocomial; Infections; Hospital; Iran

1. Background

Nosocomial infections (NIs) are one of the most important causes of complications and mortality in medical centers (1). These infections have been considered as the sixth leading cause of death in the United States and Europe (2). Infections in long-term care institutions are a constant source of morbidity in residents in these facilities (3, 4). Nosocomial infections are associated with a considerable mortality, disability, increased duration of hospitalization, hospital costs and imposition of increased incidence of health problems; therefore, prevention of hospital infections through identification and removal of cases can be very effective (5, 6). The most common infections are respiratory, urinary, skin and soft tissue and gastrointestinal infections (7). *E. coli*, Salmonella, *Clostridium difficile* and small round enteric viruses are common causes of outbreaks of gastrointestinal infections (7, 8). Although efforts made in the field of NIs control have been associated with some success, recent advances in medical science and medical interventions including extensive use of immune system inhibitors and antibiotics increased vulnerable people. This leads to an increase in antibiotic-resistant pathogens (9). Treatment of NIs, due to the emersion of antibiotic-resistant strains, can be very difficult and lead to prolonged hospitalization, extra costs and death (7, 10, 11). NIs result in up to $4.5 billion additional healthcare costs per year, and it affects approximately two million persons each year (12-17). Different studies showed that by spending much lower costs for hospital hygiene and microbiological diagnosis, NIs can be largely avoided (18-21). The condition of patient and type of hospital and ward can be associated with NIs (9, 11, 22, 23). In the study conducted

by Maa et al. in Taiwan, in which 2688 patients with NIs were studied, the prevalence of infection was about 40% and the patient's age played role in the infection (24). In another study performed in Italy in 2001, pulmonary infections were the most common NIs and the duration of hospitalization was an important factor affecting the incidence of infection (25). Based on reports by Bergmans et al. pulmonary infections were the most common NIs (26). In another study conducted in a hospital in Iraq, surgical infection was the most important factor and ICU ward had the most number of cases of infection due to invasive procedures (27). According to the national nosocomial infections surveillance report 2006, 8833 device-related infections in adults were reported from participating healthcare facilities (16, 28). Publishing the results of these researches in the scientific journals, preparation of educational bulletins and increased knowledge of authorities about these infections can be major steps in the management and control of infections (29).

2. Objectives

Nosocomial infections have adverse effects such as mortality in medical centers. The aim of this study was to determine the rate of NIs with focus on the prevalence and type of infections in hospitalized patients in Razi Hospital, Ahvaz, Iran in 2013 - 2014.

3. Materials and Methods

This was a cross-sectional study performed from March 2013 to March 2014 in Razi Hospital, southwest of Iran, with approximately 220 beds. Criteria for the diagnosis of NIs were based on The center for disease control and Prevention definitions (20, 30, 31). Patients hospitalized for more than 48 hours in different wards of the hospital and having any infection after this time were studied. We obtained patients' information's from hospital information system with support from infection control committee. Nosocomial infections were categorized according to the national nosocomial infections surveillance (NNIS). System data collection was based on NNIS system-designed questionnaire, and also on four main sites of infection (lung, urinary tract, blood and surgical sites) (5, 32-34). In the present study, the infection control supervisor recorded patients' data according to reported cases of infection, observation and sampling and after consultation with infectious diseases specialists and confirmation of the hospital infection. To determine the infected patients, urine culture, complete blood count (CBC), blood culture and chest radiography were performed. In this study, patients who died within 48 hours were excluded.

3.1. Description of Study Area

Ahvaz city, the capital of Khuzestan province, with a population of approximately 1 million and an area of 8152 square kilometers, is located between 48° and 49° and 29 minutes east of the Greenwich meridian and 31° and 45 minutes north of the equator (35-40). Razi Hospital is a tertiary-care hospital with 220 beds, located in the center of Ahvaz. The location of study area is shown in Figure 1.

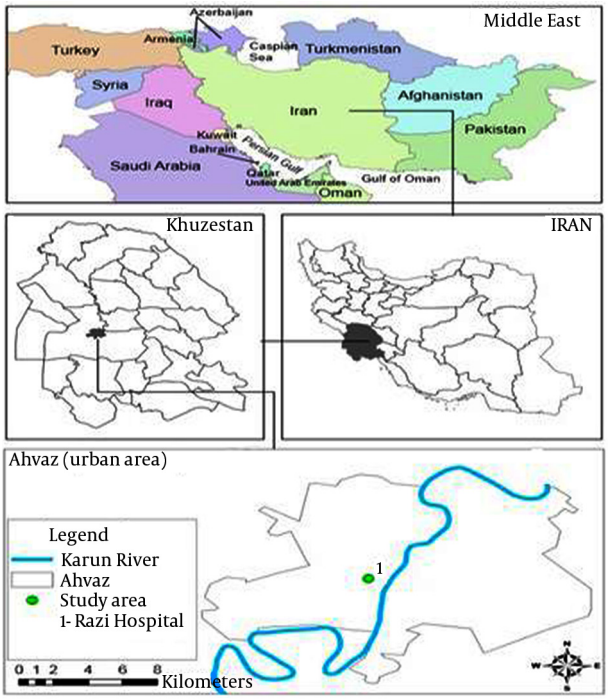

Figure 1. Location of Study Area, Razi Hospital, in the South West of Ahvaz City

3.2. Definitions

Infections acquired 48 to 72 hours after hospital admission or within 10 - 30 days after discharge were designated as nosocomial (4). Surgical site infections (SSIs) were defined as infections occurring at least two days after surgery. A case of urinary tract infection (UTI) was defined as a patient with fever, dysuria, positive dipstick for leukocyte esterase and/or nitrate and physician diagnosis and no other recognizable cause. A case of pneumonia was defined as a patient who had dullness to percussion on physical examination of the chest, abnormal chest radiography or new onset of purulent sputum. A case of bloodstream infection (BSI) was defined as a patient with at least one of the following signs or symptoms with no other recognized cause: fever, hypotension and no apparent infection in another site and physician instituted treatment for sepsis (17).

3.3. Statistical Analysis

Patient's age, sex, site of infection, ward of hospitalization and microbiology data were analyzed by SPSS software, version 16.0.

4. Results

This study was performed on 15779 patients hospitalized for more than 48 hours, from which 154 cases were identified with multidrug-resistant infection. The prevalence of coagulase-negative staphylococci and bacillus were more than other species, respectively. The mean age of patients with multidrug resistant NIs was 56 years with a standard deviation of 3.06 years (ranged 18 - 82 years). The highest rate of infection was observed in patients older than 50 years. The number of admitted patients and the incidence of NIs in different wards of hospital are presented in Table 1.

Totally, the incidence of NIs was 0.975% in this center. SSIs were the most frequent category of infection (54.55%), followed by blood stream infections (BSIs) (19.48%), pneumonia (18.18%) and UTI (7.8%) (Table 2).

The predominant bacteria in internal wards, ICU, general surgery wards, orthopedic wards, women surgery wards, infection wards and CCU wards were coagulase negative staphylococci, bacillus, *E. coli*, coagulase positive staphylococci and *Klebsiella* spp. In ICU, coagulase negative staphylococci were the most frequent pathogens (n = 6, 7.89%). Totally, the most isolated bacteria in Razi Hospital were coagulase negative staphylococci (n = 18, 23.69%) followed by bacillus (n = 16, 21.05%), *E. coli* (n = 14, 18.42%), coagulase positive staphylococci (n = 10, 13.16%), *Pseudomonas aeruginosa* (n = 6, 7.89%) and streptococci (n = 6, 7.89%) (Table 3).

The most common cause of nosocomial infections in all wards and types of infection are shown in Figure 2. SSIs, as compared to other types of infection, were the most frequent category of infection.

Prevalence of pathogens causing nosocomial infections based on the type of microorganism is shown in Figure 3. As the figure indicates, *E. coli* was the most frequent pathogen.

Table 1. The Incidence of Nosocomial Infections According to Hospital Wards, 2013 [a]

Hospital Ward	Number of Admissions	New Cases of Infection	Percent Cases of Infection
ICU	1521	33	2.17
Internal medicine	1171	2	0.17
General surgery	2161	6	0.278
Orthopedic	1701	34	2
OBGYN	7479	51	0.68
Infectious diseases	849	27	3.18
CCU	897	1	0.11
Total	15779	154	0.975

[a] Abbreviation: OBGYN, obstetrics and gynecology.

Table 2. Frequency Distribution of Type of Infection by Hospital Ward, Based on Culture Results [a,b]

Hospital Ward	Type of Infection				
	Pneumonia	UTI	SSI	BSI	Rates of Number and Percent Infection in Wards Per Total Infections
ICU	23 (14.93)	6 (3.89)	3 (1.95)	1 (0.64)	33 (21.42)
Internal medicine	-	2 (1.29)	-	-	2 (1.29)
General surgery	-	1 (0.64)	3 (1.95)	2 (1.29)	6 (3.89)
orthopedic	1 (0.64)	1 (0.64)	25 (16.23)	7 (4.54)	34 (22.07)
OBGYN	2 (1.29)	-	38 (24.67)	11 (7.14)	51 (33.11)
Infectious diseases	2 (1.29)	1 (0.64)	15 (9.75)	9 (5.84)	27 (17.53)
CCU	-	1 (0.64)	-	-	1 (0.64)
Total	28 (18.18)	12 (7.8)	84 (54.55)	30 (19.48)	154 (100)

[a] Abbreviations: BSI, bloodstream infection; SSI, Surgical site infections; UTI, urinary tract infection.
[b] Data are presented as No. (%).

Table 3. Frequency Distribution of Isolated Microorganisms by Hospital Ward [a]

Microorganism	Hospital Ward				
	ICU	Internal Medicine	General Surgery	CCU	Percentage of Infection in the Wards Per Total Infections
E. coli	3 (3.94)	9 (11.84)	2 (2.63)	-	14 (18.42)
Klebsiella	2 (2.63)	1 (1.31)	1 (1.31)	-	4 (5.26)
Enterobacter	-	2 (2.63)	-	-	2 (2.63)
Streptococci	-	5 (6.58)	1 (1.31)	-	6 (7.89)
Pseudomonas aeruginosa	2 (2.63)	3 (3.94)	1 (1.31)	-	6 (7.89)
coagulase positive staphylococci	5 (6.58)	3 (3.94)	2 (2.63)	-	10 (13.16)
coagulase negative staphylococci	6 (7.89)	9 (11.84)	2 (2.63)	1 (1.31)	18 (23.69)
Bacillus	3 (3.94)	10 (13.16)	3 (3.94)	-	16 (21.05)
Total	21 (27.63)	42 (55.26)	12 (15.79)	1 (1.31)	76 (100)

[a] Data are presented as No. (%).

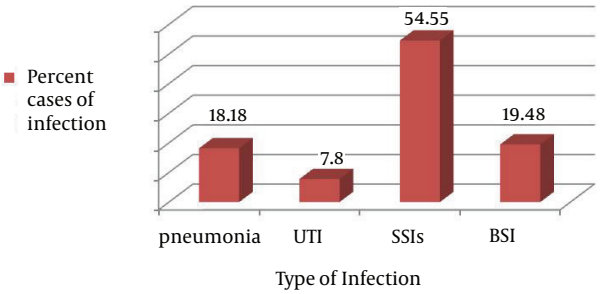

Figure 2. Percentage of Nosocomial Infections Based on the Type of Infection, Razi Hospital, 2013

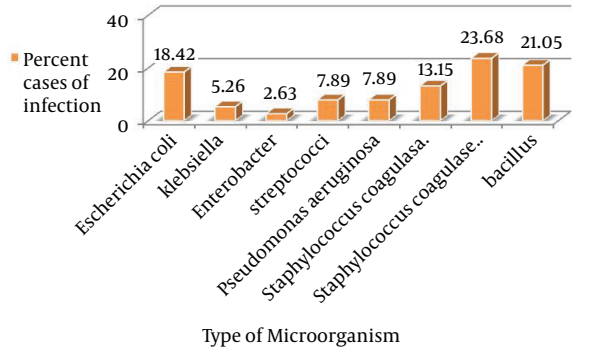

Figure 3. Percentage of Nosocomial Infections Based on the Type of Microorganism, Razi Hospital, 2013

5. Discussion

Based on the results obtained, incidence of NIs was 0.975%, which is lower than the rate of reported NIs in the Guideline (WHO nosocomial infections). Also in a study by Oncul et al. gender was a risk factor for NIs, but in a study conducted by Javanbakht et al. gender was not a risk factor for NIs (17, 41). Our results indicated that the prevalence rate of nosocomial infections was 0.975% in Razi Hospital of Ahvaz. In a study performed by Qader et al. the prevalence of NIs reported as 36% (27). Luzzati et al. reported the incidence of NIs as 30% (25). There are some possible reasons contributing to the low prevalence of NIs in our study, including lack of a reporting system for NIs and using less invasive methods of treatment for patients.

In the present study, a significant correlation between age and incidence of infection was observed. Also in other studies by Luzzati et al. (25) and Qader et al. (27), a significant correlation was found between age of patients and rate of infection. Furthermore, our results showed that *E. coli* was the most frequent pathogen, but Javanbakht et al. in 2012 performed a survey on the incidence of cross infections in Imam Reza hospital, Mashhad. Based on their results, *Klebsiella* spp. was the most frequent pathogen (17).

As the results showed, SSIs were the most common type of infection in our hospital. In a similar work, Pellizzer et al. in Italy reported urinary tract (28.4%), surgical sites (20.3%) and bloodstream (19.3%) as the most frequent sites of infection (42). Based on the study by Javanbakht et al. in Mashhad and Appelgren, SSIs were the most common type of infection (17, 43). Qader et al. (27) and Luzzati et al. (25) reported pneumonia as the most common type of infection. These differences may be due to the number of patients studied, place of study and genetic susceptibility.

Rate of NIs was increased in the elderly possibly due to their weak immune system. According to Table 1, incidence density of nosocomial infections was highest in OBGYN wards compared to other wards, probably be-

cause of high number of surgical procedures, severity of diseases and duration of hospitalization; however, Zolldann et al. (11), Unal et al. (10), Jeong et al. (44) and Kaoutar et al. (45) showed that ICU ward had the highest rate of NI compared to other wards.

Our data demonstrated that coagulase negative staphylococci, *Bacillus* spp., *E. coli*, coagulase positive staphylococci and *Klebsiella* spp., played a major role in causing NIs in 2013 in our center. This is consistent with some other studies conducted in Iran. Sohrabi et al. showed that *E. coli*, coagulase negative staphylococci and *Klebsiella* spp. were the most common microorganisms in their hospital (46).

In conclusion, although the incidence rate of nosocomial infections in this hospital was low, it is necessary to maintain continuous surveillance and implement preventive measures by wearing sterile gloves, proper and timely use of medical interventions, hand washing, especially by health personnel, health education, continuous supervision, correct use of disposable equipment, controlled antibiotic therapies, using air conditioner in each patients' room, keeping infected patients away from other patients, appropriate food and sufficient number of nurses to reduce nosocomial infections and their adverse effects. In summary, we hope this study would be useful for those involved in the care of residents in long-term care facilities. So, there is a need for development of effective surveillance systems and use of devices that decrease the risk of NIs.

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Authors' Contributions

Study concept, design and critical revision of the manuscript for important intellectual content: Shokrollah Salmanzadeh, Farid Yoesfi, Fatemeh Ahmadi, Sahar Geravandi, Mohammad Javad Mohammadi, Azadeh mahmmodi kohiand Seyed Mohammad Amin Alavi, Hossain Frozandeh; drafting of the manuscript and advisor, doing experiments: Moghgan Moien.

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