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THE EVALUATION OF NOSOCOMIAL INFECTIONS AND RISK FACTORS IN ICU PATIENTS

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Abstract

Introduction: Nosocomial infections are those types of infections which occur after 48 h of hospitalization and the patient has not been in the incubation period of another infection. As regards the effectiveness of different antibiotics, the difference in their resistance in different societies, and the importance of the proper use of medication in controlling nosocomial infections, we have decided to determine the prevalence of the bacteria causing nosocomial infections in Mostafa Khomeini hospital in a period of 3 years (2012-2014).

Materials and methods: This is a cross-sectional study which evaluates the prevalence of nosocomial infections and the risk factors in patients hospitalized in Shahid Mostafa Khomeini Hospital of Tehran in the period of 2012-2014. The study population included all patients with nosocomial infections in Shahid Mostafa Khomeini hospital over the years 2012-2014. The name of all patients with nosocomial infection was extracted using archival lists of nosocomial infection in hospital infection control committee. The data were entered into the SPSS software version 16 and were analyzed using paired t-test, Mann-Whitney, chi-square, and other relevant statistical tests.

Results: In this study, 286 patients (46.9%) were male and 324 patients (53.1%) were female. The mean patient age was 67.27 ± 21.65 years. Most of the infections' reports are related to the intensive care unit; pneumonia is the most common infection and *Acintobacter* is the highest isolated germ. There is a significant relationship between age ($p=0.01$) and hospitalization period ($p>0.001$) and the type of bacteria causing infection.

Discussion and conclusion: The results show that lung and urinary tract are still the most common areas involved in nosocomial infection. Intensive care, surgery, and internal units have the highest rate of nosocomial infection which can be due to prolonged length of stay of patients in these sectors, existence of several risk factors associated with these patients such as invasive procedure, surgical and underlying diseases, age of the patients hospitalized in these sectors, and indiscriminate use of broad-spectrum antibiotics for the treatment of patients hospitalized in these sectors.

Key words: Nosocomial infections, gram-negative *Bacillus*, gram-positive bacteria.

Introduction

Nosocomial infections are those types of infections which occur after 48 h of hospitalization and the patient has not been in the incubation period of another infection.

Nosocomial infections are currently one of the most important problems of health systems in many countries, leading to increased costs of hospitalization and medical interventions as well as increased risk of mortality. According to the World Health Organization in 2005, 5 to 10% of patients admitted to hospitals in developed countries and 25% in developing countries are suffering from nosocomial infection [1]. These infections can mostly be observed in patients who are immunocompromised or have undergone medical treatment and surgery as well as the elderly and those who received aggressive treatment or used implants and artificial organs. The prevalence of these infections in the intensive care unit (ICU) of hospitals is higher than in other sectors in a way that it is three times more in adults and children hospitalized in the ICU which is due to the usage of venous catheter and devices that will lead to bloodstream infections by coagulase-negative staphylococci [2 and 3].

The four main groups of these infections include urinary tract infections (23.2%), lower respiratory tract infections (22.9%), surgical wound (7.10%), and skin infections (6.9%) [4]. It is estimated that the rate of nosocomial infections in critically ill patients in medical centers and aching hospitals is greater than that in the private sectors due to high levels of bacterial resistance [5].

The risk factors for nosocomial infections are the length of hospitalization, inpatient portion, underlying disease or debilitating disease like diabetes mellitus, increased length of stay and increased number of catheterization (urine, blood vessels...), age (older), gender (female), type of contamination microorganism, and the need for care in the ICU [6 and 7].

Based on studies conducted, the increasing resistance to antibiotics can be observed among multiple groups of common

pathogens [8]. Also, the clear increase of resistance to antibiotics among gram-negative pathogens of urinary tract infections has been determined in several reports [9]. According to the announced statistics, two million cases of infection occur annually in the United States which impose the cost of 5.4 billion dollars to the state [10].

As regards the effectiveness of different antibiotics and the difference in resistance in the different societies and the importance of the proper use of medication in controlling nosocomial infections, the prevalence of bacteria causing nosocomial infections in Mostafa Khomeini hospital in a period of 3 years (2012-2014) was determined.

Materials and methods

This is a cross-sectional study which evaluates the prevalence of nosocomial infections and risk factors in patients hospitalized in Shahid Mostafa Khomeini Hospital of Tehran in the period of 2012-2014. The study population included all patients with nosocomial infections in Shahid Mostafa Khomeini hospital over 2012-2014. The name of all patients with nosocomial infection was extracted using archival lists of nosocomial infection in hospital infection control committee.

Thereafter, the culture results were entered into the study by having the positive culture (blood, urine, sputum, exudates) and the considered factors were evaluated. The total number of cases examined in this period was 610. All cases of patients who were hospitalized in all the wards of the hospital more than 48 h during the time of evaluation, suffered fever and patients' culture was done and was not in the incubation period of other infection on the basis of clinical symptoms and those above 12 years old and their cases of nosocomial infection committee infection control were filled by Ministry of Health and Medical Education of Iran in terms of items considered by the project such as age, gender, duration of hospitalization, use of urinary catheters and vascular and its duration, etc., were entered into the study. It is obvious that cases with incomplete information were excluded. Questions of information form were coded for ease of entering the information into the computer. The data were entered into the SPSS software version 16 and were analyzed using paired t-test, Mann-Whitney, chi-square, and other relevant statistical tests.

Results

In this study, 286 patients (46.9%) were male and 324 patients (53.1%) were female. The mean patient age was 67.27 ± 21.65 years. The youngest patient was one year old and the oldest patient was 98 years old. The average age differentiated by gender was 67.81 ± 23.92 years for males and 66.69 ± 19.45 years for females. The average hospitalization period was

23.23 ± 25.64 days. The shortest length of stay in the hospital has been 48 h and the highest length of hospitalization was 201 days. Diagram 1 shows the prevalence of the infection with separation of different wards. The highest incidence of infections was in the ICU with 379 cases (62.1%) and the lowest incidence of infections was in the psychiatric ward with 5 cases (8.0%). Among these cases, 26 patients (3.4%) had tracheostomy, 52 patients (5.8%) had history of surgery, 44 patients (2.7%) had venous feeding, 289 patients (4.47%) had suction lung secretions, 396 patients (64.9%) had venous catheter, 284 patients (64.6%) had venous catheter, 296 patients (48.5%) underwent intubation, and 307 patients (50.3%) underwent ventilator.

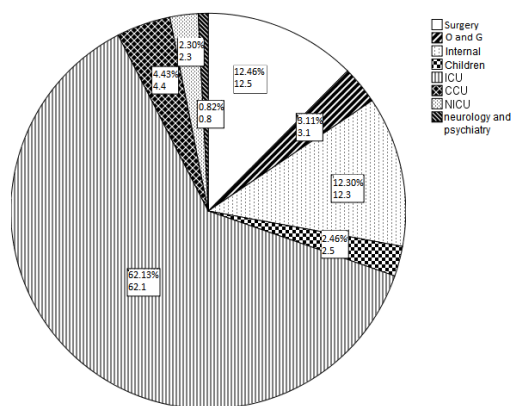


Diagram 1: The prevalence of infection with separation of different wards.

As shown in Diagram 2, the most common diagnosed nosocomial infection were respectively pneumonia and urinary tract infections and other infections were in the next places

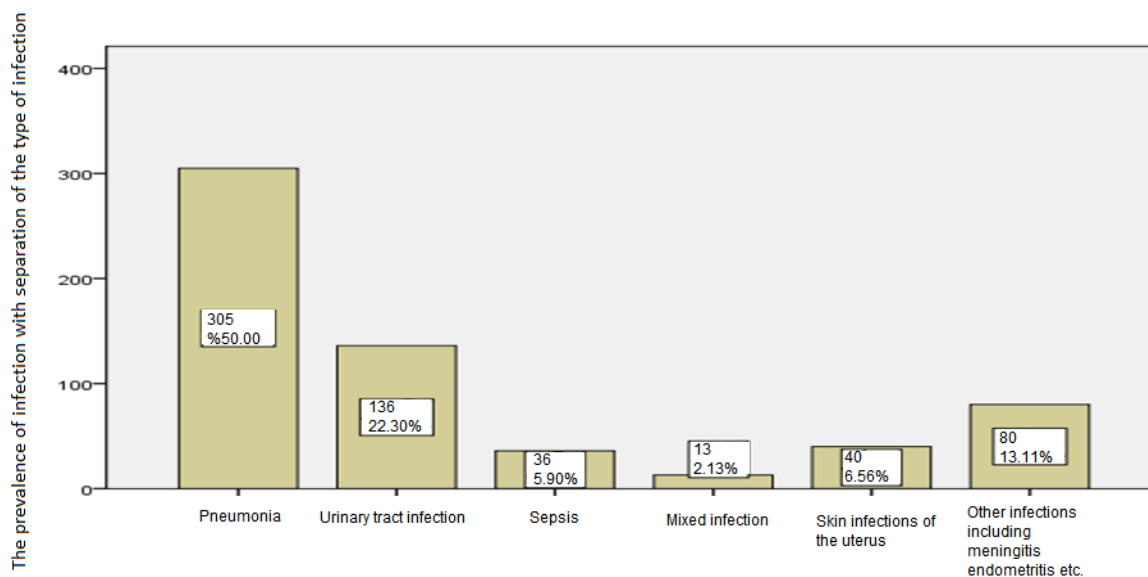


Diagram 2: The prevalence of infection with separation of the type of infection.

The prevalence of nosocomial infection in 2012, 2013, and 2014 was respectively 122, 202, and 286.

Of the 610 patients examined in this study, a total of 786 samples were taken respectively from the lower airway (505 samples, 64.8%), urine (181 cases, 23%), blood (63, 8%), wound or skin (24 cases, 3.1%), and upper airway (9 cases, 1.1%). The culture results of these samples which have been summarized in Diagram 3 show that the greatest mass of the obtained samples is *Acinetobacter* bacteria.

The most common masses of the obtained samples were *Acinetobacter* (34.6%), *Staphylococcus aureus* (18.9%), *Klebsiella* (18.2%), and *Pseudomonas aeruginosa* (11.3%). These bacteria in order of prevalence in samples obtained from urine are *Escherichia coli* (61.2%), *Enterococcus* (8.10%), *Klebsiella* (4.9%), and *P. aeruginosa* (2.7%). The most common bacteria isolated from blood samples were *P. aeruginosa* with 24.5% and *Acinetobacter* and *Klebsiella* with 20.4 and 18.4, respectively. In samples taken from the surgical wounds, *E. coli* and *S. aureus* bacteria had the highest prevalence with 38.2 and 14.7%.

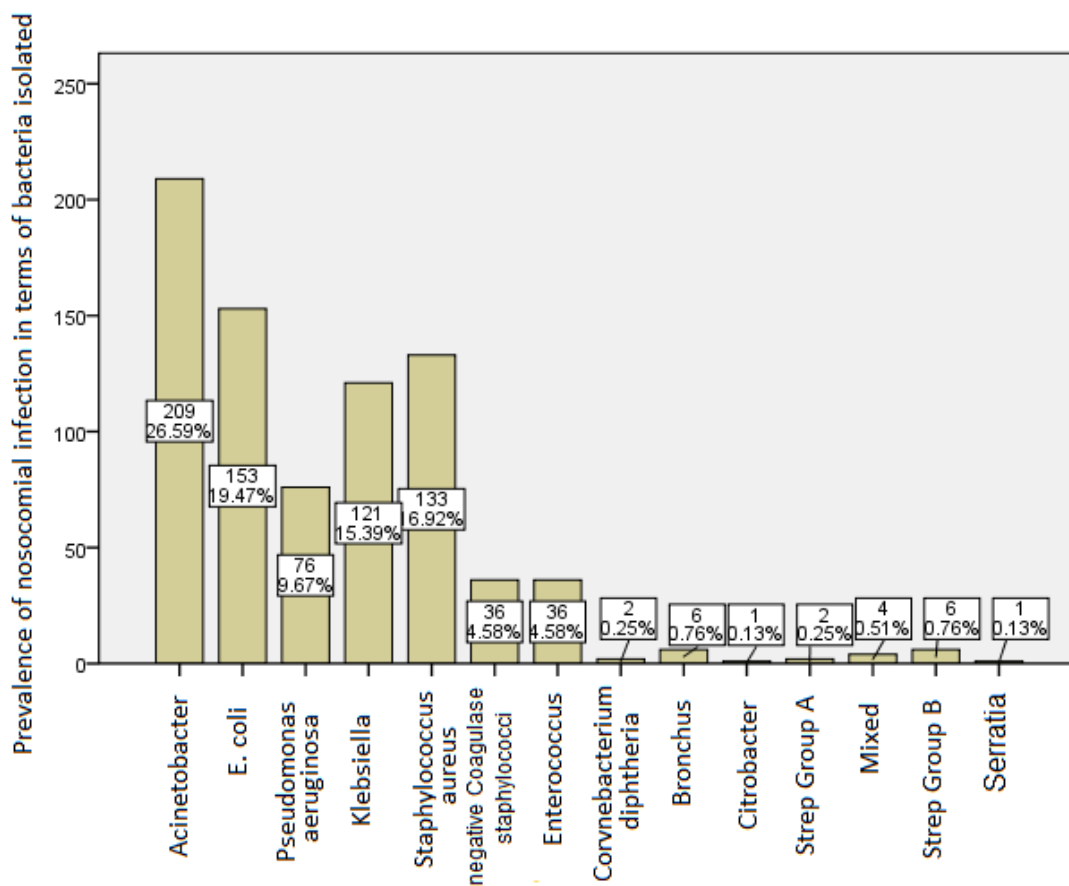


Diagram 3: Prevalence of nosocomial infection in terms of bacteria isolated.

Kruskal-Wallis test was used to compare the average ages of patients and the average length of stay in the hospital based on the type of infecting bacteria. Based on the results of this test, there was a significant relationship between age ($p=0.01$) and hospitalization period ($p>0.001$) and the type of bacteria causing the infection.

Chi-square test was used to evaluate the relationship between the type of infecting bacteria and gender of patient as well as the relationship between the type of infecting bacteria and underlying risk factors.

The results of this analysis show that there was a significant relationship between gender of the patient and the type of infecting bacteria ($P < 0.001$). There was no significant relationship between the evaluated underlying diseases in this study which was diabetes ($P = 0.94$) and high blood pressure ($P = 0.735$) and the type of infecting bacteria.

The evaluation of the relationship between the risk factors and performed invasive procedures studies including tracheotomy, surgery, intravenous feeding, suctioning secretions, pulmonary, intravenous and urinary catheters, endotracheal intubation, and ventilation with the type of infecting bacteria showed that there was no significant relationship between surgery ($P = 0.113$) and the total parenteral nutrition ($P = 0.272$) and the type of infecting bacteria, while this relationship was significant between the type of infecting bacteria and tracheostomy ($P = 0.026$), suctioning secretions, pulmonary, intravenous catheters, urinary catheters, endotracheal intubation, and ventilation ($P < 0.001$).

Discussion and conclusion

A review of other studies in this area similar to our study shows that the most common diagnosed nosocomial infections are pneumonia and urinary tract infection [11-14]. However, unlike the study of Hajibagheri et al. [15] which has identified *Klebsiella* bacteria as the most common cause of nosocomial infections and a study which has shown *S. aureus* as the most common cause of nosocomial infection [16], the bacterium *Acinetobacter* was raised as the first factor of incidence of nosocomial infection in this study and massed of *E. coli* and *S. aureus* were in the next places and *Klebsiella* was determined to be the fourth cause of nosocomial infection in this study. This finding shows the increasing incidence and prevalence of more resistant bacteria like *Acinetobacter* and *S. aureus*. Similar to the study of Amini et al. [17] which showed that the incidence rate of *Acinetobacter* has increased from 21.5 to 47.7% over 3 years; all of which have been resistant against Carbon penicillin, piperacillin, and cefotaxime and cephalothin.

Vahdat et al. (18) carried out a similar study in the period of 2003 to 2004 in one of the university hospitals of the city of Bushehr in order to evaluate the prevalence of nosocomial infection. The most common isolated organisms in this study were respectively *P. aeruginosa*, 52 cases (6.25%), *Acinetobacter baumannii*, 40 cases (19.7%), *E. coli*, 27 cases (13.3%), *Klebsiella pneumoniae*, 23 cases (11.3%), *S. aureus*, 17 cases (4.8%), *Staphylococcus epidermidis*, 16 cases (9.7%), *Enterobacter*, 14 cases (0.7%), *Streptococcus*, 13 cases (4.6%) and *Proteus* with one case. The comparison of the results

of these studies with the findings obtained from the present study shows that the incidence and prevalence of *Acinetobacter* species and *S. aureus* bacteria had a significant increase in recent years and these two bacteria have become the most common bacteria causing nosocomial infection. The reason for this can be due to misdiagnosis, inappropriate use of antibiotics in terms of time and their dose and type and inappropriate compounds found in some antibiotics [17].

The monitoring of nosocomial infection was studied in a study carried out in Japan in 2007 by Sukan et al. [19]. This cohort study on 8587 patients over 16 years old and hospitalized in the ICU for more than 48 h showed a significant relationship between nosocomial infections and urinary catheters and vascular surgery, emergency and mechanical ventilation. The results of this study are similar to the results of our study which show that tracheostomy, suction secretions from the lungs, urinary catheters, endotracheal intubation, and ventilation are risk factors for nosocomial infection.

The comparison of the average age in different types of bacteria causing nosocomial infections shows that the average age of patients with infections caused by *Acinetobacter*, *Pseudomonas*, and *S. aureus* is about 72 years and this amount is less than 70 years in other infections. The comparison of the average length of stay in hospital and the types of bacteria causing nosocomial infection shows that the prevalence of masses such as *P. aeruginosa* and *Klebsiella* is higher in long-term stay in the hospital, while the prevalence of *E. coli* bacteria is higher in short-term stay in the hospital. It can be inferred from these findings that infection due to *P. aeruginosa* or *Acinetobacter* with increase in the morbidity of patients increases the length of hospital stay or the treatment of these infections are more difficult because these infections are resistant to commonly used antibiotics which can increase the length of hospital stay.

In general, lung and urinary tract are still the most common areas involved in nosocomial infection. Intensive care, surgery, and internal units have the highest rate of nosocomial infection which can be due to prolonged length of stay of patients in these sectors, existence of several risk factors associated with these patients, such as invasive procedure, surgical and underlying diseases, age of the patients hospitalized in these sectors, and indiscriminate use of broad-spectrum antibiotics for the treatment of patients hospitalized in these sectors. The comparison of common masses in relation to the nosocomial infection in past studies and recent years' studies and this study shows the increasing rate of incidence and prevalence of masses such as *Acinetobacter* and *S. aureus* which can be due to misdiagnosis, inappropriate use of antibiotics in terms of time and their dose and type, and inappropriate compounds found in some antibiotics.

As mentioned earlier, this is a retrospective study and is naturally not immuned to errors of a retrospective study; despite this, efforts were made to accurately collect all information from patient records. The limitation of this study which are due to it being retrospective is the inability to calculate the remaining time of risk factors such as urinary or vascular catheters endotracheal tubes, intravenous feeding and other risk factors in order to be able to obtain their relation with incidence and prevalence and type of bacteria causing nosocomial infection. Also, the antibiotic test to assess the resistance of bacteria causing nosocomial infection has not been done in this study due to the type of study, time, and budget limit. This test could provide valuable information about the severity and type of antibiotic resistance and comprehensive instructions for doctors on the type and dose of appropriate antibiotic to treat common nosocomial infections. Thus, further and more comprehensive studies with more accurate methodology and prospective are necessary to prevent the prevalence of nosocomial infections, increased costs, increased length of hospital stay, and most importantly the indiscriminate use of broad-spectrum antibiotics and consequently multiple antibiotic resistance by identifying the most common cause of infection and microorganisms.

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