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## Evaluation of Healthcare-Associated Infections in Ardabil Hospitals, Iran, 2014-2015.

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### ABSTRACT

Health care associated infection (HCAI) is a major cause of morbidity and mortality in hospitalized patients particularly in developing countries. The purpose of this research was the evaluation of HCAI in patients admitted to five hospitals in Ardabil, Iran, during 2014. This was a descriptive-analytic study, conducted prospectively during 12 months from May 2014 to May 2015 in five participating hospitals in Ardabil, Iran. Data about patients' age, gender, site of infection, ward of hospitalization, underlying disease and type of microbial infection were collected and analyzed by SPSS 16.0. From 62601 patients hospitalized in our hospitals, 2163 patients had HCAI. The infections were 32.17% urinary tract, 3.74% Surgical site, 17.33% blood stream, 31.76% pneumonia and 14.96% other infection. The results of the present study showed that the incidence of infections was low (i.e., <3.45%). The incidence rates of infections were 32.59% in the intensive care unit (ICU), 18.34% in the neonatal intensive-care unit (NICU), 6.35% in the coronary care unit (CCU), 3.14% in the Pediatric intensive care unit (PICU) and 39.58% in other Wards. Regarding the etiology of infections, *Aspergillus*, *Streptococcus pyogenes* and *Salmonella paratyphi* were the lowest (0.04%) and *Escherichia coli* was the highest rate (7.79%) in this study. A significant association was observed between the type of infection and the age, sex, type of hospital as well as underlying disease ( $P < 0.05$ ). In this study, Healthcare-associated Infections had a lower frequency in comparison with the national rates. Our study results highlight that detection of nosocomial infections in Iran is still a problem and more attention should be to it. We hope that our findings promote strategies to facilitate the identification of hospital infections and help to prevention and control it in Iran.

**Keywords:** Epidemiology, Healthcare-associated Infections

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## INTRODUCTION

Health care associated infection (HCAI) is a major cause of morbidity and mortality in hospitalized patients particularly in developing countries[1]. HCAI, also known as nosocomial infection, defined as infections occurring within 48 hours of hospital admission or 3 days of discharge [2].Of every hundred hospitalized patients, 5 to 10 people will acquire HCAI [3]. HCAI increase mortality, length of hospitalization and medical costs. Furthermore, the treatment of hospital infections due to drug resistance to certain antibiotics can be extremely hard[4, 5]. Thus, the prevention of nosocomial infection through identification of infectious agents and removal of cases can be very effective [6, 7].

HCAI surveillance system has been recognized as essential part of infection control and *preventive* strategies [8-10]. Recently, more attention has been given to HCAI in Iran. However, limited data exist on the epidemiology HCAI in Iran [11]. Different studies have shown that by spending much costs regarding to diagnosis and training can reduce the incidence of nosocomial infections [12-14]. The most common endemic HCAI are urinary tract infections, skin and soft tissue infections, and gastrointestinal infections [15-17].

This article will be discussed about HCAI in intensive care unit (ICU), neonatal intensive-care unit (NICU), coronary care unit (CCU) and Pediatric intensive care unit (PICU)[18]. We performed this study in five hospitals in Ardabil to raise hospital staff awareness of HCAI and to assist in the prioritization of resources for infection control. We chose to study four common HCAIs: urinary tract infection(UTI), bloodstream infection (BSI), surgical site infection (SSI) and pneumonia infection (pneu). The purpose of this study was to determine HCAI incidence as well as the frequency and prevalence of microorganisms isolated in Ardabil hospitals during 2014-2015, giving an epidemiologic analysis and to provide a criterion for future comparison in the world.

## MATERIALS AND METHODS

This descriptive-analytic study was operated from May 2014 to May 2015 in Ardabil hospitals in Iran. The criteria for the diagnosis of healthcare-associated infections were based on the United States centers for disease control and prevention (CDC) definitions[19, 20]. Sampling from patients was performed randomly. Data about patients' age, gender, site of infection, ward of hospitalization, underlying disease and type of microbial infection were collected and analyzed by SPSS 16.0. A total of 62601 patients admitted to the Ardabil hospitals during 2014 to 2015, 2163 patients were included in this study. All patients were monitored daily for signs of and selected risk factors for infection during their hospital stay and during the 72 h after discharge. Patients who were infected at the time of admission were excluded from study.

### Statistical analysis

All data analyses were performed using the statistical software SPSS16. Statistical analysis was performed using the Pearson Chi-squared test to calculate the strength of association between the type of infection and the age, sex, type of hospital and underlying disease. A value of  $P < 0.05$  was considered significant.

## RESULTS

From 62601 patients hospitalized in our hospitals, 2163 patients had HCAI. Males comprised 1169 (54.04%) patients and females comprised 994 (45.95%) patients. The age range for the patients was from 1 to 94 years.

Three major infections (UTI, BSI and PNEU) were 81.27% of all infections. Pneumonia infection (pneu) was the highest among the clinical units. 76.12% of nosocomial pneumonia were associated with mechanical ventilation, 81.89% of UTIs occurred in catheterized patients, and 83.2% of primary BSIs in patients with a central line.

The results of the present study showed that the incidence of infections was low (<3.45%). The prevalence of infection varied considerably between the hospital wards. The highest rates of infections was 27.27% in intensive care unit (ICU)(Table 1).

**Table 1: Distribution of healthcare associated infection in hospital wards**

Hospital wards	UTI No. (%)	SSI No. (%)	BSI No. (%)	PNEU No. (%)	Other	Total no. of patients(%)
CCU	34 (1.57)	0(0)	2(0.1)	30(1.38)	1(0.04)	67(3.09)
ICU	65(3)	8(0.36)	31(1.43)	365(16.87)	121(5.6)	590(27.27)
NICU	4(0.18)	0(0)	112(5.17)	87(4.02)	41(1.9)	244(11.28)
PICU	0(0)	0(0)	12(0.55)	6(0.27)	5(0.23)	23(1.06)
Pediatrics	103(4.76)	0(0)	98(4.53)	10(0.46)	25(1.15)	236 (10.91)
Neurology	115 (5.31)	0 (0)	18 (0.83)	63 (2.91)	0 (0)	196 (9.06)
Surgery	57 (2.63)	51 (2.35)	17 (0.78)	20 (0.92)	18 (0.83)	163 (7.53)
Other wards	318 (14.07)	22 (1)	85 (3.92)	106 (4.9)	113 (5.22)	644 (29.77)
Total	696 (32.17)	81 (3.74)	375 (17.33)	687 (31.76)	324 (14.97)	2163 (100)

Abbreviations: UTI, urinary tract infection; SSI, surgical site infection; BSI, blood stream infection; PNEU, pneumonia; CCU, coronary care unit; ICU, intensive care unit; NICU, neonatal intensive care unit ; PICU, pediatric intensive care unit.

Regarding the etiology of infections, *Aspergillus*, *shigellaspp* and *Salmonellaspp* were the lowest (0.18%) and *Escherichiacoli* was the highest rate of infections (31.28%) followed by *Acinetobacter* species(11.17%). The most common pathogens in this study were isolated from ICU (39.66%) followed by neurology ward(20.85%)(Table 2).

**Table 2: Microorganisms responsible for HCAI in clinical units**

Pathogens	CCU No. (%)	ICU No. (%)	NICU No. (%)	PICU No. (%)	Pediatrics No. (%)	Neurology No. (%)	Surgery No. (%)	Other No. (%)	Total
Gram-positive bacteria									
<i>Staphylococcus aureus</i>	-	13(2.42)	-	-	1(0.18)	5(0.93)	2(0.37)	12(2.23)	33(6.14)
Coagulase-negative staphylococci	-	-	-	-	-	-	17(3.16)	-	17(3.16)
<i>Staphylococcus epidermidis</i>	-	6(1.11)	-	-	2(0.37)	10(1.86)	-	12(2.23)	30(5.58)
<i>Staphylococcus saprophyticus</i>	-	31(5.77)	-	-	-	-	-	5(0.93)	36(6.7)
<i>Enterococcus spp</i>	-	11(2.04)	-	-	-	1(0.18)	1(0.18)	-	13(2.42)
<i>Streptococcus agalactiae</i>	-	10(1.86)	-	-	-	1(0.18)	-	-	11(2.04)
Gram-positive cocci	-	25(4.65)	-	-	-	-	-	1(0.18)	26(4.84)
Gram-negative bacteria									
<i>Pseudomonas aeruginosa</i>	-	13(2.42)	-	2(0.37)	-	12(2.23)	1(0.18)	3(0.55)	31(5.77)
<i>Klebsiellaspp</i>	-	5(0.93)	6(1.11)	2(0.37)	1(0.18)	11(2.04)	-	-	25(4.65)
<i>Acinetobacterspp</i>	3(0.55)	41(7.63)	-	1(0.18)	2(0.37)	12(2.23)	-	1(0.18)	60(11.17)
<i>Escherichia coli</i>	8(1.48)	12(2.23)	2(0.37)	-	-	39(7.26)	2(0.37)	105(19.55)	168(31.28)
<i>Shigellaspp</i>	-	-	-	-	1(0.18)	-	-	-	1(0.18)
<i>Salmonella spp</i>	-	-	-	-	-	1(0.18)	-	-	1(0.18)
<i>Citrobacterspp</i>	-	3(0.55)	-	-	-	-	1(0.18)	2(0.37)	6(1.11)
<i>Serratiaspp</i>	-	2(0.37)	2(0.37)	-	-	-	2(0.37)	-	6(1.11)
<i>Proteusspp</i>	-	2(0.37)	-	-	-	1(0.18)	-	-	3(0.55)
<i>Enterobacter</i>	-	-	-	4(0.74)	1(0.18)	14(2.6)	1(0.18)	-	20(3.72)
Gram-negative bacilli	-	34(6.33)	-	-	-	-	-	3(0.55)	37(6.89)
Gram-negative cocci	-	5(0.93)	-	-	-	-	-	-	5(0.93)
Fungi									
<i>Candidaspp</i>	-	-	2(0.37)	-	-	4(0.74)	-	1(0.18)	7(1.3)
<i>Aspergillus spp</i>	-	-	-	-	-	1(0.18)	-	-	1(0.18)
Total	11(2.04)	213(39.66)	12(2.23)	9(1.67)	8(1.48)	112(20.85)	27(5.02)	145(27)	537(100)

In patients with primary BSIs, *Acinetobacter* (7.23%) was the most common pathogen; followed by *Enterobacter* (3.35%), *Staphylococcus epidermidis*(2.84%) and *Klebsiella* (2.84%). In patients with pneumonia, *Acinetobacter* (9.6%) was the most frequently reported pathogen. Of all reported isolates, 5.14% were gram-negative bacilli. In patients with UTIs, *Escherichia coli* (22.89%) was the most common isolate. Of reported isolates, 2.52% were *coagulase-positive staphylococci*. In patients with SSI, *Coagulase-negative staphylococci*

(6.74%) was the most frequently reported pathogen (Table not shown). Overall, in this study gram-negative bacteria (67.6%) were more common than gram-positive bacteria (30.92%), followed by fungi (1.48%).

A significant association was observed between the type of infection and the age, sex, type of hospital as well as underlying disease. Statistical results show that incidence of pneumonia infection was higher than other infections in older patients. Pneumonia and UTI infection was higher in men and women patients, respectively. As well as significant relationship was observed between type of infection and type of hospital and underlying disease (Table 3).

**Table 3: Association of HCAI with demographic traits and other variable**

Demographic traits	Typ of infection					Total No (%)	p-value	
	UTI No(%)	SSI No(%)	BSI No(%)	PNEU No(%)	Other No(%)			
Age	<65	435(20.11)	61(2.82)	301(13.91)	353(16.31)	255(11.78)	1405(64.95)	0.001
	≥65	261(12.06)	20(0.92)	74(3.42)	334(15.44)	69(3.19)	758(35.05)	
Sex	Male	336(15.53)	39(1.8)	198(9.15)	428(19.78)	168(7.76)	1169(54.04)	0.02
	Female	360(16.64)	42(1.94)	177(8.18)	261(12.06)	154(7.11)	994(45.95)	
Hospital s	Imam Khomeini	299(13.82)	36(1.66)	54(2.49)	156(7.21)	69(3.19)	614(28.38)	0.001
	Buali	1(0.04)	-	170(7.85)	14(0.64)	28(1.29)	213(9.84)	
	Social Security	192(8.87)	-	51(2.35)	30(1.38)	-	273(12.62)	
	Alavi	179(8.27)	13(0.6)	62(2.86)	144(6.65)	-	398(18.4)	
	Fatemi	20(0.92)	40(1.84)	6(0.27)	194(8.96)	3(0.13)	263(12.15)	
Underlying disease	Diabetes	58(2.68)	8(0.36)	2(0.09)	21(0.97)	5(0.23)	94(4.34)	0.001
	Blood pressure	70(3.23)	8(0.36)	3(0.13)	51(2.35)	6(0.27)	138(6.38)	
	COPD	8(0.36)	-	-	4(0.18)	2(0.09)	14(0.64)	
	Tuberculosis	12(0.55)	-	-	1(0.04)	2(0.09)	15(0.69)	
	Asthma	24(1.1)	-	2(0.09)	4(0.18)	7(0.32)	37(1.71)	
	Obesity	3(0.13)	-	-	3(0.13)	1(0.04)	7(0.32)	
	Immunodeficiency	31(1.43)	-	12(0.55)	7(0.32)	-	50(2.31)	
	No systemic disease	460(21.26)	68(3.14)	320(14.79)	421(19.46)	74(3.42)	1343(62.08)	

**DISCUSSION**

Based on the results of this study, HCAI had a lower frequency (3.45%) compared to the national rates (5.7% and 19.1%) [21]. This infection rate is consistent with study of Saeidimehr et al in Ahvaz, Iran [15, 22]. The reason for this low frequency of infection can be due to lack of reported cases of infection. For example, patients who have been discharged from the hospital and not returned after infection. Other reasons may be due to sampling error, lack of skills of health care workers as well as the use of less invasive methods for patients.

In the present study, UTI was the most common infection similar to the results of other studies [23, 24]. But in the study of Luzzati et al. [25] and Sugata et al. [6] pneumonia was the most common infection and based on the results reported by Javanbakht et al. [26], Lahsaeizadeh et al. [27] and Appelgren et al. [28], SSI was the most common infection. These conflict may be due to differences in geographic location and genetic susceptibility.

According to Table 1, prevalence of HCAI in the ICU were higher in comparison to other wards which is consistent with some other studies. In study of Hanan et al. [29], Unal and Garcia-Rodriguez [30] and Jeong et al. [31] ICU was the most common site of infection. This is due to the use of invasive methods, the severity of diseases and increasing the hospitalization time.

In our study, most isolated pathogens were gram-negative bacteria(67.6%), and the proportion of gram-positive bacteria was30.92%similar to study of Saeidimehr et al. in Ahvaz[15]. The most commonly isolated organism was *Escherichiacoli* followed by *Acinetobacter* species. But in the study of Sohrabi et al.*E. coli*, coagulase-negative Staphylococci and *Klebsiella* were the most common microorganisms in their hospital[32]. Fungal species are found in lower frequency(1.48%) in comparison to some other studies[6, 33].

As well as, unlike other studies[33, 34], coagulase negative staphylococci such as *S. epidermidis* showed the highest frequency in our study. This conflict may be due to neglecting this organism and considering it as a commensal bacteria by healthcare workers in their studies.

The relationship between sex and the HCAI, depending on the patient's underlying disease[35]. Nevertheless, sex plays a role in the development of certain HCAI. In our study, there was a statistically significant relationship between the sex and type of infection. In studies by Eckenrode et al. [35]there is strong evidence of an increased risk of CAUTI in females. As well as in studies Cohen et al.[36]men were at higher risk for BSI and SSI infections possibly because of propensity for skin colonization in men and anatomical differences. These are consistent with our findings. Also, we found overall relationship between age and HCAI. In studies by Eckenrode et al. [35] older patients did not have higher risk for HCAI rates that consistent with our study. These results conflict with several previous studies in which HCAI rates were the highest among elderly patients[37, 38].

In conclusion, our study results highlight that detection of nosocomial infections in Iran is still a problem and more attention should be to it. Therefore, despite the incidence rate of HCAI in our hospitals was low, it is necessary to have continuous surveillance systems by hand washing, wearing sterile gloves, using air conditioner in each patient's room, keeping infected patients away from other patients and appropriate nutrition[39].Further studies is needed in other areas of Iran to confirm our findings in this study. We hope that our findings promote strategies to facilitate the identification of hospital infections and help to prevention and control it in Iran.

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