UMSHA Press

AJCMI
Avicenna Journal of Clinical Microbiology and Infection

Avicenna J Clin Microbiol Infect, 2022; 9(2):63-69. doi:10.34172/ajcmi.2022.10

http://ajcmi.umsha.ac.ir

Original Article

The Prevalence of Nosocomial Infections and Related Microbial Agents Based on the NNIS System in Sabzevar During 2011-2015

Zahra Souizi[1], Mohammad Nematshahi[2], Mohammad Sahebkar[3], Zahra Jafarabadi[4], Masoud Hiteh[4], Rahim Akrami[5*]

[1]Infectious Disease Control Unit, Shahid Beheshti Hospital, Sabzevar University of Medical Sciences, Sabzevar, Iran
[2]Department of Anesthesiology, Sabzevar University of Medical Sciences, Sabzevar, Iran
[3]Department of Social Medicine, School of Medicine, Sabzevar University of Medical Sciences, Sabzevar, Iran
[4]Non-communicable Diseases Research Center, Sabzevar University of Medical Sciences, Sabzevar, Iran
[5]Department of Statistics and Epidemiology, School of Public Health, Sabzevar University of Medical Sciences, Sabzevar, Iran

Article history:
Received: 14 Feb. 2022
Accepted: 8 June 2022
ePublished: 29 June 2022

***Corresponding author:**
Rahim Akrami, MSc in Epidemiology, Department of Epidemiology and Biostatistics, School of Public Health, Sabzevar University of Medical Sciences, Sabzevar, Iran. Tel: 09124705302,
Email: Akrami.rahim@gmail.com

Abstract

Background: Nosocomial infection is an infection that hospitalized patients get while receiving health care. This study aimed to determine the prevalence and factors involved in the incidence of nosocomial infections, related microbial agents, and antibiotic resistance profiles.

Methods: This cross-sectional study was conducted on 390 patients with nosocomial infection admitted to Shahid Beheshti Hospital in Sabzevar from 2011 to 2015. The acquired data were assessed by the standard checklist of the National Nosocomial Infections Surveillance (NNIS) system of the Ministry of Health. The collected data were analyzed using the Stata 12 software.

Results: Of the 41 979 admitted patients during the mentioned period, 390 patients with an average age of 48.08 years suffered from a hospital-acquired infection. The prevalence of nosocomial infections was 1% with the highest rate related to the respiratory tract in men and surgical sites in women. Intravenous catheters, surgical wounds, urinary catheters, suction, ventilator, tracheotomy, and tracheostomy were the most commonly encountered factors (invasive measures) of nosocomial infection, respectively. The most prevalent causes of nosocomial infections were *Klebsiella*, *Staphylococcus aureus*, and *Acinetobacter*.

Conclusions: Based on our findings, several factors play a pivotal role in preventing hospital-associated infections, including proper follow-up and timely reporting of nosocomial infection cases. The other influential factors were accurate identification of microorganisms involved, allocation of sufficient funds to provide appropriate facilities for infection prevention, the appropriate and timely medical interventions, and the rational use of antibiotics.

Keywords: Nosocomial infections, Hospital-acquired infection, NNIS, Microbial agents

Please cite this article as follows: Souizi Z, Nematshahi M, Sahebkar M, Jafarabadi Z, Hiteh M, Akrami R. The prevalence of nosocomial infections and related microbial agents based on the NNIS system in sabzevar during 2011-2015. Avicenna J Clin Microbiol Infect. 2022; 9(2):63-69. doi:10.34172/ajcmi.2022.10

Introduction

Nosocomial infection is an infection that hospitalized patients get while receiving health care (1,2). More precisely, it is an infection that occurs at least 48 or 72 hours after admission to the hospital. At the time of admission, the person should not have obvious signs of infection and the disease should not be in its latent period; in other words, there should be specific infection criteria (relevant code) for defining this type of infection (3).

The rate of this infection is directly correlated with hospital hygiene; the prevalence of hospital-acquired infection is reported to be between 5.7% and 19.1%, as well as 5.7% and 12% in middle-income and developed/high-income countries, respectively (4-6). The prevalence of nosocomial infections in Iranian hospitals was estimated at 0.32%-9.1% (7). Although intensive care units (ICU) make up less than 5% of all hospital beds and less than 10% of all patients admitted to this ward, the highest percentage of infections is related to internal patients and hematology (7-9). The most prevalent nosocomial infections include urinary tract infections (UTIs), lower respiratory tract infections, septicemia, and surgical site infections (10). The incidence of nosocomial infections and their causes varies among different hospitals according to hygiene conditions and other factors. The most common nosocomial infection in a study in South Khorasan province was reported as pneumonia (43%) and UTI (15.1%), respectively (8). In another study conducted

in Jahrom, the reported prevalence of nosocomial infections was 32 per 10000 patients. In this study, UTIs (54.2%) and surgical site infections (29.9%) were the most common nosocomial infections (11). The urinary tract is the most common organ that is involved in nosocomial infections. Urinary catheterization accounts for 80% of the causes of urinary infections. Long-term indwelling bladder catheterization is the greatest risk factor for such infections (12).

Given the bed occupancy rate of 70%-80% of Sabzevar hospitals, along with advances in medical science and medical treatment strategies and interventions, and the lack of a specialized study in this field in Sabzevar, the importance of examining the rate of hospital-associated infections and their causes becomes more obvious. Accordingly, this cross-sectional study sought to determine the prevalence of nosocomial infections in different departments and to identify the associated microbial agents. This study further aimed to detect the microbial agents involved in such infections and their antibiotic resistance profile.

Materials and Methods

The current cross-sectional study was performed in 390 registered cases of nosocomial infections in the Shahid Beheshti Medical Center of Sabzevar using data re-analysis in 2011-2015. The National Nosocomial Infections Surveillance (NNIS) was established in the United States (1970) and has been launched in our country since 2006. ICU, Neurosurgery, General Surgery, and Orthopedic Surgery departments were investigated in this study. Data were collected according to an NNIS-based checklist, as well as diagnosis algorithms for nosocomial infections in the national guide to the nosocomial infections in the health care system for four main infection types (pulmonary, blood, urine, and surgical site). The infection control nurse collected data based on the above-mentioned system via direct observation, in addition to a daily report of patients sent by the relevant departments' head nurses. The clinical criteria-based (fever, changes in the wound site appearance and secretions, pulmonary drainage, pulmonary sounds, chest X-ray, and urinary drainage) suspected cases of nosocomial infections were continuously monitored, and related forms were completed by the time they were discharged or died. Daily monitoring focused on the signs of infection, invasive measures, antibiotic prescribing, laboratory tests, and microbial cultures. Information of the detected patients for each of the four infection types based on standard definitions was recorded in INIS software after confirmation by the infection control physician. The individuals were excluded from our study if they had a fever before 48 hours of admission and did not match NNIS definitions.

Bacteria were detected by differential diagnosis and microbial resistance based on the Disk-Diffusion method. Antibiotics were provided by EXIR Company and Shahid Ghazi Pharmaceutical Company. In addition, antibiogram discs were purchased from MadTeb Company.

Data were analyzed using Stata software (version 12). Chi-square and Fisher's exact tests were employed to assess the relationships. The significance level in all tests was considered at 0.05.

Results

Out of 41 974 hospitalized patients, 390 (1%) cases were registered with the diagnosis of hospital infections during the time period. Of these, 279 were men (71.53%) and 111 were women (28.46%). The mean age of patients was 46.08 years within the age range of 6 months to 90 years.

There was a statistically significant correlation between the incidence of respiratory infections and the infection at the site of surgery with gender ($P > 0.001$). The incidence of respiratory infections was higher in men similar to surgical site infections in women. It is worth noting that no relation was found between UTI and gender.

The respiratory tract infection rate varied among different age groups as 7 (58.33%), 35 (72.25%), 31 (67.39%), and 50 (60.89%) patients in the age range of > 10, 20-30, 50-60, and over 70 years old, respectively. The incidence of surgical site infection was 22 (50.00%) and 25 (25.55%) patients within the age range of 30-40 and 40-50 years old, respectively ($P = 0.05$). There was no significant relationship in the incidence of other types of nosocomial infections with other age groups. Similarly, no significant correlation was found between UTI and age.

The results demonstrated a significant relationship between the incidence of some particular types of nosocomial infection and certain hospital sections ($P > 0.001$), in which the incidence of respiratory tract infection and UTI was the highest in the ICU (n = 178, 79.11%) and neurosurgical (n = 16, 44.44%) departments, respectively. Further, 61 (96.83%) and 65 (98.4%) cases were detected for surgical site infection in general and orthopedic surgery departments, respectively. Overall, the incidence of hospital-acquired infections in different parts of the hospital was 17.69%, 0.38%, 0.35%, and 0.4% in the ICU, orthopedic, surgical, and neurosurgery departments, respectively, indicating that patients in the ICU are highly prone to this kind of infections.

The respiratory infection represented the highest rate in patients with head trauma with (n = 136, 76.34%), followed by 25 (83.33%) and 26 (63.41%) cases in multiple trauma and spinal column trauma, respectively. The incidence of surgical site infections was 61 cases (71.76%), implying the highest rate in patients with limb trauma, followed by 65 cases (94.20%) in patients with elective surgery.

The most commonly encountered factors (invasive measures) affecting the rate of nosocomial infections were intravenous catheter, surgical wound, urinary catheter, suction, ventilator, tracheotomy, and tracheostomy, respectively. The most frequently associated risk factors with respiratory tract infections detected in this study were 71, 184, 186, 33, and 187 cases of tracheostomy

(77.17%), suctioning (76.9%), tracheal intubation (78.15%), chest tube insertion (82.5%), and respiratory ventilation (78.22%), respectively. The total incidence of the surgical site infection was 148 cases (47.59%). No significant correlation was found between the other invasive measures and the rate of nosocomial infections (Table 1). Moreover, there was no statistically significant relationship between the incidences of infections in terms of the seasons of the year (Table 1).

The most frequent causes of infections were *Klebsiella*, *Staphylococcus aureus*, *Acinetobacter*, *Escherichia coli, Enterobacter*, and *Citrobacter* bacteria, respectively. Regarding gender, the rate of *Acinetobacter*-associated infections was 34 cases (18.09%) in men versus 6 cases (6.68%) in women. Additionally, 11 cases in men (11.8%) versus 11 cases (17.74%) in women, as well as 12 cases in men (42.26%) versus 2 cases in women (3.13%), were observed for *Enterobacter* and *Citrobacter*, respectively, which is found to be statistically significantly correlated, while for the other bacterial species, no significant correlation was reported with patients' gender (Table 2).

The findings revealed no significant relationship between patients' age or the season of the year and bacterial species, and no significant relationship between the department where the infection was reported and bacterial species, except for 2 cases of *Klebsiella* (66.67%) in the general surgery that was found to have a significant correlation (Table 2).

The antibiotic resistance of *Klebsiella* to cefazolin, ceftriaxone, imipenem, and gentamicin was 100%, 91.6%, 73.7%, and 73.6%, respectively. In the case of coagulase-negative *S. aureus*, antibiotic resistance was 80%, 82.7%, and 76.4% to ceftazidime, ceftriaxone, and imipenem, respectively. In addition, the antibiotic resistance of *Acinetobacter* to cefazolin, ceftazidime, meropenem, and vancomycin was 100%. Further, this bacterium was 92.5%, 90.6%, and 89.2% resistant to imipenem, ciprofloxacin, and amikacin, respectively. Finally, *Citrobacter* was found to be resistant to most antibiotics such as imipenem, gentamicin, cefazolin, ceftazidime, ceftriaxone, ciprofloxacin, and vancomycin (Table 3).

Discussion

Based on the findings of the present study, the rate of hospital-acquired infections in Shahid Beheshti Hospital was estimated at 1% during 2011-2015, whereas it was in the range of 0.4%-3.9% in the other hospitals in our country (8,13,14). According to international standards, the rate of these infections in developed countries varies from 5% to 20% and is estimated at 25% in developing countries. The reason for this inconsistency could be the poor follow-up of patients in this center after their discharge.

In our study, the respiratory infection rate was higher in men, and more surgical site infections were found in women, whereas in a study conducted by Amini et al (15), no significant correlation was reported between gender and nosocomial infections. The incidence of respiratory infections increases with age. There is a significant relationship between age and respiratory infections, which is consistent with the findings of Laripour and Farsad (9). The highest rate of hospital-acquired infections was 17.69% for the ICU patients, while the lowest rate was 0.35% in the general surgery department, which is in line with the results of research conducted in one of the Qom hospitals (9). A significant correlation was found between hospital departments and infection rates. Based on the CDC report, the most common nosocomial infections were UTIs and pneumonia in 1991-2002 (9), whereas the most frequent infections were pneumonia and the site of surgery in our study. This inconsistency might be attributed to the type of hospital (trauma center), long-term admission to the hospital, and careful monitoring of patients admitted to the ICU. In general, invasive measures such as tracheal intubation, bladder catheterization, and the increased length of hospitalization, as well as uncontrolled consumption of antibiotics in ICU patients, may contribute to this rate. Factors increasing the risk of nosocomial infections in ICU patients include worsening of the disease, physiological and psychological stress, age, and other factors leading to death, inappropriate use of antibiotics, and increased antibiotic-resistant organisms. The other influential factors were drug therapy for ulcers protein malnutrition and the presence of personnel who transmit the infection among patients; except for the last factor, the other ones cause nosocomial infections by altering the patient's immune response (16). Wounds are a good place for microorganisms to multiply and grow in nosocomial infections, and some studies have reported the high rates of nosocomial infections due to wounds (17,18).

The same results were reported by Laripour and Farsad (9), Apostolopoulou et al (19), and Torres et al (20). In the present study, the use of catheters, suctions, ventilators, and surgery had a significant relationship with the incidence of nosocomial infections, which corroborates with the results of Eyoh et al (21). In our study, the most common microorganisms causing these types of infections were *Klebsiella*, negative coagulase *Staphylococcus*, and *Acinetobacter*, respectively, which matches with the findings of Behzadi et al (22), representing the multidrug resistance characteristics of *Klebsiella*.

According to the results of the study, *Klebsiella* had the highest resistance to cloxacillin, ceftriaxone, ceftazidime, cefazolin, and imipenem, while the lowest resistance to amikacin and meropenem. *Staph* coagulase-negative demonstrated the highest resistance to cloxacillin, ceftriaxone, and ceftazidime whereas the lowest resistance to cefazolin and vancomycin. Based on the data obtained from this study, *E. coli* showed the highest resistance to cloxacillin, cefazolin, and ceftriaxone and the highest sensitivity to amikacin and ciprofloxacin.

The results indicated that the use of resistant antibiotics in the clinic should be limited, and antibiotics sensitive to microorganisms should be used so that we do not observe

Table 1. Frequency of Risk Factors in Hospital Infections

Parameter		Respiratory Infection		*P* Value	UTI		*P* Value	Surgery Site Infection		*P* Value
		Yes No. (%)	No No. (%)		Yes No. (%)	No No. (%)		Yes No. (%)	No No. (%)	
Gender	Female	40 (36.04)	71 (63.96)	>0.001	34 (30.63)	77 (69.37)	0.114	54 (48.65)	57 (51.35)	0.006
	Male	151 (54.12)	128 (45.88)		64 (22.94)	215 (77.06)		94 (33.69)	185 (66.31)	
Age	>1>	7 (58.33)	5 (41.67)	>0.001	3 (25.00)	9 (75.00)	0.269	4 (33.33)	8 (66.67)	0.050
	10-20	21 (39.62)	32 (60.38)		21 (39.62)	32 (60.38)		18 (33.96)	35 (66.04)	
	20-30	35 (50.72)	34 (49.28)		15 (21.74)	54 (78.26)		27 (39.13)	42 (60.87)	
	30-40	15 (34.09)	29 (65.91)		13 (29.55)	31 (70.45)		22 (50.00)	22 (50.00)	
	40-50	13 (28.26)	33 (71.74)		9 (19.57)	37 (80.43)		25 (54.35)	21 (45.65)	
	50-60	31 (67.39)	15 (32.61)		9 (19.57)	37 (80.43)		10 (21.74)	36 (78.26)	
	60-70	19 (50.00)	19 (50.00)		10 (26.32)	28 (73.68)		13 (34.21)	25 (65.79)	
	>70	50 (60.98)	32 (39.02)		18 (21.95)	64 (78.05)		29 (35.37)	53 (64.63)	
Ward	ICU	178 (79.11)	47 (20.89)	>0.001	80 (35.56)	145 (64.44)	>0.001	7 (3.11)	218 (96.89)	>0.001
	Neurosurgery	12 (33.33)	24 (66.67)		16 (44.44)	20 (55.56)		15 (41.67)	21 (58.33)	
	General surgery	1 (1.59)	62 (98.41)		1 (1.59)	62 (98.41)		61 (96.83)	2 (3.17)	
	Orthopedic Surgery	0 (0.00)	66 (100.00)		1 (1.52)	65 (98.48)		65 (98.48)	1 (1.52)	
Season	Spring	48 (57.14)	36 (42.86)	0.036	18 (21.43)	66 (78.57)	0.687	27 (32.14)	57 (67.86)	0.291
	Summer	43 (38.39)	69 (61.61)		30 (26.79)	82 (73.21)		50 (44.64)	62 (55.36)	
	Autumn	50 (48.54)	53 (51.46)		29 (28.16)	74 (71.84)		36 (34.95)	67 (65.05)	
	Winter	50 (54.95)	41 (45.05)		21 (23.08)	70 (76.92)		35 (38.46)	56 (61.54)	
Diagnosis	Abdominal and pelvic trauma	19 (47.50)	21 (52.50)	0.844	13 (32.50)	27 (67.50)	0.257	12 (30.00)	28 (70.00)	0.274
	Head trauma	136 (76.40)	42 (23.60)	>0.001	68 (38.20)	110 (61.80)	>0.001	4 (2.25)	174 (97.75)	>0.001
	Multiple trauma	25 (83.33)	5 (16.67)	>0.001	8 (26.67)	22 (73.33)	0.840	0 (0.000)	30 (100.00)	>0.001
	Vertebra trauma	26 (63.41)	15 (36.59)	0.051	15 (36.59)	26 (63.41)	0.074	7 (17.07)	34 (82.93)	0.004
	Body trauma	18 (21.18)	67 (78.82)	>0.001	9 (10.59)	76 (89.41)	>0.001	61 (71.76)	24 (28.24)	>0.001
	Elective surgery	5 (7.25)	64 (92.75)	>0.001	6 (8.70)	63 (91.30)	0.001	65 (94.20)	4 (5.80)	>0.001
Aggressive action	Prosthesis	5 (9.62)	47 (90.38)	>0.001	6 (11.54)	46 (88.46)	0.015	46 (88.46)	6 (11.54)	>0.001
	Truck	71 (77.17)	21 (22.83)	>0.001	35 (38.04)	57 (61.96)	0.001	3 (3.26)	89 (96.74)	>0.001
	Surgery	132 (42.44)	179 (57.56)	>0.001	68 (21.86)	243 (78.17)	0.003	148 (47.59)	163 (52.41)	>0.001
	Drain	47 (49.47)	48 (50.53)	0.911	22 (23.16)	73 (76.84)	0.611	43 (45.26)	52 (54.74)	0.091
	Suction	184 (76.99)	55 (23.01)	>0.001	86 (35.98)	153 (64. 02)	>0.001	13 (5.44)	226 (94.56)	>0.001
	Urethral catheter	191 (68.71)	87 (31.29)	>0.001	98 (35.25)	180 (64.75)	>0.001	36 (12.95)	242 (87.05)	>0.001
	Intravenous catheter	191 (48.97)	199 (51.03)	>0.001	98 (25.13)	292 (74.87)	>0.001	148 (37.95)	242 (62.05)	>0.001
	Nose gastric tube	188 (74.90)	63 (25.10)	>0.001	93 (37.05)	158 (62.95)	>0.001	16 (6.37)	235 (93.63)	>0.001
	Tracheal tube	186 (78.15)	52 (21.85)	>0.001	84 (35.29)	154 (64.71)	>0.001	13 (5.46)	225 (94.54)	>0.001
	Chest tube	33 (82.50)	7 (17.50)	>0.001	13 (32.50)	27 (67.50)	0.266	2 (5.000	38 (95.00)	>0.001
	Ventilator	187 (78.24)	52 (21.76)	>0.001	84 (35.15)	155 (64.85)	>0.001	13 (5.44)	226 (94.56)	>0.001

Table 2. Distribution of Microbial Agents Causing Hospital Infection by Risk Factors

Parameter		*Staph* Coagulase Positive		*Staph* Coagulase Negative		*Klebsiella*		*Escherichia coli*		*Acinetobacter*		*Enterobacter*		*Citrobacter*		*Candida*	
		Yes No. (%)	No No. (%)	Yes No. (%)	No No. (%)	Yes No. (%)	No No. (%)	Yes No. (%)	No No. (%)	Yes No. (%)	No No. (%)	Yes No. (%)	No No. (%)	Yes No. (%)	No No. (%)	Yes No. (%)	No No. (%)
Gender	Female	3 (4.84)	59 (95.16)	12 (19.35)	50 (80.65)	19 (30.65)	43 (69.35)	11 (17.74)	51 (82.26)	6 (9.68)	56 (90.32)	11 (17.74)	51 (82.26)	2 (3.23)	60 (96.77)	9 (14.75)	52 (85.25)
	Male	6 (3.23)	180 (96.77)	31 (16.58)	156 (83.42)	73 (38.83)	115 (61.17)	24 (12.77)	164 (87.23)	34 (18.09)	154 (81.91)	11 (5.88)	176 (94.12)	12 (6.42)	175 (93.58)	8 (4.28)	179 (95.72)
Age	>10	0 (0.00)	7 (100.00)	1 (14.29)	6 (85.71)	4 (57.14)	3 (42.86)	2 (28.57)	5 (71.43)	0 (0.00)	7 (100.00)	0 (0.00)	7 (100.00)	0 (0.00)	7 (100.00)	1 (14.29)	6 (85.71)
	10-20	2 (5.26)	36 (94.74)	12 (31.58)	26 (68.42)	9 (23.68)	29 (76.32)	7 (18.42)	31 (81.58)	5 (13.16)	23 (86.84)	4 (10.53)	34 (89.47)	0 (0.00)	38 (100.00)	1 (2.63)	37 (97.37)
	20-30	0 (0.00)	42 (100.00)	5 (11.63)	38 (88.37)	20 (46.51)	23 (53.49)	6 (13.95)	37 (86.05)	6 (13.95)	37 (86.05)	3 (6.98)	40 (93.02)	5 (11.63)	38 (88.37)	3 (6.98)	40 (93.02)
	30-40	0 (0.00)	23 (100.00)	3 (13.04)	20 (86.96)	11 (47.83)	12 (52.17)	3 (13.04)	20 (86.96)	0 (0.00)	23 (100.00)	0 (0.00)	23 (100.00)	2 (8.70)	21 (91.30)	1 (4.35)	22 (95.65)
	40-50	2 (9.09)	20 (90.91)	4 (18.18)	18 (81.82)	8 (34.78)	15 (65.22)	4 (18.18)	18 (81.82)	4 (17.39)	19 (82.61)	0 (0.00)	22 (100.00)	0 (0.00)	22 (100.00)	2 (9.09)	20 (90.91)
	50-60	2 (6.45)	29 (93.55)	5 (16.13)	26 (83.87)	12 (38.71)	19 (61.29)	3 (9.68)	28 (90.32)	5 (16.13)	26 (83.87)	4 (12.90)	27 (87.10)	3 (9.68)	28 (90.32)	2 (6.67)	28 (93.33)
	60-70	1 (3.45)	28 (96.55)	5 (17.24)	24 (82.76)	7 (24.14)	22 (75.86)	4 (33.13)	26 (86.67)	9 (31.03)	20 (68.97)	6 (20.69)	23 (79.31)	0 (0.00)	29 (100.00)	2 (6.90)	27 (93.10)
	>70	2 (3.75)	54 (96.43)	8 (14.29)	48 (85.71)	21 (37.50)	35 (62.50)	6 (10.71)	50 (89.29)	11 (19.64)	45 (80.36)	5 (8.93)	51 (91.07)	4 (7.14)	52 (92.86)	5 (8.93)	51 (91.07)
Ward	ICU	4 (1.95)	201 (98.05)	39 (19.02)	166 (80.98)	82 (39.81)	124 (60.19)	23 (11.22)	182 (88.78)	38 (18.45)	168 (81.55)	19 (9.27)	186 (90.73)	11 (5.37)	194 (94.63)	14 (6.86)	190 (93.14)
	Neurosurgery	2 (8.33)	22 (91.67)	2 (8.00)	23 (92.00)	5 (20.00)	20 (80.00)	6 (24.00)	19 (76.00)	2 (8.00)	23 (92.00)	1 (4.00)	24 (96.00)	3 (12.00)	22 (88.00)	3 (12.00)	22 (88.00)
	General surgery	0 (0.00)	3 (100.00)	0 (0.00)	3 (100.00)	2 (66.67)	1 (33.33)	1 (25.00)	3 (75.00)	0 (0.00)	3 (100.00)	0 (0.00)	3 (100.00)	0 (0.00)	3 (100.00)	0 (0.00)	3 (100.00)
	Orthopedic surgery	3 (18.75)	13 (81.25)	2 (12.50)	14 (87.50)	3 (18.75)	13 (81.25)	5 (31.25)	11 (68.75)	0 (0.00)	16 (100.00)	2 (12.50)	14 (87.50)	0 (0.00)	16 (100.00)	0 (0.00)	16 (100.00)
Season	Spring	1 (1.72)	57 (98.28)	10 (17.24)	48 (82.76)	23 (39.66)	35 (60.34)	10 (17.24)	48 (82.76)	9 (15.52)	49 (84.48)	4 (6.90)	54 (93.10)	5 (8.62)	53 (91.38)	4 (6.90)	54 (93.10)
	Summer	3 (4.55)	63 (95.45)	12 (18.18)	54 (81.82)	21 (31.34)	46 (68.66)	13 (19.40)	54 (80.60)	10 (14.93)	57 (85.07)	6 (9.09)	60 (90.91)	4 (6.06)	62 (93.94)	2 (3.03)	64 (96.97)
	Autumn	2 (2.94)	66 (97.06)	12 (17.39)	62 (82.61)	28 (40.58)	41 (59.42)	7 (10.14)	62 (89.86)	11 (15.94)	58 (84.06)	9 (13.04)	60 (86.96)	1 (1.45)	68 (98.55)	5 (7.25)	64 (92.75)
	Winter	3 (5.36)	53 (94.64)	9 (16.07)	51 (83.93)	20 (35.71)	36 (64.29)	5 (8.93)	51 (91.07)	10 (17.86)	46 (82.14)	3 (5.36)	53 (94.64)	4 (7.14)	52 (92.86)	6 (10.91)	49 (89.09)

the emergence of microbial resistance in the future.

The present study represents a change in nosocomial pathogens in terms of type, frequency, and rank order.

Conclusions

Given the imposition of financial and life losses due to nosocomial infections and the lack of accurate statistics, our thinking to address these issues has led us to determine the incidence of these infections and their associated factors. Accurate and timely reporting of the cases of nosocomial infections and the correct identification of nosocomial pathogens, as well as post-discharge follow-up, play important roles in the prevention of hospital infections.

Table 3. Antibiotic Resistance Against the Most Common Bacteria in Hospital Infections, %

Antibiotics	Positive Coagulase *Staphylococcus*	Negative coagulase *Staphylococcus*	*Klebsiella*	*Escherichia coli*	*Acinetobacter*	*Enterobacter*	*Citrobacter*	*Pseudomonas aeruginosa*
Amikacin	80	62.5	51.8	22.2	89.2	60	63.6	75
Imipenem	100	76.4	85.9	73.07	93.5	84.6	100	75
Gentamicin	100	64.2	79.6	73.6	75.8	70	100	80
Cefazolin	100	33.3	94.1	100	100	100	100	100
Ceftazidime	100	80	92.8	85	100	81.8	100	81.25
Ceftriaxone	100	82.3	96.8	91.6	89.2	100	100	100
Ciprofloxacin	80	73.07	77.9	56	90.6	87.5	100	92.8
Meropenem	0	66.6	63.6	16.6	100	50	50	100
Vancomycin	0	0	-	-	-	-	-	-
Cloxacillin	100	92.3	100	100	100	100	100	100

The efforts of the authorities and staff in the management and control of hospital-acquired infections include the allocation of funds for infection control-related equipment, accurate and timely implementation of medical interventions, hand hygiene, especially by healthcare staff, health education and continuous monitoring, appropriate use of disposable products, and controlled use of antibiotics.

The identification of nosocomial infection-causing microorganisms can help develop policies and guidelines for infection control. To prevent and reduce the occurrence of antibiotic resistance, the use of antibiotics, particularly beta-lactam antibiotics, which may result in multi-drug resistance, should be monitored and administered in appropriate doses, and control plans should be considered in this field.

Acknowledgments

We are greatly thankful to the Treatment Deputy, Research Deputy, the administrator of nursing services of Sabzevar University of Medical Sciences, and the administrative management team of the educational center of Shahid Beheshti Hospital, Sabzevar. Moreover, words of thanks are offered to the Clinical Research Development Unit of Vasei Hospital, Sabzevar University of Medical Science for their assistance in this article.

Conflict of Interests

There is no conflict of interests.

Ethical Approval

This study was approved by the Ethics Committee of Sabzevar University of Medical Sciences (Ethics No. IR.MEDSAB.REC.1394.56).

References

1. Habboush Y, Benham MD, Louie T, Noor A, Sprague RM. New York State Infection Control. In: StatPearls. Treasure Island, FL: StatPearls Publishing; 2022.
2. Haque M, Sartelli M, McKimm J, Abu Bakar M. Health care-associated infections-an overview. Infect Drug Resist. 2018;11:2321-33. doi: 10.2147/idr.s177247.
3. Masomiasl H, Zahraei SM, Majidpor A, Nateghian A, Afhami SH, Rahbar M, et al. National Guideline of Nosocomial Infection Surveillance. 1st ed. Tehran: Ministry of Health, Treatment and Medical Education; 2006. [Persian].
4. Saleem Z, Godman B, Hassali MA, Hashmi FK, Azhar F, Rehman IU. Point prevalence surveys of health-care-associated infections: a systematic review. Pathog Glob Health. 2019;113(4):191-205. doi:10.1080/20477724.2019.1632070.
5. Barbato D, Castellani F, Angelozzi A, Isonne C, Baccolini V, Migliara G, et al. Prevalence survey of healthcare-associated infections in a large teaching hospital. Ann Ig. 2019;31(5):423-35. doi: 10.7416/ai.2019.2304.
6. Gori F, Vonci N, Santoriello G, Quercioli C, Messina G, Sancasciani S. Hospital acquired infection, evaluation of point of prevalence in a 147 beds Italian hospital. Eur J Public Health. 2019;29(Suppl 4):ckz186.502. doi: 10.1093/eurpub/ckz186.502.
7. Mosadeghrad AM, Afshari M, Isfahani P. Prevalence of nosocomial infection in Iranian hospitals: a systematic review and meta-analysis. Iran J Epidemiol. 2021;16(4):352-62. [Persian].
8. Bijari B, Abbasi A, Hemati M, Karabi K. Nosocomial infections and related factors in southern khorasan hospitals. Iran J Med Microbiol. 2015;8(4):69-73. [Persian].
9. Laripour M, Farsad S. Investigate the incidence of nosocomial infection in one of the hospitals in Qom province. Iran J Med Microbiol. 2011;5(3):7-17. [Persian].
10. Kampf G, Gastmeier P, Wischnewski N, Schlingmann J, Schumacher M, Daschner F, et al. Analysis of risk factors for nosocomial infections--results from the first national prevalence survey in Germany (NIDEP Study, Part 1). J Hosp Infect. 1997;37(2):103-12. doi: 10.1016/s0195-6701(97)90180-8.
11. Rahmanian V, Shakeri H, Shakeri M, Rahmanian K, Rahimi M. Epidemiology of nosocomial infections in patients admitted in hospitals Jahrom-2016. J Jahrom Univ Med Sci. 2017;15(1):57-66. doi: 10.29252/jmj.15.1.57. [Persian].
12. Majumder MMI , Ahmed T, Ahmed S, Khan AR. Microbiology of Catheter Associated Urinary Tract Infection. In (Ed.), Microbiology of Urinary Tract Infections - Microbial Agents and Predisposing Factors. IntechOpen. 2018. doi: 10.5772/intechopen.80080
13. Baghaei R, Mikaili P, Nourani D, Khalkhali HR. An epidemiological study of nosocomial infections in the patients admitted in the intensive care unit of Urmia Imam Reza hospital: an etiological investigation. Ann Biol Res. 2011;2(5):172-8.
14. Barak M, Mamishi S, Siadati SA, Salamati P, Khotaii G, Mirzarahimi M. Risk factors and bacterial etiologies of nosocomial infections in NICU and PICU Wards of children's medical center and Bahrami hospitals during 2008-2009. J Ardabil Univ Med Sci. 2011;11(2):113-20. [Persian].
15. Amini M, Sanjari L, Jalalinadoushan M. Frequency and related factors of nosocomial infections in ICU of tertiary hospital in Tehran, Iran, according to NNIS. Int J Infect Dis. 2011;15:S56.
16. Bersten AD, Handy J. Ohs Intensive Care Manual E-Book. Elsevier Health Sciences. 2013.

17. Amini M, Sanjari L, Vasei M, Oloomi S. Prevalence of nosocomial infections and related factors in the intensive care unit of Shahid Mostafa Khomeini hospital, Tehran based on NNIS system. J Army Univ Med Sci. 2009;7(1):9-14. [Persian].
18. Hadadi A, Rasoulinejad M, Maleki Z, Yonesian M, Shirani A, Kourorian Z. Antimicrobial resistance pattern of Gram-negative bacilli of nosocomial origin at 2 university hospitals in Iran. Diagn Microbiol Infect Dis. 2008;60(3):301-5. doi: 10.1016/j.diagmicrobio.2007.10.010.
19. Apostolopoulou E, Bakakos P, Katostaras T, Gregorakos L. Incidence and risk factors for ventilator-associated pneumonia in 4 multidisciplinary intensive care units in Athens, Greece. Respir Care. 2003;48(7):681-8.
20. Torres A, Aznar R, Gatell JM, Jiménez P, González J, Ferrer A, et al. Incidence, risk, and prognosis factors of nosocomial pneumonia in mechanically ventilated patients. Am Rev Respir Dis. 1990;142(3):523-8. doi: 10.1164/ajrccm/142.3.523.
21. Eyoh AB, Toukam M, Atashili J, Fokunang C, Gonsu H, Lyonga EE, et al. Relationship between multiple drug resistance and biofilm formation in Staphylococcus aureus isolated from medical and non-medical personnel in Yaounde, Cameroon. Pan Afr Med J. 2014;17:186. doi: 10.11604/pamj.2014.17.186.2363.
22. Behzadi P, Behzadi E, Yazdanbod H, Aghapour R, Akbari Cheshmeh M, Salehian Omran D. A survey on urinary tract infections associated with the three most common uropathogenic bacteria. Maedica (Bucur). 2010;5(2):111-5.