ORIGINAL ARTICLE

Rate of the incidence of hospital-acquired infections in Iran based on the data of the national nosocomial infections surveillance

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Abstract

Hospital-acquired infections (HAIs) lead to increased length of hospital stay, inappropriate use of broad-spectrum antibiotics and multiple antibiotic resistance. This study aimed to investigate the rate of HAIs in Iran. In this multi-centre study, the rate of HAIs was calculated based on the data collected through Iranian nosocomial infections surveillance for patients with HAIs, as well as through hospital statistics and information systems on hospital-related variables. Data were analysed using STATA software; in addition, ArcGIS was used for plotting the geographical distribution of HAIs by different provinces. The mean age of the 107 669 patients affected by HAIs was 52 ± 26.71 years. Just over half (51.55%) of the patients were male. The overall rate of HAIs was 26.57 per 1000 patients and 7.41 per 1000 patient-days. The most common HAIs were urinary tract infections (26.83%; 1.99 per 1000 patient-days), ventilator-associated events (20.28%; 1.5 per 1000 patient-days), surgical-site infections (19.73%; 1.45 per 1000 patient-days) and bloodstream infections (13.51%; 1 per 1000 patient-days), respectively. The highest rate of HAIs was observed in intensive care units. Device, catheter and ventilator-associated infections accounted for 38.72%, 18.79% and 16% of all HAIs, respectively. Based on the results, HAIs are common in intensive care units, and urinary tract infections and device-related infections are more prevalent in Iran. To reduce HAIs it is recommended to implement appropriate policies and interventions, train staff about the use of devices, and prepare and update protocols and guidelines for improving the quality of care.

Keywords: Hospital-acquired infections, Incidence, Iran, Rate, surveillance system
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Introduction

Hospital-acquired infections (HAIs) are one of the causes of adverse events, mortality and reduced quality of life in hospitalized individuals, especially in developing countries; they lead to increased hospital length of stay (LOS), increased medical and health-care system costs, inappropriate use of broad-spectrum antibiotics and multiple antibiotic resistance [1].

By definition, HAIs refers to infections that are not present at admission and occur within 48–72 hours after admission or up to 6 weeks after discharge, not during the incubation period [2]. In addition, infections acquired by staff in a hospital setting or infections of neonates occurring in the birth canal are also considered as HAIs [3].

Hospital-acquired infections are estimated to account for a financial loss of $4.5 billion and a mortality rate of 88 000 annually, whereas the total costs spent on controlling HAIs is much lower than the cost of their treatment [4]. The most important types of HAIs are catheter-associated urinary tract infections (CAUTI), ventilator-associated events/respiratory infections/pneumonia

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(VAP), surgical-site infection (SSI) and central line-associated bloodstream infections/septicaemia (CLABSI). Device-related infections including VAP, CAUTI and CLABSI account for 25.6% and SSIs accounts for 21.8% of HAIs. These two groups of infections together account for 47.4% of all HAIs [5].

The high prevalence of infections caused by urinary catheters leads to a cumulative increase in the burden as well as complications of and deaths from UTIs [3]. VAP is an iatrogenic infection with a mortality rate of approximately 10% [6,7], which is estimated to affect more than 250 000 Americans annually [8]. SSI is associated with an increase of 60% in the risk of intensive care unit (ICU) admission, 6.5 days of increase in LOS, $300 of increase in hospital costs, and a five-fold increase in readmission [5]. In addition, statistical data have shown that the rate of bloodstream infection (BSI) in hospitalized patients is about 1% and the rate of mortality is about 25%–30%, increasing by 50% with increasing severity of sepsis [9].

A meta-analysis study of the burden of HAIs in Southeast Asia in 2015 showed that the pooled prevalence of overall HAIs was 9%. Also, the pooled incidences of VAP, CLABSI and CAUTI were 14.7 per 1000 ventilator-days, and 4.7 and 8.9 per 1000 catheter-days, respectively. The attributed mortality of infected patients varied from 7% to 46% [10]. In the Zhang et al. survey of 5 868 147 patients in 189 hospitals in Guangdong province, China, 1.24% had one or more HAIs [11]. The prevalences of device-associated infections, including VAP, CAUTI and CLABSI were 7.92 per 1000 ventilator-days, and 2.06 and 0.63 per 1000 catheter-days, respectively [11].

In Iran, statistical data have shown that the prevalence of HAIs is 1.3%–10% [12–14]. Various factors such as surgery, immune system disorders, use of immunosuppressant drugs, chronic diseases such as diabetes, cirrhosis, renal failure, cancers, use of broad-spectrum antibiotics, as well as some therapeutic interventions such as intubation, venepuncture and endoscopy have an important role in increasing the prevalence of HAIs [15]. Based on the national point prevalence survey developed by the European Centre for Disease Prevention and Control, variables associated with HAIs included age and male sex, surgery during current hospitalization, and presence of central venous or urinary catheters [16].

Prevention of HAIs is essential and within the focus of the health-care system. Many factors contribute to the spread of these infections and HAI control is now a global priority. Because accurate measurements are needed to improve any situation, infection control measures must first include the precise determination of hospital-level infections using reliable data. Studies have shown that feedbacks on health-care outcomes for different types of infections in hospitals can reduce the incidence of infection [17,18]. This study aimed to investigate the rate of HAIs in Iran in 2017.

Methods

Data sources

Iranian nosocomial infections surveillance (INIS). Using the standard definitions defined by the national hospital-acquired infections surveillance system (INIS) as a method for diagnosing HAIs, the national infectious control committee registers the four main groups of infection including the following: CAUTI, VAP, SSI and CLABSI. The data are collected with the aim of reducing mortality, morbidity and complications of HAIs, reducing hospital costs through decreasing the average length of hospitalization and therapeutic interventions, maintaining and promoting health, and increasing patient satisfaction.

Iranian nosocomial infection surveillance was developed in 2010 and now collects data from about 787 hospitals and records different types of information including age, gender, number of hospitalizations, number of deaths, number of surgeries, date of infection, province, university, affiliated organization, devices used (urinary, artery, umbilical, peripheral, and permanent and temporary central venous catheter) and outcome of infection.

Hospital statistics and information system (AVAB). The hospital statistics and information system is a web-based system for monitoring and evaluation of different hospitals. Its objective is to facilitate the process of policy-making and planning in the field of health and to meet equitable allocation of resources. The system records hospital characteristics including province, university, affiliated organization, accreditation degree, activity status, type of specialty, ward type and performance indicators including the average LOS and bed occupancy in 972 hospitals in Iran.

In this multi-centre study, INIS was used to collect data on patients with HAIs (107 669 patients with HAIs in 2017) and AVAB was used to collect data on hospital-related variables and their linkage to calculate the rate of HAIs (i.e. data on 744 hospitals).

Statistical analysis

Mean (standard deviation) was used to describe quantitative variables and frequency (percentage) was used to assess qualitative variables. Infections occurring within less than 48 hours of hospitalization were excluded from the calculation of length of hospitalization until infection and the total length of hospitalization. Data were analysed using STATA software (version 12) (StataCorp, College Station, TX, USA).

For each variable, the rate per patient was calculated by dividing total number of patients with HAIs by total number of hospitalizations multiplied by 1000.

The rate per patient-day for each variable was calculated by dividing total number of patients with HAIs by the total average patient-days multiplied by 1000. In addition, the average patient-days was calculated by the number of hospitalizations (based on the data collected from INIS) multiplied by the average LOS (based on the data collected from AVAB).

For each infection type, the rate per device-day was calculated by dividing total number of HAIs by total device-days multiplied by 1000. For SSIs, total number of SSIs was divided by total number of surgeries in each hospital. In addition, device-associated infections rate was calculated by dividing total number of HAIs related to ventilator and catheters by total device-days multiplied by 1000.

Results

The mean age of 107 669 patients with HAIs was 52 ± 26.71 years (51.93 ± 27.23 years in men and 52.09 ± 26.12 years in women). Just over half (51.47%; 55 419) of patients were male (sex ratio: 1.06 male/female).

The mean length of hospitalization was 29.22 ± 45.1 days (31.5 ± 46.42.23 days in men and 26.83 ± 43.58 days in women) (Table 1).

Based on data collected from 744 hospitals, the overall rate of HAIs was 26.57 per 1000 patients and 7.41 per 1000 patient-days (2.65% of the patients had HAIs). The rate of HAIs per 1000 patient-days was 7.01 in government hospitals and 8.24 in profit hospitals (Table 2).

The highest rate of HAIs per 1000 patients and per 1000 patient-days by ward type was observed in general ICU, transplant, internal ICU and surgical ICU (Fig. 1). The most common HAIs in patients were UTI (26.83%; 7.13 per 1000 patients and 1.99 per 1000 patient-days), VAP (20.28%; 5.39 per 1000 patients and 1.5 per 1000 patient-days), SSI (19.73%; 5.24 per 1000 patients and 1.45 per 1000 patient-days) and BSI (13.51%; 3.59 per 1000 patients and 1 per 1000 patient-days) (Fig. 2).

Concerning device-days, the rate of VAP, pneumonia and lower respiratory tract infections was 97.48 per 1000 device-days and the rate of SSI was 25.37 per 1000 surgeries (Table 3). Device, catheter and ventilator-associated infections accounted for 38.72%, 18.79% and 16% of HAIs, respectively. The most common catheter-associated infection was urinary tract infection (17.25 per 1000 device-days) (Table 4).

TABLE 1. Distribution of hospitalization-infection length and length of hospitalization by gender among hospital-acquired infection patients in Iran 2017

	Hospitalization until infection length			Length of hospitalization		
Gender	*n*	Mean ± SD	Median (Q1–Q3)	*n*	Mean ± SD	Median (Q1–Q3)
Male	55 149	16.06 ± 32.69	7 (2–18)	48 370	31.5 ± 46.41	20 (9–38)
Female	52 113	14.22 ± 32.08	6 (2–15)	46 038	26.83 ± 43.58	15 (7–32)
Missing	137	9.31 ± 12.12	4 (2–13)	96	28 ± 22.94	23 (13–36.5)
Total	107 669	15.16 ± 32.39	7 (2–17)	94 408	29.22 ± 45.1	17 (8–35)

Discussion

Hospital-acquired infections are a major problem for patient safety and can increase financial and non-financial burdens imposed on the health-care system [19,20]. In the present study, the overall rate of HAIs was 26.57 per 1000 patients (2.62%) and 7.41 per 1000 patient-days, which is lower than the rates observed in other low- and middle-income countries [21,22]. In addition, the most common HAIs were UTI (26.83%), VAP (20.28%), SSI (19.73%) and BSI (13.51%).

In Labi et al.'s study, the overall prevalence of HAIs in Ghana was 8.2%. The most common HAIs were SSIs (32.6%), BSIs (19.5%), UTIs (18.5%) and VAP (16.3%) [20]. In China, the prevalence of HAIs among 53 939 patients was 3.7%. In addition, the most prevalent HAIs were lower respiratory tract infections (47.2%), UTI (12.3%), upper respiratory tract infections (11%) and SSI (6.2%) [23]. Rafter et al. reported that the prevalence of HAIs' adverse events in Ireland was 4.4% with an incidence of 38 per 1000 admissions [19]. Moreover, Bianco et al. detected 147 HAIs in 1283 patients, with an incidence rate of 17.4 per 1000 patient-days [24], which is higher than the rate observed in our study.

In a meta-analysis of studies in Iran in 2018, the highest prevalence of HAIs was related to BSIs (9%), pneumonia (7.1%), SSIs (4.4%) and UTIs (3.1%), respectively [25]. The findings of our study about the most common HAIs are consistent with the results of Eshrati et al.'s 2018 study conducted on 7 018 393 cases of hospitalizations, and Zahraei et al.'s study in 2012 conducted on 1 879 356 patients admitted to hospitals in Iran; these two studies reported UTIs and VAP as the most prevalent types of infection, respectively [26,27]. The incidence rate of HAIs was 11.81 per 1000 hospitalizations in 491 hospitals in Iran [26].

Hospital-acquired infections were more prevalent in ICU wards. Similar findings have been reported in other studies [28,29]. In this study, device-, catheter- and ventilator-

TABLE 2. **Hospital-acquired infections count and rate by affiliation in Iran-2017**

Variables	*n*	%	No. of hospitalizations	Rate per 1000 patients	Average patient-days	Rate per 1000 patient-days
Government	79 266	82.17	2 909 132	27.25	11 263 504.8	7.01
Semi-government	4181	4.33	160 777	26	455 574.1	9.18
Profit	8522	8.83	366 486	23.25	1 034 378	8.24
Non-profit/other	2353	2.44	119 826	19.64	260 015.4	9.05
Not clear	2149	2.23	74 308	28.92	—	—
Total	96 471	100	3 630 529	26.57	13 013 472.7	7.41

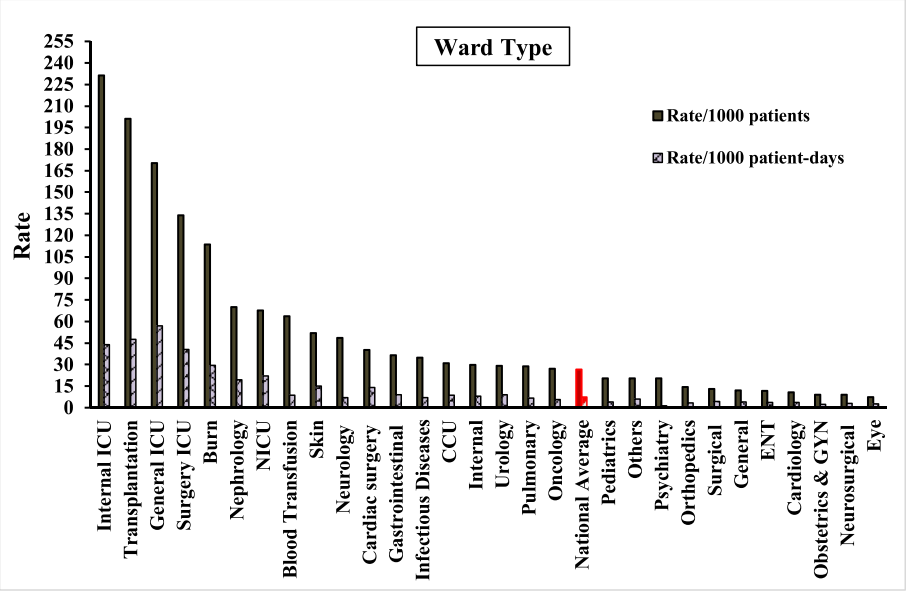
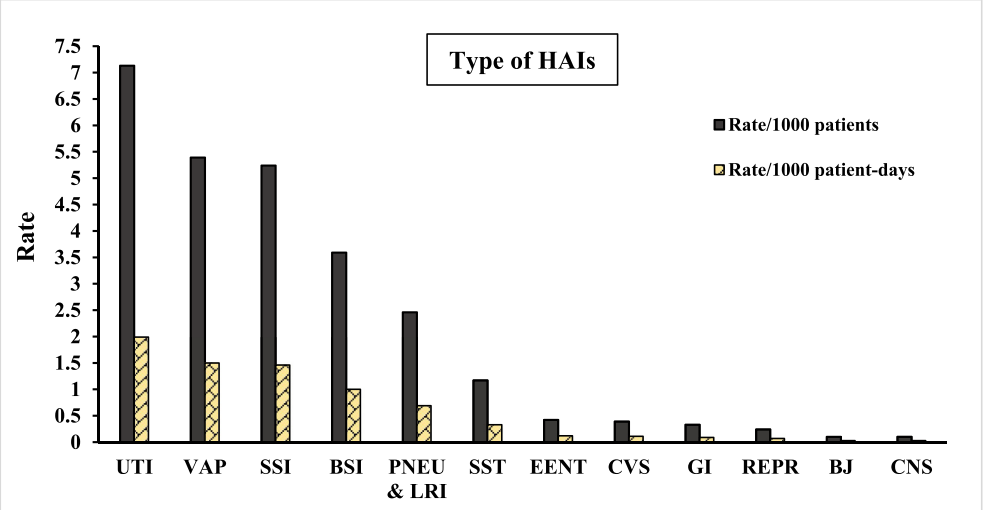


FIG. 1. Hospital-acquired infection rates per 1000 patients and per 1000 patient-days by ward type in Iran 2017.



UTI=Urinary Tract Infection; **VAP**=Ventilator Associated Penumonia; **SSI**=Surgical Site Infection; **BSI**=Blood Stream Infection; **PNEU & LRI**=Penumonia Events & Lower Respiratory Infection; **SST**=Skin and Soft Tissue; **EENT**=Eye, Ear, Nose, Throat or Mouth; **CVS**=Chorionic Villus Sampling; **GI**=Gastrointestinal System; **REPR**=Reproductive Tract Infection; **BJ**=Bone and Joint; **CNS**=Central Nervous System

FIG. 2. Hospital-acquired infection rates per 1000 patients and per 1000 patient-days by infection type in Iran 2017.

TABLE 3. Hospital-acquired infections count and rate (based on device-days) by infection type in Iran 2017

Type of infection	n	Device-days	Rate per 1000 device-days
Ventilator-associated events, pneumonia events and lower respiratory tract infection	28 506	292 433[a]	97.48
Blood stream infection	13 038	346 3[b]	37.65
Urinary tract infection	25 881	768 843[c]	33.66
Surgical-site infection	19 031	750 029[d]	25.37[e]

[a]Ventilator-days;
[b]central venous catheter (permanent and temporary) -days;
[c]urinary catheter-days;
[d]number of surgeries;
[e]per 1000 surgeries.

TABLE 4. Device-associated infections count and rate in Iran 2017

Device-associated infections	n	Device-days	Rate per 1000 device-days
Urinary catheter	13 262	768 843	17.25
Arterial catheters	125	38 542	3.24
Umbilical catheters	92	5878	15.65
Peripheral venous catheter	1471	2 300 782	0.64
Permanent central venous catheter	522	57 663	9.05
Temporary central venous catheter	2660	288 670	9.21
Ventilator	15 445	292 433	52.82
Others	3773	—	—
Catheter-Total	18 132	3 752 811	4.83
Device-Total	37 350	3 460 378	1.79

associated infections accounted for 38.72%, 18.79% and 16% of HAIs, respectively, though other studies have reported lower rates. Device-associated infections accounted for only 7.1% and 7.9% of all HAIs in the studies by Labi et al. and Chen et al., respectively [20,23]. In addition, concerning device-days (catheter-days and ventilator-days), the rate of HAIs observed in our study is much higher than those reported in other studies [30,31], this could be because other studies have been conducted in only one ward of a hospital.

Our study had some limitations. First, it was based on 1-year calculations of rates and geographical distribution; we did not access information about HAIs over different years. Calculation of incidence rate over several years could show a trend of changes in HAI rates in Iran. Second, the data were not collected from all hospitals in Iran. However, this study was conducted using registered data with a coverage of about 76.5% that was randomly collected from all provinces, so it can be claimed that the results are reliable. In addition, this study was the largest of its type; it was the first comprehensive study that was conducted using data registered by INIS and AVAB. It used data that assessed the rate of HAIs using both patient-days and device-days in Iran, which might be more accurate and can be a better indicator to follow HAIs.

Conclusion

Based on the results of our study, HAIs are common in ICU wards, and UTIs and device-related infections are more prevalent in Iran. These infections lead to prolonged hospital LOS and increased costs for patients and the health-care system. To reduce HAIs it is recommended to implement appropriate policies and interventions, train staff about the use of devices (catheters and ventilators), and prepare and update protocols and guidelines for improving the quality of care.

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Conflicts of interest

The authors declare that they have no competing interests.

Authors' contributions

NI, SS and HN contributed to the study concept and design, acquisition, analysis and interpretation of data, and to drafting of the manuscript. BE contributed to study concept and design, and to acquisition, analysis and interpretation of data. KE contributed to drafting of the manuscript, and YM contributed to analysis and interpretation of data.

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