AN EPIDEMIOLOGICAL SURVEY AND CLINICAL OUTCOME OF HEALTHCARE-ASSOCIATED INFECTION IN A TERTIARY CARE ICU

Arif S Sheikh

ABSTRACT
Introduction: Healthcare-associated (nosocomial) infections are defined as those infections that are not present or incubated at the time of admission to the hospital. The WHO estimates that the rate of healthcare-associated infections (HAIs) is 7%–12% among hospitalized patients worldwide, where >1.4 million people had infection-related complications during their stay in the hospital. The burden of HAIs is more in developing countries, with the highest prevalence in the ICUs. Aim: To study the Incidence, type of causative organisms and site of healthcare-associated infection in adult ICU. To assess the impact of healthcare-associated infection on the length of stay and mortality. Methodology: A prospective – cohort study, which was studied for five months from October 2019 to February 2020. Patients admitted to the intensive care unit and then developed an infection and who stayed for more than 48 hours were included. Depending on the criteria, patients were classified into catheter-associated urinary tract infection (CAUTI), central line-associated bloodstream infections (CLABSI), ventilator-associated pneumonia (VAP), surgical site infections (SSI). Results: A total of 111 cases were studied as per recruitment criteria; 18 cases had healthcare-associated infections. Cumulative incidence rate (attack rate) was 16.22%, ventilator-associated pneumonia (VAP) rate = 5.16 per 1000 ventilator days, urinary tract infection rate (CAUTI) = 3.95 per 1000 catheter days, central line-associated bloodstream infection (CLABSI) rate = 6.17 per 1000 central line days. Bloodstream infection (BSI) 38.9% was the commonest site infection, followed by pneumonia 27.8%, urinary tract infection (UTI) 22.2% and surgical site infection (SSI) 11.1%, respectively. Gram-negative bacteria were the most frequently associated organism. The most common pathogen was Klebsiella pneumoniae (45.5% cases), followed by E. coli (18.1% cases), a combination of Staphylococcus aureus and Pseudomonas in (9.2% cases) and others like Acinetobacter baumannii, Citrobacter freundii, Enterobacter cloacae (each 4.5% cases). The average length of stay for patients with Healthcare-associated infections in ICU was 18.06 days±11.021 days. Mortality with healthcare-associated infection was 16.7%. Mortality was associated with patients having bloodstream infection and pneumonia, and organism associated with mortality were Klebsiella pneumoniae and Staphylococcus aureus. Conclusion: Healthcare-associated infections (HAI) develop in patients while receiving care in health facilities. This study provides information for the prevention strategies for HAI and improving the health care service level.

Introduction
Modern medicine has seen increased patient admission into hospitals due to both communicable and non-communicable diseases. In recent years, nosocomial infections have become even more problematic because of increased numbers of immune-compromised patients, increasing antibiotic resistance in pathogenic bacteria, increased rate of fungal and viral superinfections, an increased number of invasive procedures and invasive devices.

The WHO estimates that the rate of healthcare-associated infections (HAIs) is 7%–12% among hospitalized patients all over the world, where >1.4 million people had infection-related complications during their stay in the hospital [1,2,3]. The burden of HAIs is more in developing countries, with the highest prevalence in the ICUs. Indian estimate revealed the overall rate of 14.7% HAIs corresponding to 22.5 infections/1000 ICU days.[4] Indian data on HAI during 2004–2012 showed that the HAI rates vary from 4.36% to 83.09%, with infections per 1000 patient days ranging from 6.16 to 40.66[5]. The incidence of healthcare-associated infection from the data published by Malhotra et al. is 8.78%.[6]. The incidence of ventilator-associated Pneumonia in the country is 37% [7] among patients in intensive care. The incidence of central line-associated bloodstream infection was 6.3 per 1000 device days. The incidence of Catheter-associated urinary tract infection was 9.08 per 1000 device days. The studies done in developed countries have shown an incidence of Ventilator-associated pneumonia in the USA by CDC NHSN criteria as 4.4 per 1000 device days. The incidence of CLABSI by the same criteria was 1.1 per 1000 central line days. The incidence of CAUTI for the year 2014 was 0.7 per 1000 device days.[8] This shows great variability in incidence rates of device-associated countries among various countries, especially the developed and developing countries. The common organisms causing Ventilator-associated Pneumonia in the USA are Pseudomonas (24%), Staph aureus (20.4%) followed by streptococcal species and Enterobacteriaceae (14.4%).[9] In India, the common organism is Acinetobacter species (41.03%), followed by other gram-negative bacilli [10]. The common organism associated with Central line-associated bloodstream infection in the US is Staphylococcus aureus, whereas in India, it is Enterobacteriaceae. These can be prevented by adequate and appropriate application of preventive strategies, which can be implemented strictly at the bedside. The basic norms for surveillance strategies and general preventive measures such as standard isolation precautions and monitoring of antibiotic use should be followed without fail. Specific practical measures for ICU related infections should be in place, and the monitoring of activities should be documented regularly as “bundle care” in view of standardizing the practice, irrespective of place or person. It is now mandatory that the essential practices are prioritized and integrated fully into regular hospital administrative procedures as a continuous process for improving quality health care.

ICU patients are at risk for acquiring nosocomial infection. The present study is to define the underlying disease and assess the severity of illness of nosocomial infections in ICU patients. The primary objective of the research is to study the Incidence, predominant causative organism and site of Healthcare-associated Infection in Adult ICU. The secondary objective is to assess the impact of Healthcare-associated infection on the length of stay and mortality.

Material and Methods
Study design
Prospective – cohort study

Study setting
This study was conducted Adult Intensive Care Unit at MPCT hospital, Navi Mumbai. A total of 111 cases after 48 hours of admission into the intensive care unit were studied from OCTOBER 2019 to FEBRUARY 2020.

Study Participants
111 cases as per recruitment criteria.

Inclusion criteria
Adult patients aged above 18 years who were admitted to the intensive care unit.

Exclusion criteria
Patients transferred from another hospital or intensive care unit were excluded from this study.

Outcome
Primary outcome: To determine the incidence, anatomical sites and causative organisms of Healthcare-associated infection in an adult ICU.

Secondary outcomes: The impact of Healthcare-associated infection on the length of stay and mortality.

Sample size calculation
The primary objective is to study the Incidence of Healthcare-associated infection in Adult intensive care units; for the sample size calculation, the statistical input of 12% as incidence is taken from the following reference article “Nosocomial infections in the intensive care unit: Incidence, risk factors, outcome and associated pathogens in a public tertiary teaching hospital of Eastern India Sugata Dasgupta, Soumi Das, et.al.[11] With the expected proportion of 0.12, 9% precision, 95% desired confidence level, and the study required a totally of 50 ICU patients.

Formula
\[ n = \frac{Z_{1-\alpha/2}^2 \cdot p(1-p)}{d^2} \]

where,
\[ p : \text{Expected proportion} \]
\[ d : \text{Absolute precision} \]
\[ 1 - \alpha/2 : \text{Desired Confidence level} \]

Methodology
This study was conducted at MPCT hospital, Navi Mumbai. A total of 111 cases after 48 hours of admission into the intensive care unit were studied from OCTOBER 2019 to FEBRUARY 2020. Detailed history along with physical examination was made for each patient. The study design was a Prospective study for five months. A sample size of 111 cases was included in the study with a detailed history to determine risk factors associated with ICU acquired nosocomial infection; the following risk factors were recorded: age, gender, cause of ICU admission. Underlying disease, co-morbidity, device in-situ: Central line, arterial line,
For Patient with catheter-associated urinary tract infection (CAUTI) must meet the following 5 criteria:

1. Patient had an indwelling catheter > 2 days
2. Fever > 100.4°F
3. Positive urine culture >100,000 cfu/ml
4. Patient has at least one of the following features; Cloudy urine/ Malodorous urine / Pyuria (urine analysis >10 WBC/HPF)
5. No other cause evident

For patients with central line-associated bloodstream infections (CLABSI), Patient must meet the following 4 criteria:

1. Patient has indwelling central venous catheter > 2 days
2. Fever (>100.4°F) or hypothermia (< 97.7°F)
3. One or more positive blood culture with a recognised pathogen or common skin contaminant is cultured from two or more blood culture on separate occasions
4. No other source evident

Ventilator-associated pneumonia Patient must meet the following 5 criteria;

1. Patient mechanically ventilated > 2 days
2. Abnormal chest X-ray: 2 or more serial radiographs with at least one of the following:
   - New or progressive and persistent infiltrate/ consolidation/ cavitition
   - Pneumatocele
3. Systemic features:
   - Fever (>100.4°F) or hypothermia (< 97.7°F) with no other recognised cause
   - Leucopenia (total WBC < 4000/cmm) or leucocytosis (total WBC > 12000/cmm)
4. Respiratory findings:
   - Purulent ET aspirate or increased respiratory secretions or increased suctioning requirements
   - Worsening gas exchange (PaO2/FiO2 > 240), increased O2 requirements or increased ventilator demand
5. If only one of the two findings mentioned in "4" is present, then diagnosis needs to be supported by positive culture (ETA/BAL/blood/pleural fluid)

In immunocompromised patient
   - Any one of the findings mentioned in "3 & 4" with a positive culture and an abnormal chest X-ray to diagnose pneumonia is sufficient

Patient without underlying pulmonary or cardiac disease
   - One definitive chest radiograph is acceptable

D) Surgical Site Infections (SSI) Patient must meet the following 2 criteria

1. Patient had surgery within the past 30 days for all surgeries and 90 days for surgeries with prosthetic devices and
2. Any one of the following:
   - Purulent discharge from the incision and positive culture from an aseptically obtained culture of fluid or tissue from the superficial incision
   - Abscess at the surgical site involving the deeper layers and a positive pus culture (swab from deep pus)
   - Surgeon’s diagnosis of SSI Investigations were sent as per the above provisional diagnosis based on clinical criteria.

Haemogram with blood indices, ESR, RBS, Urine Routine, ECG, Chest X-Ray, Blood urea/creatinine, LFT, Serum, electrolytes, Urine Culture Sensitivity, Blood Culture Sensitivity, Catheter tip Culture Sensitivity, CSF analysis (where indicated), ET tube tip Culture Sensitivity, Sputum test (AFB, Gram stain, Culture Sensitivity), Pus Culture Sensitivity were done. The media commonly used were Blood Agar, Mac Conkey’s Agar, Brain heart infusion broth for all culture sensitivities. Fastidious organisms were done on Muller Hington Agar. Cultures were done where clinically indicated. Based on biochemical properties, pathogens will be identified. The collection of samples will be done in aseptic precautions.

For assessing outcome, each patient was followed-up till ICU discharge or death. Length of ICU stay was recorded as the number of days from admission to discharge from the ICU. The length of ICU stay and mortality in patients with nosocomial infections were statistically compared.

Statistical Analysis

For continuous data such as age, the descriptive statistics n, Mean, SD, and for non-normally distributed interval data and ordinal data, median (interquartile range [IQR]) will be presented. The number of patients and percentages will be presented for categorical data. The Chi-square or Fisher’s exact test will be applied to find the association between categorical variables. All tests will be two-sided at a=0.05 level of significance. Another statistical test will be carried out if it is deemed. All analyses will be done using Statistical Package for Social Services (SPSS) software Version 21.0 (Armonk, NY: IBM Corp).

Results

The study was conducted in the Adult Intensive Care Unit at MPCT hospital, Navi Mumbai. A total of 111 cases 48 hours after admission into the intensive care unit were studied from OCTOBER 2019 to FEBRUARY 2020. The mean age was 65.94 years ± 13.59 years, with an age range between minimum age 31 years and maximum age was 92 years. The present study revealed that 55.6% (n= 10) of the study population were males, and 44.4% (n=8) were females (Table 1).

Hypertension 31.6% (N=12), followed by smoking 18% (N=9), diabetes mellitus 15.8% (N=6), were the most common comorbidities observed, followed by malignancy 15.8%(N=6), past history of ischemic heart disease 10.5% (N=4), history of chronic kidney disease 7.9% (N=3) and bronchial asthma 2.6% (N=1). (Table 1)
Table 1 Distribution of Healthcare-associated infection as per Age groups, Gender and Comorbidities.

<table>
<thead>
<tr>
<th>AGE GROUP (Years)</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;40</td>
<td>1</td>
<td>5.6</td>
</tr>
<tr>
<td>41 to 69</td>
<td>11</td>
<td>61.1</td>
</tr>
<tr>
<td>≥70</td>
<td>6</td>
<td>33.3</td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
<td>100.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GENDER</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>8</td>
<td>44.4</td>
</tr>
<tr>
<td>Male</td>
<td>10</td>
<td>55.6</td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
<td>100.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COMORBIDITIES</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>HYPERTENSION</td>
<td>12</td>
<td>31.6</td>
</tr>
<tr>
<td>DIABETES MELLITUS</td>
<td>6</td>
<td>15.8</td>
</tr>
<tr>
<td>CHRONIC KIDNEY DISEASE</td>
<td>3</td>
<td>7.9</td>
</tr>
<tr>
<td>ISCHEMIC HEART DISEASE</td>
<td>4</td>
<td>10.5</td>
</tr>
<tr>
<td>BRONCHIAL ASThma</td>
<td>1</td>
<td>2.6</td>
</tr>
<tr>
<td>MALIGNANCY</td>
<td>6</td>
<td>15.8</td>
</tr>
</tbody>
</table>

*number & percentage may exceed 18 & 100 because of multiple responses

On the calculation of Cumulative Incidence rate (attack rate) and infection rate per 1000 patient’s days or per 1000 device days, the following values were obtained:

A) Cumulative Incidence rate (attack rate)

\[
\text{Cumulative Incidence rate} = \frac{\text{number of new hospitals acquired infections in a period}}{\text{number of patients observed in the same period}} \times 100
\]

\[
= \frac{18}{111} \times 100
\]

\[
= 16.22\%
\]

B) On the calculation of the infection rate per 1000 patient’s days or per 1000 device days

the following values were obtained:

Overall Healthcare-associated infection rate = 16.84 per 1000 patient days

Number of device-associated infections for specific site \( \times \) 1000

Number of device days

Ventilator-Associated Pneumonia (VAP) rate = 5.16 per 1000 ventilator days

Urinary tract infection rate (CAUTI) = 3.95 per 1000 catheter days

Central line-associated bloodstream infection (CLABSI) rate = 6.17 per 1000 central line days.

Out of total 18 Healthcare-associated infected cases, Blood Stream Infection (BSI) was commonest 38.9% (n=7), followed by Pneumonia 27.8% (n=5), followed by Urinary Tract Infection (UTI) 22.2% (n=4) and lastly Surgical Site Infection (SSI) 11.1% (n=2) respectively(Table 2 and Figure 1). UTI was related to the catheter and Pneumonia to a ventilator. Mostly bacterial organisms were detected in different cultures except for one case of pneumonia which had also grown Fungal. The most common pathogen was Klebsiella pneumoniae (45.5% cases), followed by E. coli (18.1% cases), a combination of Staphylococcus aureus and Pseudomonas in (9.2% cases) and others like Acinetobacter baumanii, Citrobacter freundii, Enterobacter cloacae (each 4.5% cases) (Table 3). Klebsiella pneumoniae was a common causative organism in Bloodstream infections, Pneumonia, Surgical site infections and urinar tract infections.

Figure 1 Distribution as per Site.

The present study revealed that distribution of site of Healthcare-associated infection with and without device was 83.3% and 16.7%, respectively (Figure 2).

Figure 2 Distribution of Site of healthcare associated infection with and without device.
Table 2 Distribution Healthcare-associated infection as per Site and infection with and without device.

<table>
<thead>
<tr>
<th>SITE</th>
<th>Frequency</th>
<th>Percentage</th>
<th>Infection With device</th>
<th>Infection without device</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumonia</td>
<td>5</td>
<td>27.8</td>
<td>5(100%)</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>UTI</td>
<td>4</td>
<td>22.2</td>
<td>4(100%)</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>BSI</td>
<td>7</td>
<td>38.9</td>
<td>6(85.71%)</td>
<td>1(14.29%)</td>
<td>7</td>
</tr>
<tr>
<td>SSI</td>
<td>2</td>
<td>11.1</td>
<td>2(100%)</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>18</strong></td>
<td><strong>100.0</strong></td>
<td><strong>15(83.3%)</strong></td>
<td><strong>3(16.7%)</strong></td>
<td><strong>18</strong></td>
</tr>
</tbody>
</table>

Table 3 Distribution of pathogen according to site.

<table>
<thead>
<tr>
<th>CAUSATIVE ORGANISMS</th>
<th>Site</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pneumonia</td>
<td>UTI</td>
</tr>
<tr>
<td>Acinetobacter baumanii</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Citrobacter freundii</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>E. coli</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Enterobacter cloacae</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Kleb. pneumoniae</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Pseudomonas aeruginosa</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Staphylococcus aureus</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Fungal</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>7</td>
<td>4</td>
</tr>
</tbody>
</table>

Among device-related cases, 100% of cases with pneumonia were ventilator-associated pneumonia (VAP), 100% cases of urinary tract infection were associated with a catheter (CAUTI), and 85.71% cases were central line-associated bloodstream infections (CLABSI) (Table 2). Total of 15 patients had a device-associated infection, and 3 patients had no association with the device. Among device associated infection organisms associated were Klebsiella pneumoniae (n=7), E. coli (n=3), followed by Pseudomonas. (n=2), Acinetobacter baumanii (n=1), Citrobacter freundii (n=1), Enterobacter cloacae (n=1), Staphylococcus aureus and Fungal (n=1). Among infections not associated with the device, organisms associated were Klebsiella pneumoniae (n=3), E. coli(n=1) and Enterobacter cloacae (n=1). The study was statistically not-significant between the groups (p>0.05) by chi-square test.

Among the patients with Healthcare-associated infection, maximum patients with urinary tract infection had a mean stay in hospital more than 14 days, maximum patients with pneumonia had mean stay for more than 20 days, maximum patients with surgical site infection had mean stay for more than 27 days, while patients with bloodstream infection had a mean stay for 16 days. There was statistically no significant difference among the values between the groups (p>0.05), which may be because of the smaller sample size (Figure 3).

Out of 18 patients with Healthcare-associated infection, 83.3% (N= 15) were alive, and 16.7% (N=3) died on follow up analysis (Table 4). Mortality was associated with bloodstream infection n=2 and pneumonia n=1 (Figure 4). The study was statistically not-significant between the groups (p>0.05) by chi-square test.

**Discussion**

Healthcare-associated infections (HAIs) are becoming a problem for hospitalized patients. They are major causes of death and disability worldwide. Thus, a continuous surveillance and monitoring system is imperative for determining the extent of the problem and for its effective prevention and control. In this context, the findings of the present study on Healthcare-associated infections among admitted patients in adult intensive care units are as follows.

The present study revealed that maximum study subjects, 61.1 % (n=11), belonged to the 40-70 years of age group, 33.3 % (n=6) belonged to more than 70 years and 5.6 % (n=1) to less than 40 years of age. The mean age was 65.94 years ±13.59 years,
The present study revealed that the cumulative incidence rate (attack rate) of Healthcare-associated infections was 16.2%. According to a WHO report, Healthcare-associated infection rates in developing countries vary from 5.7% to 19.1% (but mostly >10%). In a similar study done by H Mythri and KR Kashinath et al. [12] the incidence of Nosocomial infection was 17.69%. Possible deterrents of the burden of health-care-associated infection in this facility may include understaffed facility, paucity of knowledge and improper application of basic infection-control measures.

The present study revealed that a maximum number of cases had Hypertension with 31.6% (N=12), followed by diabetes mellitus 15.8% (N=6), malignancy 15.8% (N=6), smoking 18% (N=9), history of ischemic heart disease 10.5% (N=4), history of chronic kidney disease 7.9% (N=3), bronchial asthma 2.6% (N=1). A similar study Mortality and risks related to healthcare-associated infection by Ester Sena Souza et al. [13] showed that the analysis of pathologies associated with the HAI diagnosis allowed for the identification of a high frequency of comorbidities (43.5%) among patients with HAI, of which cerebrovascular diseases (20.4%), congestive cardiac insufficiency (11.6%) and neoplasia (11.6%) being the most prevalent comorbidities. However, other comorbidities showed a stronger impact on the mortality of patients with HAI. Another study, Prevalence of nosocomial infections in the intensive care unit by Ambana Gowda Durga et al. [14] showed that 22% had diabetes mellitus, 48% had hypertension, and 30% had related Co-morbidities.

In our study Out of total 18 Healthcare-associated infected cases, Blood Stream Infection (BSI) was commonest 38.9% (n=7) followed by Pneumonia 27.8% (n=5), Urinary Tract Infection (UTI) 22.2% (n=4) and Surgical Site Infection (SSI) 11.1% (n=2) respectively. UTI was related to the catheter and Pneumonia to a ventilator. Amongst device-related cases, 100% of cases with pneumonia were ventilator-associated pneumonia (VAP), 100% cases of urinary tract infections were associated with a catheter (CAUTI), 85.71% cases were central line-associated bloodstream infections (CLABS). Similarly, concerning the role played by invasive devices in contribution to nosocomial infections, a study by H Mythri and KR Kashinath et al. [12] showed that 62.5% of UTI occurred in catheterized patients, 60% of pneumonia was associated with mechanical ventilation and 100% of bloodstream infections with catheters. A similar study on Healthcare-associated infections acquired in intensive care units. Annual Epidemiological Report 2016 [15] showed similar results, stating 98% of pneumonia episodes were associated with intubation, 48% of bloodstream infection (BSI) episodes were catheter-related, and 98% of Urinary Tract Infection (UTI) episodes were associated with the presence of a urinary catheter.

It was observed in our study that mostly bacterial organisms were detected in different cultures except for one case of pneumonia which had Fungal growth. Most common pathogen was Klebsiella pneumoniae (45.5% cases), followed by E.coli (18.1% cases), combination of Staphylococcus aureus and Pseudomonas in (9.2% cases) and others like Acinetobacter baumanii, Citrobacter freundii, Enterobacter cloacae (each 4.5% cases).

Klebsiella pneumoniae was a common causative organism in Bloodstream infections, Pneumonia, Surgical site infections and urinary tract infections. Similarly in a study conducted by Maumita De and Deepanshu Mukherjee. et al. [16] It was observed that the most commonly occurring pathogens were gram-negative bacteria such as Pseudomonas and Klebsiella (both in 23.8% cases), followed by Staphylococcus aureus and E. coli (both in 19% cases), followed by Staphylococcus epidermidis (in 9.6% cases) and Streptococcus pneumoniae (in 4.8% cases). WHO also reported gram-negative rods as the most common nosocomial isolates in developing countries, and the most frequent single pathogen was S. aureus in the mixed patient populations. [16]

In our study, out of the total 18 patients who were the study population with Healthcare-associated infection, 83.3% (N=15) were alive, and 16.7% (N=3) died. There was a statistically non-significant difference seen for the values between the groups (p>0.05), which may be affected because of a smaller sample size. Similarly, in the study done by Rosenthal et al. [17], the crude mortality rate for patients with device-associated infections ranged from 35.2% (for central venous catheter-associated bloodstream infection) to 44.9% (for VAP). In a similar study on Nosocomial infections in the intensive care unit conducted by Sugata Dasgupta, Soumi Das et al. [18], mortality in ICU patients with nosocomial infection was 17.2%.

The average length of stay for patients with Healthcare-associated infection in our ICU was 18.06 days±11.021 days. Among the patients with Healthcare-associated infection, maximum patients with urinary tract infection had mean stay in hospital more than 14 days, maximum patients with pneumonia had mean stay for more than 20 days, maximum patients with surgical site infection had mean stay for more than 27 days, while patients with bloodstream infection had a mean stay for 16 days. There was a statistically non-significant difference seen for the values between the groups (p>0.05), which may be affected because of a smaller sample size. Similarly study carried out by Sugata Dasgupta, Soumi Das et al. [17] showed that the average length of stay for Healthcare-associated infection in ICU was 17.28 days±8.59 days. Another study was done by Huixue Jia,1 Liuyi Li et al. [19], showed that mean length of stay in patients

**Table 4 Association of site of Healthcare-associated infection with mortality**

<table>
<thead>
<tr>
<th>SITE</th>
<th>Mortality</th>
<th>Total</th>
<th>Chi-square value</th>
<th>P-value of chi square test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Alive</td>
<td>Dead</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pneumonia</td>
<td>4</td>
<td>1</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>UTI</td>
<td>4</td>
<td>0</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>BSI</td>
<td>5</td>
<td>2</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>SSI</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>15</td>
<td>3</td>
<td>18</td>
<td></td>
</tr>
</tbody>
</table>
with urinary tract infection was more than 21 days, with pneumonia, the mean stay was more than 22 days; with surgical site infection, the mean stay was more than 23 days, while patients with bloodstream infection had a mean stay for 25 days.

In our study, among the total of 18 patients with Healthcare-associated infection, a total of 3 mortality was seen. Mortality was associated with patients with bloodstream infection n=2 and pneumonia n=1, and a statistically non-significant difference was seen for the frequencies between the groups (p>0.05). Similarly, a study of mortality related to hospital-associated infections in a tertiary hospital by Anne Mette Koch, Roy Miodini Nilsen et al. [20] showed an increased risk of death from bloodstream infection and pneumonia.

Mortality in our study was associated with Klebsiella pneumoniae (n=2) and Staphylococcus aureus(n=1). A similar study on mortality and risks related to healthcare-associated infection by Ester Sena Souza et al.[13] Klebsiella pneumoniae is the most associated microorganism for mortality (21.2%) cases. Another study, The burden of nosocomial Staphylococcus aureus bloodstream infection in South Korea: a prospective hospital-based nationwide study by Chung-Jong Kim et.al.[11] showed that deaths associated with BSI occurred in 81 cases (31.9%) of MRSA-BSI. In a subgroup analysis of central-line associated bloodstream infections (CLABSI), 30 of 94 (31.9%) MRSA-BSI patients died, and 27 out of the 30 deaths were associated with SA-BSI.

The main problems in developing countries are understaffing, poor infrastructure in ICU and poor maintenance of records making the situation difficult to get clarity on the incidence of these infections. Although it is difficult to solve some problems associated with financial hardship in developing countries, most solutions are simple and not resource demanding. Infection control strategies such as hand hygiene and wearing gloves, paying attention to well-established processes for decontamination and cleaning of soiled instruments and other items, followed by either sterilization or high-level disinfection, and improving safety in operating rooms and other high-risk areas where the most serious and frequent injuries and exposures to infectious agents occur can resolve the problem to a major extent.

**Limitation**

- The sample size was very less.
- Unequal distribution of samples according to gender and age due to which exact prevalence of nosocomial infections could not be calculated for independent variables.
- The mere presence of Healthcare-associated infections (HAI) among the present study cases cannot be ruled out. Hence, further systematic and standardized large scale studies are suggested in government sectors for the prevention and management of these nosocomial infections. The study was also limited to medical intensive care, so the conclusions made will be limited to the same.

**Conclusion**

Healthcare-associated infections (HAI) develop in patients while receiving care in health facilities and represent one of the frequent preventable adverse patient outcomes in health care settings.

- The present study found the incidence rate of Healthcare-associated infections as 16.2%.
- Blood Stream Infection (BSI) 38.9% was the commonest site infection, followed by Pneumonia 27.8%, Urinary Tract Infection (UTI) 22.2% and Surgical Site Infection (SSI)11.1%, respectively.
- Gram-negative bacteria were the most frequently associated organism. The most common pathogen was Klebsiella pneumoniae (45.5% cases), followed by E. coli (18.1% cases), the combination of Staphylococcus aureus and Pseudomonas in (9.2% cases) and others like Acinetobacter baumanii, Citrobacter freundii, Enterobacter cloacae (each 4.5% cases).
- The average length of stay for patients with Healthcare-associated infection in ICU was 18.06 days±11.021 days.
- Mortality with Healthcare-associated infection was 16.7%. Mortality was associated with patients having bloodstream infections and pneumonia.

This study can provide information for the prevention strategies of HAI to improve health care service level, as well as it can help to raise interest to conduct further research in this field. It noted that even in a tertiary health care facility where most of the health care staff are well trained, the healthcare-associated infection rate could not be brought down to <10%. This might be because of extremely limited awareness of the problem, reluctance to take precautionary measures, lacking the maintenance of aseptic technique during invasive procedures, empirically misuse and overuse of antimicrobials and also, very importantly, precedence of other health priorities over patient safety considerations. Further research on other causative agents and risk factors of HAI can help to identify specific preventive measures in future.

**Ethics committee approval**

No human or animal experiments were conducted in this study. Prior institutional ethical clearance was taken. Consent was given by the patients for publication and use of data for research purposes. All sources used for documentation were adequately mentioned concerning copyright laws.

**Funding**

None.

**Conflict of interest**

None.

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