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ORIGINAL ARTICLE

An evaluation of culture-positive infections and risk factors in patients admitted to the ICU of Imam Reza hospital in Birjand, Iran in 2015-2016

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Abstract

Introduction: Culture-positive infections include a broad range of nosocomial infections in the intensive care unit (ICU). Investigation and control of these infections is a global priority that aims to minimize infections in order to reduce mortality, decrease the length of stay in the hospital and also significantly reduce the cost of treatment. The purpose of this study was to investigate culture-positive infections and the risk factors in patients admitted to the ICU of Imam Reza (AS) hospital in Birjand.

Methods: In this cross-sectional study (descriptive-analytical), all patients admitted to the ICU at Imam Reza hospital in 2015 were enrolled in the study. The patients' blood, urine, wounds and sputum samples were taken to culture upon their admission and CSF cultures were performed when needed. People who initially had positive cultures, as well as those who were pre-treated with antibiotics, as well as those who or their family did not agree to participate, were excluded from the study. In culture negative cases, 48-72 hours after admission, cultures were repeated. Risk factors such as underlying disease, age, gender, duration of hospitalization and the use of catheters were evaluated in positive samples. Data analysis was performed by SPSS v.18 software and using Chi-square test.

Results:A total of 669 patients with an average age of 46.12 ± 26.08 years were enrolled in the study. The average length of stay was 4.8 ± 8.11 days. The incidence rate of nosocomial infection in patients was 68 (10.2%). Respiratory infection with 79.3% was the most common source of infection. Surgical wound infection with 44.1% and urinary tract infection with 23.5% were the next common types of infection. The most common isolated bacteria from urinary tract infections were *Escherichia coli* and *Pseudomonas spp.,* while coagulase-negative *staphylococcus* and *Klebsiella spp.* were the most commonly isolated bacteria from other types of infections. The incidence of nosocomial infections correlated significantly with age, duration of hospitalization and risk factors such as central catheters, endotracheal tube, ventilator, chest tube, NG TUBE, ventilator and tracheostomy ($P<0.05$).

Conclusions: According to the results of this study, more attention should be paid to the patients with culture-positive infections and to the reduction of associated risk factors. It is also recommended to avoid any unnecessary interventions in the ICU. In addition, in case of need for catheterization, care and hygiene practices are essential in order to prevent infections.

Key Words:*Nosocomial Infections; risk factors; Intensive Care Units*

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Introduction

Hospital infection refers to cases of infections that occur at least 48-72 hours after the patient is admitted to hospital and in patients who are not in a coma at the time of ad

mission (1). Nosocomial infections cause a significant mortality in patients admitted to hospitals each year. More than 20% of nosocomial infections occur in the ICU, and they are responsible for 10-80% of the deaths. However, only a small number of cases of nosocomial infections is reported (2). It is relatively highly costly to treat nosocomial infections; nevertheless, by allocating considerably less budget, over half of the nosocomial infections can be controlled and their prevalence can be prevented (3). According to the World Health Organization study (WHO) conducted in 55 hospitals in 14 countries, on average, 78% of patients are admitted to hospitals as affected by nosocomial infections. At any time, over 1.4 million people worldwide suffer from nosocomial infections (4). The highest rate of nosocomial infections has been reported from hospitals in the Eastern Mediterranean (11.8 %) and Southeast Asia (10%) (3). According to the World Health Organization, the highest prevalence of nosocomial infections has been in the intensive care unit (ICU), orthopedic and surgery units (3). More than 20% of nosocomial infections occur in the ICU and the crude mortality rate of such infections is 10-80% (5). Elderly patients are also at an increased risk of nosocomial infections.

The source of nosocomial infections can be microbial flora of hospital staffs or the patient's own flora. Some organisms may be acquired through objects or materials that have been contaminated with human resources (6). The most common sites of nosocomial infection are a urinary tract, respiratory tract, surgical wounds, and blood. The frequency and severity of nosocomial infection are different depending on the patient's age, type of surgery, duration of catheterization (in the urinary system or vascular system), treatment with immunosuppressive medications, and other factors (7). Hospital infections show different rates of mortality due to the characteristics of the infectious agent (resistance, strength, aggressiveness, and virulence) and the features of patients who are suffering from the infection. In a study in Germany, it was showed that nosocomial infections increased mortality of patients by three-fold (8). A study by Behnia et al. (2014) on 43 patients with pneumonia in the ICU showed that the most frequent organisms were Pseudomonas (40 %) and Acinetobacter (34%) where 60% of the cases resulted in death (9). Another study by Katsovich (2010) in Tuzla, which was carried out on all patients admitted to the ICU, showed that 11.27% of the cases had culture-positive infections where respiratory infections with 60% and urinary tract infections with 16% were the most frequent infections. The aim of this study was to assess culture-positive infections in the ICU of Imam Reza (AS) hospital in Birjand in 2015.

Methods

This cross-sectional study (descriptive-analytical) was approved and conducted in Birjand University of Medical Sciences. The Ethics code dedicated for this research is IR.bums.REC.1394.17. In this study, the samples including blood, urine, sputum, and wounds were initially taken before antibiotic administration from all patients who were hospitalized for any reason in the ICU of Imam Reza Hospital in 2015. All patients with the initial positive culture as well as patients who had taken antibiotics for any reason in the past 72 hours or those who were not satisfied to participate in the study were excluded. Samples with coordination were transferred to the microbiology department of Imam Reza hospital and were cultured by a microbiologist in an allocated environment. Again after 48 hours of hospitalization, re-sampling was performed on patients who had negative prototype culture. Positive culture refers to the isolation of one microorganism or more from the sample. The positive samples were evaluated for risk factors including underlying disease, age, gender, length of stay in the ICU, use of urinary catheters and mechanical ventilation tubes, central venous catheter, nasogastric tube, IV line, surgical drains and blood transfusion, type of pathogen, and other risk factors. The collected data was analyzed with SPSS software version 18 using descriptive statistical tests (percent, frequency) and chi-square test.

Results

During the study period, 669 eligible patients were hospitalized in the ICU of whom 232 patients were women and 437 were men. Demographic and clinical characteristics of the patients along with associated risk factors are shown in Table 1. From among the whole 669 patients, 68 (10.2%) had a culture-positive infection of whom 20 patients were women (29.41%) and 48 patients (70.59%) were men. There was no statistically significant difference between the two groups (Table2).

Table 1: Frequency distribution of demographic characteristics and risk factors of patients admitted to the ICU in 2015

Characteristics		N(%)
Age group (Year)	10≤	64(9.5)
	11-20	73(10.9)
	21-30	93 (13.9)
	31-40	79 (11.8)
	41-50	48(7.1)
	51-60	72 (10.7)
	61-70	82 (12.2)
	71-80	93(14.0)
	≥80	65(9.7)
Gender	Female	232 (34.7)
	Male	437 (65.3)
Disease history	Diabetes	91(12.0)
	Hypertension	208(27.5)
	Cancer	114 (15.1)
	Heart disease	157(20.7)
	kidney disease	45(5.9)
	Chronic lung disease	141(21.1)
Risk factors	Surgery	455(22.1)
	Urinary Catheters	669(32.6)
	Peripheral catheter	67(3.2)
	Central Catheters	265(12.9)
	Tracheal tube	595(29.0)

Table 2: Comparison of incidence rate of culture-positive infections based on age and sex

Characteristics		N (%)	P-value
Age group	10≤	3 (4.7)	0.03
	11-20	3 (4.1)	
	21-30	16 (17.2)	
	31-40	9 (11.4)	
	41-50	9 (18.8)	
	51-60	10 (13.9)	
	61-70	6 (7.3)	
	71-80	8 (8.6)	
	80≥	4 (6.2)	
Gender	Female	20 (29.4)	0.34
	Male	48 (70.6)	

A statistically significant correlation was observed between increased age and the incidence of culture-positive infection so that the highest frequency (18.8%) was related to the age groups of 41-50 years (Table 2). Besides, the incidence of infection was significantly increased in patients with an increased length of hospitalization (P<0.001). The patients hospitalized for more than 10 days (65.8%) in the ICU showed culture-positive infections, while only 19.8% of the patients who were hospitalized between 5 and 10 days had culture-positive infections. As for the patients with 3-5 days hospitalization, the rate was reduced to 2.3% and for the patients with 2-day hospitalization, it dropped to 0.6%. The most common underlying diseases in all patients were hypertension and chronic pulmonary heart diseases, whereas, in culture positive subjects, history of surgery (60.3%) and chronic lung disease (22.05%) were the most frequent underlying disease.

The average duration of urinary catheterization was 4.74±8.08 days; peripheral catheterization was 4.74±8.08 days; the endotracheal tube

3.05±7.47 days; chest tube 0.78±4.25 days; and NG tube 3.9±7.86 days. There was also a significant relationship between the use of various procedures, such as intubation, use of urinary catheters, vascular catheters, Chest Tube and NG Tube with the incidence of respiratory, urinary tract, and blood infections (Table 3).

The most common infections were upper respiratory tract infection with a frequency of 38.2% and surgical wound infection with a frequency of 13.2%. In 35.3% of the cases, two infections and in 10.3% of the cases three infections occurred simultaneously. In all these mixed infections, there was also a respiratory infection. Thus, the respiratory tract infection was observed in 79.3% of all cases. The rate of mortality in all patients was 113 people (16.9%). The mortality rate was significantly higher in patients with culture-positive infections (P<0.001), so that 39.7% of the patients with positive cultures and 14.3% of the patients with negative cultures died. This difference was statistically significant (P=0.001). The most common bacteria in wound infection was *Pseudomonas aeruginosa* (12 cases, 17.6%); in UTI, it was *E. coli* (4 cases, 8.5%); and in lung secretions, they were gram-negative *Staphylococci* (15 cases, 22.5%) and Klebsiella spp. (10 cases, 14.7%). Table 4 presents the types and the frequency of pathogens found in positive-culture patients.

Table 3: Comparison of incidence rate of nosocomial infections in terms of underlying disease and risk factors

Underlying disease or risk factors		N (%)	P value
Diabetes	yes	5 (5.5)	0.11
	no	63 (10.9)	
Hypertension	yes	10 (4.8)	0.002
	no	58 (12.6)	
Cancer	yes	7 (6.1)	0.12
	no	61 (11.0)	
Heart disease	yes	5 (3.2)	0.001
	no	63 (12.3)	
Kidney disease	yes	2 (4.4)	0.19
	no	66 (10.6)	
Chronic lung disease	yes	0 (0.0)	<0.001
	no	68 (12.9)	
Surgery	yes	41(9.0)	0.15
	no	27 (12.6)	
Central Catheters	yes	19 (28.4)	<0.001
	no	49 (8.1)	
Tracheal tube	yes	61 (23.0)	<0.001
	no	7 (1.7)	
Chest tube	yes	17 (23.0)	<0.001
	no	51 (8.6)	
NG tube	yes	63 (14.4)	<0.001
	no	5 (2.2)	

Table 4: The Frequency of pathogens found in positive-culture patients

Pathogen name	N (%)
E. coli	11 (9.6)
Pseudomonas spp.	9 (7.8)
Coagulase-negative staphylococci	37 (32.4)
Acinetobacterbaumannii	17 (14.9)
Candida albicans	5 (4.3)
Candida (other spp.)	2(1.75)
Klebsiella spp.	26 (22.8)
Enterococcus spp.	3 (2.6)
Gram positive bacillus	1 (0.87)

Discussion

The aim of this study was to investigate the risk factors of culture-positive infections in the ICU patients at Imam Reza hospital of Birjand in 2015. From among the patients under study, 65.3% were men and mostly in the age groups of 21-30 and 71-80 years (13.9%) with the average age of 46.12±26.08 years. The prevalence of the culture-positive infections in these patients was 10.2%.

There is a discrepancy between the reported rates of culture-positive infection in the ICUs of Iranian hospitals compared to those of other countries. For instance, Amini*et al* (11) showed that the rate of ICU infection in Mostafa-Khomeini Hospital was 10.85%, while this rate in the study by Assar *et al* (12) conducted in Golestan Hospital was 12%, and at Imam-Reza Hospital in Urmia, it was reported as 54.45% (13). All of these studies were performed in 2009.

The rates of ICU infections were reported as 11.27% by Katsovich*et al.* (10) in Bosnia, 17.7% by Rosenthal *et al*. in 55 intensive care units of 8 developing countries (14), 14.7% by Riper *et al* in France(15), and 26.8% by Ding *et al.* in China (16).

The obtained statistical data in Birjand is consistent with findings of several studies in Iran and in the world, while there is some discrepancy between the results of this study with some other studies. Factors that could cause actual statistical decrease can be attributed to the following facts:

- Some cases of nosocomial infections occur after discharge when the patients are still in the incubation period; such cases were not considered in this study and some other studies.
- Although we excluded the subjects who had taken antibiotics within 72 hours from admission to the hospital, some patients were enrolled in the study despite the use of antibiotics.
- On the other hand, the ICU of Imam Reza Hospital is a surgical ICU and therefore the length of hospitalization is less than the internal ICU, which can reduce the rate of infections. In addition, the presence of trained and experienced ICU staffs that are aware of preventive strategies like changing the angiocath and catheters at certain times is one of the contributors to infection reduction.

In this study, most cases with positive cultures (38.3%) were related to the patients with respiratory infection and given that in some cases respiratory infection was accompanied by other infections, 79.4% of the cases suffered overall from respiratory infections.

Ding et al. (16) in 2009 reported that 68.5% of the cases in ICU had respiratory infections. Amini et al. (11) reported 77.3% and Akbari et al. reported 47.27% of the ICU patients had respiratory infections (13).

In accordance with other studies, several factors including disturbance of consciousness in trauma patients, aspiration, and the use of endotracheal chest tube are the risk factors associated with high prevalence of respiratory infections.

In this study, there was a significant correlation between positive cultures and length of stay in hospital, so that 65.8% of the patients who were hospitalized more than 10 days had positive cultures, while only 2.3% of the patients who stayed for less than 5 days had positive cultures.

Amini*et al.* (11) showed that hospitalization for 26.44 days is a risk factor for ICU infections. Also, Mahdavi*et al.* (17) in 2011 reported that the length of stay about 19-21 days is a risk factor for ICU infections, while Richard (19) in USA reported that a hospitalization length of 7 days can increase the risk of infection.

As it is obvious, the increased length of stay in the ICU indicated a risk factor for ICU infection in all studies and only the number of days is different. One of the reasons for this short period (10 days) is that the surgical ICU patients often have a variety of urinary, central and peripheral catheters, and endotracheal tube, which increase the risk of other infections such that t the length of urinary catheterization and the use of chest tube correlated significantly with the incidence of infection. This has been proven by several studies including Lavazati in 2011 in Italy (20), Pekka in 2006 in the United States (21), Nell in 2010 in the United States (22), and Amini in Tehran (11).

In this study the most frequent organisms isolated from urinary tract infections were E coli and Pseudomonas, while the most frequent organisms in respiratory, wounds, and blood infections were coagulase-negative Staphylococci and *Klebsiella spp.* respectively. In a study conducted in Bushehr, Vahdat*et al.* (2004) indicated that the most common isolated organisms were Pseudomonas and Acinetobacter (23). Maryam *et al.*, (24) also reported that E coli with 64.3% frequency, coagulase negative Staphylococci with 11.2%, and *Klebsiella spp.* with 8.2% frequency were the most common isolated organisms.

The difference between the results of this study with some other findings lies with the source of ICU infection. In some studies, the urinary tract infection was the most frequent ICU infection that is mostly caused by Gram-negative bacilli rather than cocci.

On the other hand, routine and empiric use of broad-spectrum antibiotics may result in positive culture of severe infections in the ICU, such as *Acinetobacter spp.* and Pseudomonas spp. which are resistant to treatment.

Furthermore, positive culture of coagulase-negative staphylococci can be due to the hands of the ICU personnel where in the absence of effective and complete cleaning, the bacteria can be transmitted to patients.

The isolation of pathogens such as coagulase-negative Staphylococcus from the blood and the respiratory system of the ICU patients that have underlying diseases including diabetes, chronic pulmonary heart disease or steroid use confirms the need for treatment.

One of the findings of this study was the correlation between mortality rate and the incidence of positive cultures, so that 39.7% of the patients with positive cultures and 14.3% of the patients with negative cultures died (P<0.001).

Rasand*et al.* (2013) in Brazil and Nell *et al.* (2010) in the USA showed that there is a direct relationship between ICU infections and the rate of mortality (24). This could mainly be a result of increased antibiotic resistance (25, 26, 27, 28).

Conclusions

In line with other studies, the present study indicated that there is a correlation between the patients' outcome (prognosis) and the culture-positive infections in the ICU; hence, early detection and stepwise treatment approach is vital for these patients.

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Conflict of Interest: None

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