Nosocomial Infections and their Risk Factors at Mubarak Al-Kabeer Hospital, Kuwait

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Abstract

Healthcare-associated infections (HAIs) include almost all infections that do not originate from a patient's admitting diagnosis. This study is a retrospective cohort study aimed at assessing the prevalence of HAIs at Mubarak Al-Kabeer Hospital (MKH) in Kuwait during the years 2006-2008. MKH is a teaching hospital associated with Kuwait University Faculty of Medicine with a combined medical and surgical intensive care unit (ICU), pediatric intensive care unit (PICU) and 14 wards with 534 beds. There are approximately 20,000 patients discharged from this per year. This retrospective study investigated HAIs in the years 2006-2008. One-way analyses of variance showed that the average attack rate for HAIs in 2006 was significantly lower than in 2007 or 2008 (p<0.01). For HAIs with methicillin-resistant Staphylococcus aureus (MRSA), our results revealed 10 (3.3%) MRSA infections in 2006 out of a total of 307 infections, 29 (6.6%) MRSA infections out of 441 total infections in 2007 (p<0.05) and 21 (5.5%) MRSA infections out of 387 total infections in 2008. Pseudomonas aeruginosa (up to 22.5%) and Acinetobacter baumannii (up to 22.1%) were the most predominant pathogens isolated during the period of investigation. Our findings revealed an increasing rate of HAIs among MKH patients. Risk factors for HAIs included the high number of patient admissions and our results indicated the need for effective infection surveillance and control programs to be implemented in the hospital.

Key Words: Nosocomial infections – Healthcare – Associated Infections (HAIS).

Introduction

HEALTHCARE-associated infections (HAIs), also known as hospital-acquired infections or nosocomial infections, encompass almost all clinically evident infections that do not originate from a patient’s initial diagnosis [1]. HAIs are not a new problem, they have always presented a challenge for the healthcare service. Infections are considered HAIs if they develop 48 hours or more after hospital admission or within 30 days following discharge and often affect the urinary tract, skin, mucus membranes, surgical sites, or manifest as pneumopathy acquired in an intensive care unit (ICU). During the 21st century, some severe cases of HAIs have arisen [2], due to the increased appearance of bloodstream infections and multidrug-resistant bacteria, such as vancomycin-resistant enterococci (VRE), methicillin-resistant Staphylococcus aureus (MRSA) and multidrug resistance Gram-negative bacteria [3]. Recent figures indicate that as many as one in ten hospital patients acquires a HAI [4]. There is an important difference between infection with antibiotic resistant bacteria and colonization. Infection can develop into serious illness due to contamination of wounds, or direct contamination of the bloodstream or other tissues. While colonization with antibiotic resistant bacteria may arise in the gut, nasal cavities or other bodily surfaces [5] and colonizing bacteria may persist for years within their hosts without causing disease [6,7], such hosts are known as carriers. Hospitals that successfully reduce the number of infections with antibiotic resistant bacteria [7] may see no overall reduction in prevalence, because they will also be continually admitting antibiotic resistant bacteria (ARB) carriers [7,8].

Surveillance of HAIs has become an essential part of infection control and quality assurance in all hospitals [9-11]. Standards for surveillance have been approved in the United States [10], the United Kingdom [12], Australia [13], Canada [14] and Germany [15]. Increase attention is now paid towards the enhancement of infection control practices and patient safety [16]. Consistent surveillance programs for HAIs have been applied across hospitals to produce accurate data for inter-hospital comparisons [17]. However, these programs are time-
consuming and labor intensive to establish and maintain, making multicenter studies difficult to coordinate [18]. Instead, prevalence surveys are regularly performed to give baseline information about HAI rates and to establish priorities for infection control, because these types of large-scale surveys are less costly and less time-consuming [18].

Material and Methods

Setting:
This study was carried out at Mubarak Al-Kab eer Hospital (MKH), a teaching hospital associated with Kuwait University Faculty of Medicine. MKH is located in Hawally province and has a combined medical and surgical ICU, pediatric intensive care unit PICU and 14 wards with 534 beds. There are approximately 20,000 patients per year discharged from this hospital. MKH receives high ratios of device-utilizing patients which leads to an increased risk of HAIs.

Patients:
This investigation is a retrospective study investigating HAIs at MKH from 2006-2008. Reports of HAIs are released annually by the Infection Control Department, Kuwait. Every year an annual report was also prepared by the hospital to illustrate the number and percentage of HAIs in the ICU, PICU, critical care unit (CCU), and the different hospital wards (including the general medical/surgical wards and the internal medicine wards for males and females). Patients included in this study were admitted to MKH in the period between 2006 and 2008 and were diagnosed with a HAI (s) (according to the Centers for Disease Control (CDC) definition [19]) during their hospital stay. The infection control team in the hospital performed standard surveillance that involved ward rounds, microbiology reviews and chart reviews. Kuwait National Nosocomial Infection Surveillance (KN-NIS) worksheets were used. Infection control surveillance was conducted, as hospital-wide rather than targeted surveillance. All patients diagnosed to have a HAI, according to the CDC definition, were included in the study. The percentage of HAIs in the hospital was determined by dividing the total number of HAIs by the number of patients discharged from each individual department, including the ICU.

In the ICU, surveillance included in addition to the above-mentioned method calculation of patients’ days as well as the device days (Ventilator, central line and central vascular catheters) then these days were used as denominators to calculate the HAI according to the following formulas:

\[
\text{Incidence rate} = \frac{\text{No. of new nosocomial infections}}{\text{No. of patient days}} \times 1000
\]

\[
\text{Device-associated infection (DAI) rate} = \frac{\text{No. of DAIs for a specific site}}{\text{No. of device days}} \times 1000
\]

Examples:

- Central line-associated bloodstream infection rate = \[ \frac{\text{No. of central line-associated bloodstream infections}}{\text{No. of central line days}} \times 1000 \]

- Urinary tract infection (UTI) rate = \[ \frac{\text{No. of urinary catheter-associated UTIs}}{\text{No. of urinary catheter days}} \times 1000 \]

- Ventilator-associated pneumonia rate = \[ \frac{\text{No. of ventilator-associated pneumonia cases}}{\text{No. of ventilator-days}} \times 1000 \]

Surveillance included all types of HAIs (catheter related bloodstream infection (CRBSI), UTIs, pneumonias, surgical site infection (SSI), cutaneous and subcutaneous infections, and gastrointestinal tract (GIT) infections) and all surveyed patients were observed for the development of these types of infections. Data on the medical condition of patients, procedures performed, type of pathogens involved, and the site and rate of infection, were collected from patient's medical records. Information on the type of surgery received by patients was also collected, and the resulting wounds were characterized as follows:

1- Clean wounds: Uninfected operative wounds in which inflammation was not encountered, and the respiratory, gastro-intestinal, genital or urinary tracts, or the oropharynx, were not entered, and there was no break in aseptic techniques. In addition, clean wounds were primarily closed and, if there is drainage, this was also closed. Operative wounds that follow non-penetrating trauma, e.g., fractured neck of the femur, were included in this category provided they met these criteria.

2- Clean-contaminated wounds: Operative wounds in which the respiratory, alimentary, genital or urinary tracts were entered under controlled conditions and without unusual contamination, providing there was no evidence of infection or a major break in aseptic techniques. Procedures that did not enter one of these body tracts were not classified as clean-contaminated wounds e.g., orthopaedic procedures. Specifically, operations involving the biliary tract, appendix, vagina and oropharynx were included in this
category, provided no evidence of infection or a major break in aseptic techniques was encountered.

3- Contaminated wounds: Operations on fresh, open, traumatic wounds, operations where there was a major break in aseptic techniques (e.g., open cardiac massage), or operations in which there was gross spillage from the GIT, or acute inflammation without pus, were all included in this category.

4- Dirty or infected wounds: Operations in which acute inflammation with pus was encountered or perforated viscera were found, operations on traumatic wounds which had retained devitalised tissue, foreign bodies or faecal contamination, or where the operation on the traumatic wound had been delayed. Operations included in this category were those in which the organisms responsible for post-operative infections were likely to have been present in the operative field before surgery.

Samples from different sites were collected routinely from all patients. Samples were cultured on appropriate bacteriological culture media and incubated in air at 37°C for 24h. Representative isolates were identified using an automated Vitek II ID system (bioMérieux, Marcy l’Etoile, France).

This study was approved by the Public Authority for applied Education and Training, Kuwait, in April 2009 and was then approved by the Medical and Health Committee (research No. 381) for Public Health at the Ministry of Health, Kuwait, in January 2010.

Data analysis:

Statistical analysis of the data was carried out using SPSS for Windows (version 17.0). Differences in the data between surveyed hospital were analyzed using the chi-square ($\chi^2$) test, F test and one-way analysis of variance (ANOVA). A probability of <0.05 was considered significant.

Results

A total of 20,931, 20,626 and 21,392 patients were discharged from MKH during 2006, 2007 and 2008, respectively. Among them 1,135 patients acquired an infection during their hospital stay. In 2006, the total number of infections among discharged patients reached 307, with an attack rate of 1.47%. In 2007, the number of infections reached 441, with an attack rate of 2.14%. In 2008, the number of infections was 387, with an attack rate of 1.8%.

Total attack rates varied by month in the different years, as shown in Table (1). ANOVA showed that the average attack rate in 2006 was significantly lower than that in 2007 and 2008 ($p<0.01$). However, there was no significant difference in the attack rate between 2007 and 2008 and no significant variations within months in the different years were detected ($p>0.05$).

The lowest average MRSA infection rate was recorded in 2006, it increased in 2007, and then remained the same in 2008. For hospital-associated MRSA infections, 10 cases were reported in 2006 (attack rate 0.47/100 discharges) out of a total of 307 (3.3%) infections, 29 cases were reported in 2007 (attack rate 3.85/100 discharges) out of 441 (6.6%) total infections, and 21 cases were reported in 2008 (attack rate 3.9/100 discharges) out of 387 (5.5%) total infections. The mean percentage ± SD of the total attack rates of HAIs during the years 2006, 2007 and 2008 was 1.47±0.83, 2.14±1.88, 1.81±1.22, respectively.

The MRSA attack rate varied by month for each year and no consistent trend was observed Table (2). One-way ANOVA showed that the average attack rate in 2006 was significantly lower than that in 2007 and 2008 ($p<0.05$). However, there was no statistically significant difference between the years 2007 and 2008. The mean ± SD of the MRSA infection rate during the years 2006, 2007 and 2008 was 1±0.83, 2±1.88 and 2±1.22%, respectively.
The attack rate for HAIs in the ICU did not differ significantly between the years 2006-2008 (p>0.05) and no consistent pattern was observed. The monthly attack rate varied from 3-11% in 2006, 3-14% in 2007 and 4-13% in 2008. The mean ± SD of the HAI rate in the ICU during 2006, 2007 and 2008 was 7±2.3, 10±3.8 and 9±3.4% respectively.

Fig. (1) represents the attack rate of HAIs in the ICU and shows the organisms involved. Pseudomonas aeruginosa (56.6%) and Acinetobacter baumannii (63.0%) were the predominant pathogens isolated during the period of investigation. The only significant difference detected among pathogens was the attack rate of Candida albicans between the years 2007 and 2008. For the rest of the data, the frequencies were less than five, so p-values could not be calculated.

As shown in Table (3), the attack rate of HAIs in the ICU was higher in 2008 than in 2006 or 2007. Statistically, a highly significant difference was found between the attack rate of HAIs in the ICU in 2006 and 2008 and again between 2007 and 2008, while no significant difference was found between 2006 and 2007. The percentage of infections in these two years was also low compared with 2008. Generally, the percentage of HAIs in the different wards of the hospital was low during 2006 and 2007 and showed no significant difference among wards, with the exception of wards W5 and W10, or between the years 2006 and 2007. The highest percentage of HAIs in almost all wards, except PICU, was recorded in 2008.

Fig. (2) shows the attack rates of HAIs in different wards. The ICU had the greatest percentage of HAIs, followed by the PICU, and then ward 12 (internal medicine patients). Statistically, a significant difference was found in the attack rate of infections between ICU and PICU, and the highest percentage of infections was recorded in 2008.

Table (4) presents the attack rate of HAIs, according to the infection site, for the different years. The number of infections and the attack rates of UTIs during 2006, 2007 and 2008 were 80 (26.1%), 110 (24.9%) and 77 (19.9%), respectively. The number of infections and the attack rates of lower respiratory tract infections during 2006, 2007 and 2008 were 38 (12.3%), 54 (0.23%) and 26 (6.7%), respectively. For surgical site infections, the number of infections and the attack rates were 63 (20.5%), 87 (19.7%) and 81 (20.9%), over these three years. The number of UTIs differed significantly between the years 2006 and 2008, 2007 and 2008, and 2006 and 2007. The lowest attack rate of UTIs was recorded in 2008. Similar patterns and significant differences were found between the years for lower respiratory tract infections. The number of blood stream infections (BSIs) differed significantly between 2007 and 2008. The infection rate of cutaneous and subcutaneous infections was lowest in 2006 and differed significantly between the years 2006 and 2007. The attack rate from other causes of infection differed significantly only for the years 2006 and 2007, and 2006 and 2008.
Table (4): Distribution of infections among different sites.

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<tbody>
<tr>
<td>Urinary tract infections</td>
<td>26.06</td>
<td>24.94</td>
<td>19.9</td>
<td>&gt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
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<tr>
<td>Upper respiratory tract infections</td>
<td>0.23</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Lower respiratory tract infections</td>
<td>12.38</td>
<td>12.24</td>
<td>6.72</td>
<td>&gt;0.05</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Surgical site infections</td>
<td>20.52</td>
<td>19.73</td>
<td>20.93</td>
<td>&gt;0.05</td>
<td>&gt;0.05</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Blood stream infection</td>
<td>32.9</td>
<td>33.11</td>
<td>44.7</td>
<td>&lt;0.01</td>
<td>&gt;0.05</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Cutaneous &amp; subcutaneous</td>
<td>3.26</td>
<td>7.71</td>
<td>5.17</td>
<td>&lt;0.01</td>
<td>&gt;0.05</td>
<td>&gt;0.05</td>
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<tr>
<td>Vascular site infection</td>
<td></td>
<td></td>
<td>0.52</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Others (CNS/GIT infections)</td>
<td>4.89</td>
<td>2.04</td>
<td>1.29</td>
<td>&lt;0.05</td>
<td>&lt;0.01</td>
<td>&gt;0.05</td>
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<tr>
<td>Eye infection</td>
<td></td>
<td></td>
<td>0.26</td>
<td></td>
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<tr>
<td>Ear infection</td>
<td></td>
<td></td>
<td>0.52</td>
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Fig. (3) illustrates the attack rate of HAIs among the four different types of operations (clean, clean-contaminated, contaminated, dirty) during the period of investigation, 2006-2008. Statistical analysis indicated that dirty operations were associated with a 20% higher rate of infection than the other type of operations. The total number of clean operations was 887, 995 and 934 in the years 2006, 2007 and 2008, respectively, with a total number of infections and attack rates of 14 (1.6%), 19 (1.9%) and 13 (1.4%), respectively. The total number of clean-contaminated operations was 1454, 1142 and 669, with a total number of infections and attack rates of 12 (0.83%), 14 (1.2%) and 6 (0.9%), respectively. For contaminated operations, the total number of operations was 697, 1059 and 1423, with a total number of infections of 3 (0.4%), 5 (0.5%) and 7 (0.5%), respectively. Finally, the total number of dirty operations was 200, 252 and 225 during the years 2006, 2007 and 2008, respectively, with a total number of infections and attack rates of 16 (8%), 14 (5.5%) & 22 (9.78%), respectively. Although the attack rate of infections in dirty operations was higher, the infection rates between the four different types of operations (clean, clean-contaminated, contaminated, dirty) did not vary significantly between years and no clear trends were observed for different months (p>0.05).

Fig. (1): The attack rate of HAIs in the ICU.
The study presented here is a retrospective cohort study investigating the attack rates and risk factors associated with HAIs in MKH during the years 2006-2008. Despite following the same healthcare guidelines, the rate of HAIs may be higher in larger hospitals than in smaller hospitals because larger hospitals receive a higher number of patients, increasing the risk of HAIs. In addition, teaching hospitals such as MKH receive a high ratio of device-utilization patients which also increases the risk of HAIs, as demonstrated by a study that found that hospitals with a capacity of 600 beds had a significantly higher number of HAIs than hospitals with a 200-bed capacity [20].

The results of our study indicated a significant number of MRSA infections in MKH. The number of antimicrobial-resistant HAIs is increasing at an alarming rate worldwide. MRSA is now a constant problem in various hospital settings, where it can routinely be isolated from floors, benches, bed frames, furniture handles and linen. Colonized or infected patients and staff who are carriers of MRSA act as reservoirs of this pathogen [21]. Infections with MRSA or other HAIs may necessitate the isolation of patients in an attempt to control the spread of infection, but procedures such as ward closures are expensive exercises considering that many hospitals have limited resources [22].

Our findings indicated that the percentage of HAIs in the ICU was higher in 2008 which could be attributed to the increasing number of patients admitted during this year. In our study, the attack rate of HAIs in the ICU was found to be higher than in some previous reports [23-25] but lower than in others [26]. The differences in attack rates between studies may be attributable to the efficiency of different preventative practices in different hospital settings. In addition, the rate of HAIs in different hospital settings is not easy to compare due to differences in the type of unit, the type of ward, the duration of hospital stays and the commencement of HAIs. We found that the ICU, the PICU and ward 12 had the highest percentage of HAIs. According to the Joint Commission on Accreditation of Healthcare Organizations (JCAHO), HAI rates are considered indicators of the quality of hospital care [27,28]. The attack rate of HAIs, especially in the ICU, could be increased due to the following factors: The use of sedative medications, tracheostomy and enteral feeding of the patients. These factors may increase the aspiration [29] which may be related to the development of HAIs [30,31]. Some studies have reported that certain sedative medications were associated with HAIs and, for this reason, special precautions should be taken with patients that receive this type of medication [32]. Invasive procedures, such as tracheostomy, have been demonstrated to be risk factors.
factors for HAIs, especially healthcare-associated pneumonia [33-35]. The risk factors for HAIs could be reduced, or even avoided, by suctioning respiratory tract secretions under aseptic conditions which decreases the attack and mortality rates associated with HAIs. Enteral feeding is also considered a risk factor of HAIs [29] as enteral feeding and the use of nasogastric tubes may lead to aspiration and reflux, which increase the risk of HAIs, especially in ICU patients [23]. The development of HAIs in ICU patients can lead to extended ICU stays, leading to a significant economic burden.

UTIs were the most common type of HAIs in MKH, as reported in a previous study [36]. The high rate of UTIs may be due to urinary catheterization. Lower respiratory tract infections and surgical site infections were the second and third most frequent types of infection recorded in this study. The frequency of occurrence of infections at different sites may change according to the hospital population and setting [37].

In this study, some healthcare-associated pathogens were isolated and the most frequently isolated pathogens in order of predominance were: P. aeruginosa, A. baumannii, C. albicans, Klebsiella pneumoniae and E. coli. P. aeruginosa and E. coli were most frequently associated with UTIs. S. aureus was most frequently associated with surgical site infections, followed by enterococci and E. coli. P. aeruginosa was associated with lower respiratory tract infections, as were S. aureus and Klebsiella SPP. [38]. Our findings indicate the importance of focusing on the removal of devices, which increase the risk of infection, and targeting interventions to Gram-negative bacteria rather than purely MRSA. It has been reported that establishing effective infection surveillance and control programs in hospitals could prevent one third of HAIs [23].

The range and occurrence of HAIs is rapidly increasing due to compromised hygiene, immunosuppressive treatment and the over use of antibiotics. The expense associated with HAIs in most developing countries has not been documented [39]. In addition, there is insufficient financial support for healthcare by the governments of most developing countries, which can lead to inappropriate or inadequate HAI control and surveillance activities. The rate of morbidity and mortality associated with HAIs is higher in developing countries than in developed countries. This is due to a lack of healthcare information systems, hospital epidemiology and infection control programmes that are essential for the prevention and control of HAIs. It is important to consider all of the risk factors in the development of effective strategies to combat HAIs.

Conclusions:

Gram-negative bacteria are the most common cause of HAIs in Kuwait and UTIs and ventilator-associated pneumonia are the most common associated infections. In our study, invasive device use was found to be common, potentially increasing the rate of HAIs. In Kuwait, intensive care resources should be targeted at these problems rather than pursuing MRSA active surveillance or other interventions being considered in the US and Europe. Computer surveillance is an appropriate method for monitoring infection control and identifying changes in risk factors that could increase the HAI rate and be used as indicators of the quality of hospital care. In these kinds of studies, demographic data such as age and gender should be recorded as many studies have revealed that the risk of HAI is affected by a patients age and gender. The authors also recommend the application of case-mix assessments and case-mix adjustments [40,41].

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