ORIGINAL ARTICLE

Incidence of Health-care-Associated Infections and Adherence to Prevention Strategies: A Study at a Military Hospital

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Abstract

Background and Aim: One of the most common adverse events that occur during the provision of health-care services is health-care-associated infection (HAI). HAIs include catheter-associated urinary tract infections (CAUTI), surgical site infections (SSI), ventilator-associated pneumonia (VAP), and central line-associated bloodstream infections (CLABSI). The purpose of this study is to explore the prevalence of HAIs and assess compliance with HAI prevention strategies in a military hospital in Alkharj. **Methods:** The data were collected from electronic health records in addition to patient charts, microbiological laboratory reports, and admission/discharge/transfer records. The data were presented as frequencies and percentages. **Results:** The overall CLABSI rate was 0.91/1,000 central line days, the overall rate of CAUTI was 0.27/1,000 urinary catheter days, the overall rate of VAP was 0.49/1,000 ventilator days, and the overall SSI rate for the year was 0.15%. This study reveals a low prevalence of HAIs, including CLABSI, SSIs, CAUTI, and VAP, alongside high adherence to prevention protocols at the military hospital in Alkharj. **Conclusion:** The findings of the study demonstrate the effectiveness of the hospital's infection control measures. Sustained efforts in monitoring, training, and protocol evaluation are crucial to maintaining these outcomes, serving as a model for other healthcare facilities aiming to reduce HAIs and improve patient safety.

Key words: Adherence, health-care-associated infections, prevalence, preventive measures

INTRODUCTION

One of the most common adverse events that occur during the provision of health-care services is health-care-associated infection (HAI). These infections typically show up within 30 days of obtaining medical care or 48 h or more after being admitted to the hospital.[1] Initially defined as nosocomial infections, HAIs were historically linked to acute-care hospital settings. Today, the term includes infections acquired across diverse health-care environments, such as long-term care facilities, outpatient clinics, primary care practices, ambulatory centers, and home-based care.[2] HAIs specifically affect patients who acquire infections during medical care that were not available or evolving when the patient was admitted. This definition also extends to infections that arise after a patient leaves a health-care facility, as well as infections contracted by health-care workers during their professional duties.[3]

The Centers for Disease Control and Prevention (CDC) categorized HAIs into specific types, including central line-associated bloodstream infections (CLABSI), ventilator-associated pneumonia (VAP), surgical site infections (SSIs),

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and catheter-associated urinary tract infections (CAUTI). Recognizing their substantial risk to patient safety, the CDC prioritizes surveillance and prevention strategies to mitigate these infections.[4] This classification aligns with research by Al-Tawfiq and Tambyah, who identified SSIs, CLABSI, CAUTI, and VAP as the primary HAIs contributing to morbidity in health-care settings. Their work underscores the critical need for targeted interventions to address these preventable complications.[5]

VAP refers to a respiratory infection developing in patients receiving mechanical ventilation.[6] CLABSI happens when microorganisms are introduced through central venous catheters, leading to systemic bloodstream infections.[6] CAUTI affects any component of the urinary tract, from the urethra to the kidneys, typically linked to indwelling urinary catheters.[6] SSIs manifest at the incision site following surgical procedures, often complicating post-operative recovery.[6] These HAIs represent persistent challenges in clinical environments, underscoring the necessity for sustained preventive strategies to reduce their incidence and severity.

Beyond the HAIs previously described, HAIs also include antibiotic-resistant infections and *Clostridium difficile* infections. Of particular concern are those caused by multidrug-resistant pathogens such as *Klebsiella pneumoniae*, notably strains such as metallo-β-lactamase (NDM-1)-producing *K. pneumoniae*, colistin-resistant *K. pneumoniae*, carbapenemase-producing *K. pneumoniae*.[7,8] These resistant organisms present major clinical challenges, driving the urgency for enhanced infection control protocols, antimicrobial stewardship, and surveillance to curb their spread in health-care environments.

HAIs afflict millions of patients globally each year, with approximately 80,000 individuals impacted daily in Europe alone. This pervasive issue imposes heavy societal and economic strain on health-care infrastructures.[9] Previous studies demonstrate that HAIs contribute to persistent disabilities, extended hospitalization, accelerated antimicrobial resistance, elevated healthcare costs, and avoidable fatalities.[10] A substantial body of research consistently links HAIs to heightened morbidity and mortality rates, reinforcing their status as a critical public health concern.[11-16] These collective findings highlight the urgent need for comprehensive prevention frameworks and stringent infection control practices to mitigate risks in clinical environments.

Implementing a range of prevention strategies is essential to lessen the occurrence of HAIs. According to Collins, key measures include practicing hand hygiene, maintaining environmental cleanliness, demonstrating strong leadership, using personal protective equipment (PPE) correctly, following evidence-based treatments, promoting antimicrobial resistance initiatives, ensuring good respiratory hygiene, and utilizing assessment tools to avoid HAIs.[17] Despite the importance of these practices, there is limited research on the rate of HAIs and the extent to which health-care professionals in Saudi Arabia adhere to preventive care bundles. This study seeks to address this gap by estimating the occurrence of HAIs in a major city in Saudi Arabia. Specifically, it aims to explore the occurrence of HAIs and assess compliance with HAI prevention strategies in a military hospital located in Alkharj.

METHODS

Study setting

The research was carried out at the Alkharj Military Industrial Corporation Hospital, which was established in Alkharj city at the end of 1979. This is a small hospital that has a capacity of 60 beds. The facility has implemented a HAI surveillance system, which involves monitoring all inpatients throughout their hospital stay.

Data collection

The study included all confirmed HAI cases identified by the Department of Infectious Diseases in 2024. Infections occurring before 2024 or those not classified as HAIs were excluded. Data were gathered from reports prepared by the infectious disease department and the infection control unit.

Ethical approval

Ethical approval for the study was granted by the hospital's Ethical Committee. To ensure patient privacy, all identifiable information was excluded from the data collection and analysis process.

Data analysis

Six tables displayed the data as frequencies and rates. These tables included the rates of CLABSI, SSIs, VAP, CAUTI, overall HAIs, and adherence to prevention practices.

Trained staff put the HAI surveillance system into place to determine the prevalence of illnesses linked to health-care settings using predetermined standards for classifying HAIs. The data were collected from electronic health records in addition to patient charts, microbiological laboratory reports, and admission/discharge/transfer records. Infection rates for SSIs were shown to be higher after the patients' discharge period than during hospitalization.

The rate of HAIs was calculated by dividing the number of HAIs by the number of patient admissions and multiplying by 100%. The rate of SSIs was calculated by dividing the SSIs number by the number of surgical cases and after that, the result was multiplied by 100% to convert it to a percentage. The rate of VAP, CLABSIs, and CAUTIs were determined by dividing the number of infections by the total number of device days and multiplying the results by 1,000.

Percentages were used to show compliance of healthcare personnel with preventive actions to control HAI. These included adherence to the central line maintenance bundle, the central line insertion bundle, the ventilator bundle, the SSI bundle, the urinary catheter bundle, the hand hygiene protocols, the safe injection practices, and the use of PPE.

RESULTS

The rate of CLABSIs

The CLABSI rate was 0/1,000 central line days in the intensive care unit (ICU), pediatric medical and surgical ward (PMSW), and pediatric ICU (PICU). In contrast, the rates were 1.07 and 1.90/1,000 central line days in the neonatal ICU (NICU) and adult medical and surgical ward (AMSW), respectively. The CLABSI rate across all units was 0.91/1,000 central line days, calculated as two cases out of 2,198 central line days [Table 1].

The rate of CAUTIs

The CAUTI rate was 0/1,000 urine catheter days in the NICU, PMSW, and PICU. The rate was 0.20/1,000 urine catheter days in the AMSW compared to 0.7/1,000 in the ICU. The overall CAUTI rate across all units was 0.27/1,000 urine catheter days, with three cases out of 11,059 catheter days [Table 2].

The rate of VAP

The VAP rate was 0.49/1,000 ventilator days, calculated as (2/4048) *1,000. The rate was 0/1,000 ventilator days in the PMSW, NICU, the PICU, and AMSW. In contrast, the rate was 3/1,000 ventilator days in the ICU [Table 3].

The rate of SSIs

The SSI rate was 0.14% in the first 3 months of 2024, 0% in the second quarter of 2024, and 0% in the third 3 months of 2024. However, the rate increased to 0.51% in the fourth quarter of 2024. The overall SSI rate for the year was 0.15%, calculated as (four cases out of 2,589 procedures) *100% [Table 4].

The rate of HAIs

The rate of HAIs was 0.10% in the first 3 months of 2024, 0.16% in the second quarter of 2024, 0.05% in the period between July 01, 2024 and September 30, 2024, and 0.22% in the last 3 months of 2024. The overall HAI rate for the year was 0.13%, based on 11 cases out of 8,270 admissions [Table 5].

Table 1: The rate of central line-associated bloodstream infections

Department	Number of CLABSI cases	Central line days	CLABSI rate (per 1,000 central line days)
ICU	0	686	0
PICU	0	33	0
NICU	1	934	1.07
AMSW	1	522	1.90
PMSW	0	23	0
Total	2	2,198	0.91

ICU: Intensive care unit, PICU: Pediatric intensive care unit, NICU: Neonatal intensive care unit, AMSW: Adult medical and surgical ward, PMSW: Pediatric medical and surgical ward

Table 2: The rate of catheter-associated urinary tract infections

Department	Number of CAUTI cases	Urinary catheter days	CAUTI RATE (per 1,000 urinary catheter days)
ICU	1	1,398	0.7
PICU	0	34	0
NICU	0	18	0
AMSW	2	9,542	0.20
PMSW	0	67	0
Total	3	11,059	0.27

ICU: Intensive care unit, PICU: Pediatric intensive care unit, NICU: Neonatal intensive care unit, AMSW: Adult medical and surgical ward, PMSW: Pediatric medical and surgical ward

Table 3: The rate of ventilator-associated pneumonia

Department	Number of VAE cases	Ventilator days	VAE rate (per 1,000 ventilator days)
ICU	2	652	3.0
PICU	0	24	0
NICU	0	522	0
AMSW	0	2,483	0
PMSW	0	367	0
Total	2	4,048	0.49

ICU: Intensive care unit, PICU: Pediatric intensive care unit, NICU: Neonatal intensive care unit, AMSW: Adult medical and surgical ward, PMSW: Pediatric medical and surgical ward

The overall compliance rate for PPE, hand hygiene, and care bundles

Table 6 displays the overall compliance rates for PPE, hand hygiene, and care bundles. Compliance rates for PPE, hand hygiene, urinary catheter bundle, ventilator bundle, SSI bundle, and safe injection practices ranged between 90% and

Table 4: The rate of surgical site infections

Period	Number of SSI cases	Number of surgeries	Rate of SSI (%)
January 01, 2024–March 31, 2024	1	738	0.14
April 01, 2024–June 30, 2024	0	618	0
July 01, 2024–September 30, 2024	0	641	0
October 01, 2024–December 31, 2024	3	592	0.51
Total	4	2,589	0.15

Table 5: The rate of healthcare-associated infections

Months	Number of HAI cases	Number of admissions	HAI rate (%)
January 01, 2024–March 31, 2024	2	2,035	0.10
April 01, 2024–June 30, 2024	3	1,925	0.16
July 01, 2024–September 30, 2024	1	2,010	0.05
October 01, 2024–December 31, 2024	5	2,300	0.22
Total	11	8,270	0.13

95%. The overall compliance rate for the central line insertion bundle was 99%, whereas the central line maintenance bundle had a 97% compliance rate.

DISCUSSION

The current study sought to examine the prevalence of HAIs and evaluate adherence to HAI prevention protocols at a military hospital in Alkharj. The findings revealed an overall SSI rate of 0.15% for the year. Similarly, Haseeb *et al*. reported a low SSI rate of 1.9% in a hospital in Makkah.[18] John *et al*. documented SSI rates of 4.68% in general surgery and 3.57% across the entire department at Sheikh Khalifa Medical City.[19] In addition, Wong and Holloway found an SSI incidence of 11.7% in the general surgery department of a Malaysian hospital.[20] While the current study observed lower SSI rates, earlier research in Saudi Arabia reported higher prevalence. Alsareii documented an overall SSI rate of 10.2% at a tertiary care hospital,[21] and Khairy *et al*. identified a 6.8% rate at a Riyadh-based university hospital.[22] Regarding VAP, this study noted a comparatively low incidence. Globally, reported VAP rates vary significantly. Zhang *et al*. found 7.92 cases/1,000 catheter-days.[23,24] Jahani-Sherafat reported 7.88 cases/1,000 mechanical ventilator-days across Iranian teaching hospitals.[25] Khan *et al*. documented a mean monthly

Table 6: The overall compliance rate for PPE, hand hygiene, and care bundles

Item	Compliance rate (%)
Compliance rate for personal protective equipment	93
Hand hygiene compliance rate	90
Compliance with urinary catheter bundle	94
Compliance with ventilator bundle	95
Compliance with central line insertion bundle	99
Compliance with central line maintenance bundle	97
Compliance with surgical site infection bundle	91
Compliance with safe injection practice	92

rate of 2 cases/1,000 device-days in an Indian ICU.[11,12] Iordanou *et al*. observed 10.1 cases/1,000 ventilator-days in a Cypriot ICU.[26] These disparities highlight variability in infection surveillance and prevention practices, underscoring the importance of standardized protocols to reduce HAI risks.

The present study found a low incidence of CLABSIs, a trend consistent with prior research. For example, Ahmed *et al*. documented CLABSI as comprising 10% of all device-related HAIs,[27] whereas Gaid *et al*. reported a rate of 14.2% for such infections.[28] Zhang *et al*. further observed a CLABSI prevalence of 0.63 cases/1,000 catheter-days,[23,24] and Jahani-Sherafat noted a rate of 5.84 cases/1,000 central line-days in Iranian academic hospitals.[25] Similarly, the study identified low rates of CAUTIs, mirroring earlier findings. Zhang *et al*. reported a CAUTI prevalence of 2.06 cases/1,000 catheter-days,[23,24] and Jahani-Sherafat recorded 8.99 cases/1,000 urinary catheter-days in the same hospital settings.[25] In addition, Khan *et al*. highlighted a mean monthly CAUTI rate of 1.25 cases/1,000 device days among ICU patients in an Indian teaching hospital.[11,12] These results collectively underscore the alignment of the current findings with global data on device-related HAIs.

The current study revealed notably high compliance rates with PPE, hand hygiene protocols, and care bundles. Enhanced adherence to these preventive strategies has been linked to reduced HAI rates, as demonstrated by multiple studies. Al-Thaqafy *et al*., for instance, documented a rise in ventilator bundle compliance between 2010 and 2013 period from 90% to 97% after introducing the Institute for Health-care Improvement (IHI) ventilator bundle, which coincided with a decline in VAP rates from 3.6 to 1.0 cases/1,000 ventilator days.[29] Bagga *et al*. further highlighted a marked decrease in SSIs following rigorous implementation of preventive care bundles.[30] Similarly, Yaseen *et al*. observed a reduction in CLABSI rates from 2.0 to 0 cases/1,000 central line-days after adopting the IHI prevention bundle.[31] Prakash *et al*. reported a 51.4% drop in CAUTI rates through a care bundle approach,[32] whereas Ormsby *et al*. noted improved reliability in central venous catheter bundle adherence, alongside a modest (though non-significant) reduction in CLABSI rates.[33] The study also underscored the critical role of proper PPE utilization, particularly face masks, in infection control. Prior research supports the efficacy of facemasks in curbing disease transmission, especially by blocking respiratory droplets.[34,35] This aligns with findings by Ong *et al*., who emphasized strict environmental and hand hygiene practices, coupled with PPE use, to mitigate nosocomial spread of SARS-CoV-2 during the COVID-19 pandemic.[36] Together, these findings reinforce the importance of sustained compliance with preventive measures to minimize HAIs.

The study has two main limitations. First, its single-hospital design limits the generalizability of the results to other health-care settings. Second, it focused solely on care bundles implemented by health-care professionals and did not assess environmental factors such as air and surface quality in hospital wards. Future research should investigate the role of environmental factors (such as mold presence in the air and on surfaces) in influencing the prevalence of HAIs.

CONCLUSION

This study reveals a low prevalence of HAIs, including CLABSI, SSIs, CAUTI, and VAP, alongside high adherence to prevention protocols at the military hospital in Alkharj. These findings demonstrate the effectiveness of the hospital's infection control measures. Sustained efforts in monitoring, training, and protocol evaluation are crucial to maintaining these outcomes, serving as a model for other healthcare facilities aiming to reduce HAIs and improve patient safety.

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DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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