

Studying the Frequency of Nosocomial Infection and its Relative Factors in the Intensive Care Unit of Hospitals Based Upon NNI System

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ABSTRACT

Nosocomial infections (NIS) are among the important issues of the previous century and current area that impose heavy costs on the healthcare system, elongate the period of hospitalization, and increase the mortality and morbidity rate among patients. The present research seeks to determine the frequency of nosocomial infections and their relative causes in the ICU of Besat Hospital of Tehran. This is a descriptive-cross sectional research lasting from March to August 2015. The questionnaire designed by NNIS was used to collect information. The patients' clinical symptoms were regularly checked and if they were suspected of having infections, the necessary tests and cultivations were conducted. SPSS software was used to analyze the resulting data. A frequency rate of 35% was observed among the 377 patients in the hospital. The most common infections were pneumonia (89.4%), surgical site infection (4.5%), UTI (3%), and blood infection (3%). The most common pathogen in nosocomial infection was *Acinetobacter* (59.8%). A statistically significant correlation was observed between using mechanical ventilation, nasogastric tube and Central venous catheter and incidence of nosocomial infections ($P < 0.50$). There is also a significant correlation between intubation and affliction with nosocomial infection ($P < 0.50$). Using invasive methods and longer periods of hospitalization increase the risk of affliction with infection. Developing strategies to control and prevent infections based upon constant training of health center staff will also help decrease nosocomial infection in ICU.

Keywords: nosocomial Infection, ICU, NNI System

INTRODUCTION

Hospital infections can be traced back to the old days when first hospitals were established. Their importance raised over time and they turned into a major challenge against the health system of countries. Hospital acquired infections is a term to refer to infections observed among those hospitalized in the hospital. These infections were not previously observed and reported in the patient and they were not in the latency period when the patient was admitted to the hospital [1].

Of various units in a hospital, ICU (intensive care unit) is one of the most sensitive professional units. Although 5 to 15% of hospital beds are located in this unit, as much as 30% of all hospital infections are observed in this unit [2-3] which is 2 to 5 times as much as what is observed in other hospital units rendering this part very important [4-5].

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Intensive care unit medicine has experienced major developments in recent decades as modern technologies have grown and clinical trials have defined standards to treat patients requiring intensive care.

Of all microbial causes of nosocomial infections, *Pseudomonas aeruginosa* in lower respiratory system infection, *Escherichia coli* in the urinary system [3], *Candida albicans* in blood infection [6], and *Staphylococcus aureus* and *Klebsiella* [7- 8] in surgical site infection are known as the most common microbial causes.

It should be noted that most of these infections are transmitted through the hands of the personnel in therapeutic centers. Various studies have pointed to the fact that washing hands with water and soap or antimicrobial products such as Chlorhexidine and Alcohol help significantly reduce hospital infections [9]. In other words, most of these infections are controllable and can be prevented using this technique. A useful and efficient supervision plan for hospital infections can reduce the prevalence of this complication [3].

A review article and meta-analysis conducted in the US in 2011 showed that the frequency of nosocomial infection in developing countries was 49.9 out of every 1000 days of hospitalization; however, this rate in the US was 13.6 cases for every 1000 days of hospitalization which shows a significant difference [10]. Depending upon the population studied and various criteria of patient selection, the death toll caused by nosocomial infection in ICU ranges from 12 to 80 percent [3].

The costs imposed on the health system as a result of nosocomial infections in 2007 (assuming a rate of 4.5 cases of nosocomial infections in every 100 cases of hospitalization) are estimated around 6.65 billion dollars. 3.5 billion dollars of this expenditure is associated with nosocomial infections in the ICU that elongate the period of patients' hospitalization to one week or longer [11].

Considering the high rate of mortality and morbidity associated with nosocomial infections, their early diagnosis and treatment using proper antibiotics is quite important. This fact points to the necessity of accurate and comprehensive planning to prevent and control hospital acquired infections [12].

Consequently, the present research seeks to determine the frequency of hospital acquired infections and its relative factors in the intensive care unit (ICU) of Besat Hospital of Tehran.

MATERIALS AND METHODS

This is a descriptive - cross-sectional research. Considering the certainty rate of 95% and prevalence rate of 30% for nosocomial infections in ICU and a maximum difference of 5%, the sample volume was estimated to be 322. All patients hospitalized in the ICU of Besat Hospital of Tehran in the above-said period took part in the research.

Inclusion criteria:

- patients hospitalized in the ICU of Besat Hospital of Tehran in the above-said period
- a minimum of 48 hours hospitalization in ICU
- commencement of nosocomial infection symptoms after 48 hours following their hospitalization
- commencement of nosocomial infection symptoms immediately after hospitalization among those patients with a history of hospitalization in ICU within the last one month.

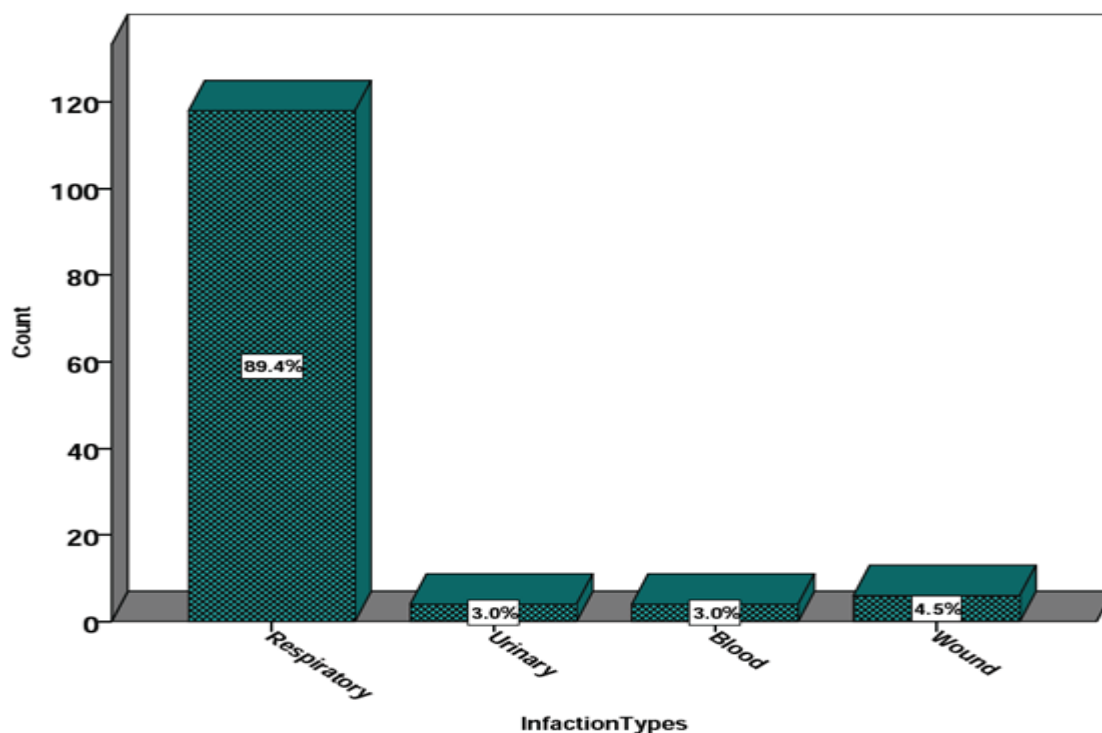
Exclusion criteria:

- patients spending less than 48 hours in the ICU of Besat Hospital.
- patients passing away less than 48 hours following their hospitalization in ICU.
- patients resorting from the ICU of other hospitals.
- patients who have fever before 48 hours.

Data collection was conducted using the questionnaire designed based upon NISS (National Nosocomial Infection Surveillance System) system and in accordance with nosocomial infection diagnosis algorithm for the main 4 infections (pulmonary, urinary, blood and surgical site infections) mentioned in the national guide to nosocomial infection care system whose reliability and validity was previously confirmed. If a patient was suspected of having nosocomial infections, the doctor or nurse responsible for controlling nosocomial infection would trace the patients with due observation of clinical criteria by completing the relative forms till the patients are discharged from ICU or pass away. If the patient possessed one of the standard definitions of each of the 4 above-said infections, the diagonal code would be inserted in the corresponding place of the table. To determine the source of infection in patients, CBC test, urinary cultivation, blood and other discharges cultivation and radiography of the chest were carried out. SPSS v.22 was used to analyze the data. Parametric and non-parametric statistical tests were utilized to study the frequency of nosocomial infections in the ICU of Besat Hospital and its relative factors by setting a significance level of $P < 0.50$.

Table 1. The correlation between age and length of hospitalization in ICU with nosocomial infection

Variables	Nosocomial Infection	Mean	SD	T	df	P-Value
Age	Pos	64.17	19.699	-0.384	375	0.701
	Neg	65.02	20.647			
ICU stay	Pos	22.55	17.524	8.838	160.732	0.000
	Neg	8.34	7.967			

**Figure 1.** Frequency of all types of nosocomial infections

RESULTS

As many as 377 patients were hospitalized in the research period in the ICU of Besat Hospital of Tehran. This number consisted of 218 male and 159 female patients. As many as 132 cases of nosocomial infections were reported among 84 (63.9%) male and 48 (36.1%) female patients. No significant difference was observed between the two groups in terms of affliction with nosocomial infection ($P > 0.05$). The participants aged 16 to 92 years with an average age of 64.6 years old. The average age of those with nosocomial infection was 64.17 years old while this average for those without this complication was 65.02 years. No significant correlation was observed between patients' age and affliction with hospital infection ($P > 0.05$).

The average length of hospitalization in ICU for those with nosocomial infection was 22.55 days, while this period for others was 8.34 days. A significant difference was observed between the two groups in terms of the length of hospitalization ($P < 0.05$).

132 cases of nosocomial infections were reported and the following frequencies were observed for each complication: 118 cases of Infection of lung parenchyma (89.4%), 6 cases of surgical site infection (4.5%), 4 cases of blood infection (3%), and 4 cases of urinary system infection (3%). The frequency of Infection of lung parenchyma was significantly more than what was observed for other infections ($P < 0.05$) (Figure 1).

The most common types of bacteria responsible for nosocomial infections with their respective frequencies are presented here: Acinetobacter with a frequency of 59.8% (the most common organism that causes Infection of lung parenchyma and surgical site infection), Escherichia coli with a frequency of 10.6% (the most common strain that causes urinary infection), Pseudomonas and Klebsiella with a frequency of 7.6%, Staphylococcus aureus with a frequency of 6.1%, and Negative coagulase staphylococcus with a frequency of 1.5% (the most common organism causing blood infection) (Figure 2).

Table 2. The correlation between intubation and affliction with nosocomial infection

		Intubation		df	P-Value
		Pos (%)	Neg (%)		
Nosocomial Infection	Pos	103 (78.0)	29 (22.0)	1	0.001
	Neg	85 (34.7)	160 (65.3)		
Total		188 (49.9)	189 (50.1)		

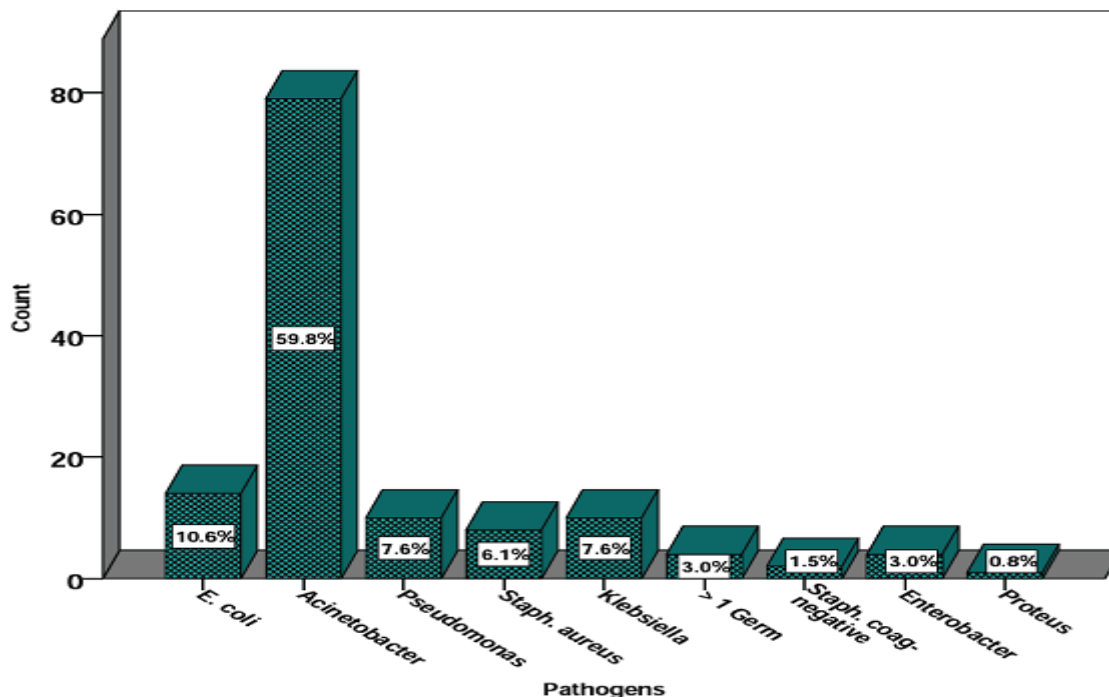


Figure 2. Frequency of pathogens that affect nosocomial infection

We also found a significant correlation ($P < 0.05$) between background diseases and affliction with nosocomial infections. 19.9% of all the patients hospitalized in the ICU had high blood pressure, 11.4% were suffering from diabetes, 22.5% had more than one background disease, and 43.5% had no background disease.

All patients had urinary catheter, half of them had tracheal tube and mechanical ventilation (49.9%), 33.4% had nasogastric tube, 31.3% had a central venous catheter, and 20.7% had drain in the site of operation.

A significant correlation was observed between invasive procedures such as mechanical ventilation, central venous catheter, nasogastric tube, and affliction with nosocomial infection ($P < 0.05$). However, no significant correlation was observed between surgical site drain and nosocomial infection ($P > 0.05$). As all the hospitalized patients had urinary catheter, it was impossible to determine its correlation with nosocomial infection ($P > 0.05$).

There is a significant correlation between nosocomial infection and the length of hospitalization ($P < 0.05$).

There is a significant correlation between intubation and affliction with nosocomial infection ($P < 0.05$)

DISCUSSION

Nosocomial infection is one of the most common types of therapeutic problems in all hospitals observed in 5 to 10% of all patients hospitalized in the hospital [13]. Repetitive use of invasive methods and tools and continuous contact with medical personnel increases the risk factor and possibility of transmission of microbes [14]. Various studies in different countries have reported various levels of nosocomial infection in different centers ranging from 10 to 70%. The frequency of nosocomial infection in our research was 35% which was in line with previous researches. No significant correlation was observed between patients' age and gender and affliction with nosocomial infections. Luzzati et al [15] have talked about old age as the risk factor of nosocomial infection, while Askarian et al (16) have reported the masculine gender as a factor that contributes of nosocomial infection with significant correlation. This inconsistency may be attributed to the high average age of the patients hospitalized in the ICU of Besat Hospital which makes correct statistical comparison between the two groups difficult. A one-year research by Amini et al (2006) in Shahid Mostafa Khomeini Hospital of Tehran found as many as 75 cases of hospital infections out of 691 patients hospitalized in ICU with a prevalence rate of 10.85% [7]. The most common types of infection are: infection of lung parenchyma (77.3%), urinary system (18.7%), surgical site (2.7%), and blood flow

(1.3%). In this research, nosocomial infection 48 hours following hospitalization is defined based upon NNIS criteria which is similar to our research.

Our research also reported 132 cases of nosocomial infection out of 377 patients hospitalized in the ICU of Besat Hospital of Tehran with a prevalence rate of 35%. This inconsistency and difference in the prevalence of nosocomial infections can be attributed to the higher rates of invasive operations and greater use of deep catheters in the ICU of Besat Hospital of Tehran and more accurate reporting. The most common type of nosocomial infection in Amini et al. was infection of lung parenchyma and *Acinetobacter* was the most common strain. These points are in line with our research. That research failed to find a significant correlation between the procedures observed in ICU such as intubation and mechanical ventilation, urinary and deep catheter and incidence of nosocomial infection. This is not in line with the results of our research. This is probably due to the fact that we studied a general ICU in our research but the ICU in their research was internal and surgical or traumatic patients requiring invasive measures such as venous catheters or deep arterial catheter are less. On the other hand, patients are hospitalized for a shorter time in operational ICU. Ozer et al (2009) conducted a 9-month study on 135 patients hospitalized in ICU in Turkey [17]. The participants were those whose nosocomial infections were reported from 48 hours following their hospitalization in ICU to 5 days after sending them to other units. Their research reported a frequency rate of 68% for nosocomial infections (a relatively high prevalence), while this frequency in our research was 35%. This difference is probably due to greater use of invasive measures and longer period of using them and difference in definition of nosocomial infection in Ozer's research. In our research, investigations continued up to the time of hospitalization or death in ICU. This research found a significant correlation between intubation and nosocomial infections similar to our research. As many as 93% of patients in Ozer's research had mechanical ventilation, while this rate in our research was 50%. A significant correlation was observed between the length of hospitalization and nosocomial infection in our research. It was 22.55 days. Ozer believes that patients' stay in ICU for 9 days is a risk factor, while our research makes no mention of this issue. A research was conducted by Shelley et al on 11282 patients in 183 hospitals from May to September of 2011 in the US. The most common types of nosocomial infection in various units of the hospital were pneumonia and surgical site infection each with a frequency of 21.8% followed by gastrointestinal system, urinary system, and blood infection. The prevalence of nosocomial infection in this disease was 4.5% with a death rate of 11.5%. The most common types of pathogens were *Clostridium difficile* (12%), *Staphylococcus aureus* (10%), and *Klebsiella pneumoniae* (9.9%). Ozer studied infection in all units of the hospital while our research was focused merely on ICU. As the prevalence of infection in the ICU is 2 to 5 times more than other units, the high rate in infection in our research (35%) makes sense. The order of nosocomial infection prevalence in that research is similar to what is reported in our research, but we didn't study the infections of gastrointestinal system in our research. The most common types of pathogens in our research were *Acinetobacter* (60%), *Escherichia coli* (10.6%), *Pseudomonas* and *Klebsiella* (7.6% each one) and *Staphylococcus aureus* (6%). As our research did not study the gastrointestinal system, it is expected to observed some differences between the two studies in terms of the pathogens found [18, 19].

On the 8th of May 2007, a multicenter point prevalence research was conducted in 75 countries from 5 continents in order to study the consequence of nosocomial infection in ICU. The follow up period of patients continued 60 days after the research. As many as 13796 patients in 1265 ICU's were studied. The prevalence of nosocomial infection ranged from 60% in central and south America to 46% in Africa (with an average of 51%). The most common nosocomial infection was pneumonia (64%). The most common organism engaged in nosocomial infection is associated with Gram-negative bacteria and the greatest frequency in this group is seen in *Pseudomonas*. In terms of common infections and the greater frequency of Gram-negative bacteria, this research is in line with our study. However, *Acinetobacter* was the most common strain separated from cultivations. The results of the above-said research reported different frequencies for each organism in various parts of the world. For example, the prevalence of *Acinetobacter* in North America was 3.7% while this frequency in Asia was 19.2%. This difference points to the fact that using local data to use empirical antibiotics type is a good guide. The death toll caused by nosocomial infection in this disease was 25%. It was also shown that infection with *Acinetobacter* and *pseudomonas* was associated with a greater rate of death. These infections have become a serious challenge in ICU's [20, 21].

CONCLUSION

Using invasive methods and longer periods of hospitalization increase the risk of affliction with infections. What's more, developing strategies for controlling and preventing infections based upon continuous education of health centers employees helps significantly reduce nosocomial infections in ICU.

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