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Research Article

Epidemiology and risk factors of healthcare associated infections from intensive care unit of a tertiary care hospital

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ABSTRACT

Background: Nosocomial infections (NIs) result in increased morbidity, mortality and length of hospital stay. The Incidence of NIs, their risk factors and the antibiogram patterns vary across and within countries. We assessed the rates, infection sites, pathogens and risk factors of health-care-associated infections in ICU of a tertiary care hospital.
Methods: In this retrospective study, all the patients admitted in Intensive Care Unit over a period of 6 months during August 2015 to January 2016 were included in the current study. Routine surveillance of various health-care-associated infections such as catheter-associated urinary tract infections (CAUTI), central-line-associated blood stream infections (CLABSI), and ventilator-associated pneumonias (VAP) was done by the Department of Microbiology through an Infection Surveillance Proforma. Patients' records including Infection Surveillance Proforma served as study tools. Odd's ratio was calculated to ascertain the strength of association of each risk factor.
Results: Incidence rates of health-care-associated infections were 9.06/1000 urinary catheter days, 13.35/1000 central venous pressure line days and 5.42/1000 ventilator days. Most common organisms isolated from urine were *Pseudomonas aeruginosa* (34.48%), *Enterococcus* species (13.79%), *Klebsiella pneumonia* (13.79%) and *Candida species* (13.79%). Similarly three topmost organisms isolated from blood were *Klebsiella pneumoniae* (32.26%), *Acinetobacter* species (29.03%) and *Pseudomonas aeruginosa* (16.13%). *Acinetobacter spp.* (40.0%), *Pseudomonas aeruginosa* (33.33%) and *Klebsiella pneumonia* (13.33%) were most commonly responsible for tracheal infections. Presence of diabetes and COPD as well as length of ICU stay ≥8 days was significantly associated with health-care-associated infections.
Conclusions: Diabetes, COPD and ICU stay for ≥8 days were found to be significantly associated with device-associated infections in our ICU. Data thus generated can be used to plan and modulate the potential intervention measures while managing device-associated infections.

Keywords: Epidemiology, Risk factors, Device-associated infections, Intensive care unit

INTRODUCTION

Health-care-associated infections are amongst the important key factor which determines the clinical outcome among patients admitted in critical care areas such as intensive care units (ICUs).[1] Surveillance of device-associated infections has become an integral feature of infection control in all hospitals. Nosocomial infections (NIs) result in increased morbidity, mortality

and length of hospital stay.[2] The Incidence of NIs, their risk factors and the antibiogram patterns vary across and within countries.[3]

Intensive care units act as epicentres for Nosocomial infections and the development of antimicrobial resistance due to prolonged hospitalization, serious illness and a high use of antibiotics.[4] Device-associated infections include catheter-associated urinary tract infections (CAUTI), central-line-associated blood stream infections (CLABSI), and ventilator-associated pneumonias (VAP). Infection Control Committee, of any hospital, serves as a major tool for the surveillance of these infections. The hospitals in developed countries generate their infection-control surveillance data from time to time.

This is also pertinent for empirically treating infections, especially in the intensive care unit (ICU) setting, where a thorough knowledge of the epidemiology, type, nature, and risk factors for infections as well as the antimicrobial resistance patterns of invading microorganism is needed.[5] There are very few published studies on the epidemiology of NIs from India. The present study was therefore conducted to assess the rates, infection sites, pathogens and risk factors of health-care-associated infections in ICUs of a tertiary care hospital.

METHODS

The present study was planned and executed by the Department of Anesthesiology in collaboration and consultation with the Departments of Microbiology and Critical Care Medicine of a tertiary care teaching institution of northern India. In this retrospective study, all the patients admitted in Intensive Care Unit over a period of 6 months during August 2015 to January 2016 were included in the current study. Routine surveillance of various health-care-associated infections such as catheter-associated urinary tract infections (CAUTI), central-line-associated blood stream infections (CLABSI), and ventilator-associated pneumonias (VAP) was done by the Department of Microbiology through an Infection Surveillance Proforma.

Patients' records including Infection Surveillance Proforma served as study tools. Medical records department (MRD) was approached and data was collected on all patients who received mechanical ventilation during the study period. The relevant data were recorded from medical records, bedside flow sheets, radiographic reports, and reports of microbiological studies of the patients. Other relevant details were also captured viz. name, age, gender, IPD number, primary diagnosis, date of admission in hospital and ICU.

As a routine, first sample (urine, blood, and tracheal aspirate) of every patient admitted in ICU is sent for bacteriological culture to keep a baseline record to exclude infection at the time of admission into ICU, to get the true picture of infection rate as per hospital policy. The laboratory evidence such as TLC/DLC, culture reports (repeat isolation of same bacterial strain), and other investigations like X-ray findings are correlated with the clinical findings such as temperature, pulse rate, blood pressure, auscultatory findings, and any other specific symptoms to assess infection or colonization. Antibiotic susceptibility testing was carried out following Clinical Laboratory Standards Institute (CLSI) guidelines using the Kirby–Bauer method. At the end of each month the data is analyzed, and based on CDC guidelines, infection rates are calculated and discussed in infection control meeting.

The patients who were studied for diagnosis of CAUTI had an indwelling catheter in situ or indwelling catheter removed <7 days of onset of symptoms or symptoms appearing 48 h after insertion of catheter. A diagnosis of symptomatic UTI was made when patient had at least one of the following signs or symptoms with no other recognizable cause: Fever ≥38.8°C, urgency, frequency, dysuria, or suprapubic tenderness and patient had a positive urine culture, that is, ≥105 microorganisms/ml of urine with no more than two species of microorganisms.

The diagnosis of asymptomatic bacteriuria was made when patient had an indwelling urinary catheter within 7 days before the culture and patient had a positive urine culture, that is, ≥105 microorganisms/ml of urine with no more than two species of microorganisms and patient with no fever (38.8°C), urgency, frequency, dysuria, or suprapubic tenderness. In our study, for diagnosis of CAUTI, asymptomatic bacteriuria was included as all the patients had Foley's catheter in situ.

Central-line-associated blood stream infection was considered if a central line was in place for 48 h before the onset of signs and symptoms, there being no other recognized cause for positive blood culture and 1 positive blood culture with recognized pathogen or >2 blood cultures, drawn on separate occasions, positive for common skin contaminant (including *Diphtheroids*, *Bacillus*, *Propionobacterium spp*, coagulase-negative *Staphylococci*, viridans group *Streptococci*, *Micrococcus spp*).

For the purpose of this study, the diagnosis of VAP was considered in patients who had a device to assist or control respiration continuously through a tracheostomy or by endotracheal intubation within the 48-h period before the onset of infection, inclusive of the weaning period. As per guidelines, VAP was diagnosed through combination of clinical, radio graphical and microbiological findings as follows: Dullness to percussion on physical examination of chest and/or chest radiographic examination showing new or progressive infiltrate, consolidation, cavitations or pleural effusion and any of the following (a) New onset of purulent sputum or change in character of sputum, (b) organism isolated from blood culture, (c) positive quantitative

culture from specimens like transtracheal aspirate, bronchial brushing, or lung parenchyma biopsy. In our study, quantitative transtracheal aspirates with counts of ≥106 colony forming units/ml was used for the diagnosis of VAP.

The study adhered to the tenets of the Declaration of Helsinki for research in humans. Informed consent was obtained from study subject's next of kin after discussing advantages and risks. Permission of Institutional ethics committee (IEC) was sought before the commencement of the study. Data was collected for various risk factors for device associated infections viz. age (>60 years), male sex, length of ICU stay (≥8 days), and various co-morbidities like diabetes type II, chronic obstructive pulmonary disease (COPD), previous hospitalization, and surgical interventions. All the questionnaires along with other relevant data were manually checked and were then coded for computer entry. After compilation of the collected data, analysis was done using Statistical Package for Social Sciences (SPSS), version 20 (IBM, Chicago, USA). The results were expressed using appropriate statistical methods. The chi- square (χ^2) test or Fisher's exact test was used to compare different groups. Odd's ratio was calculated to ascertain the strength of association of each risk factor. A two tailed $p<0.05$ was considered statistically significant.

RESULTS

The total number of patients admitted in the study period in our ICU was 226. Out of which 122 were males and remaining 104 were female patients. Thirty-nine patients were aged more than 60 years whereas remaining were less than 60 years. 14 patients had diabetes among the patients included in the study. Out of 226 patients, 52 suffered 61 episodes of device-associated infections. Thus, the overall infection percentage was 23% and infection rate was 26.99%. Central-line-associated blood stream infection (13.08%) was the most common health-care-associated infection followed by UTI (10.61%) and VAP (5.69%). All of the 226 patients had indwelling urinary catheter. The number of UTI episodes was found to be 24 (10.61%) among the ICU patients who had indwelling urinary catheter. A total of 214 patients had intravascular catheter (right subclavian or internal jugular). The episodes of blood stream infection were 28 (13.08%) among ICU patients having central line catheters. A total of 211 patients were intubated/tracheostomized. Total 12 (5.69%) episodes of VAP were found (Table 1).

Table 1: Burden of health care associated infections and its associated parameters among study subjects.

Variable		UTI	CLABSI	VAP
Percentage of the total health care associated infections (%)		10.61	13.08	5.69
No. of infection/1000 device days		9.06/1000 catheter days	13.35/1000 central line days	5.42/1000 ventilator days
Most common organism isolated (%)	1st	*Pseudomonas aeruginosa*	*Klebsiella pneumoniae*	*Acinetobacter spp.*
	2nd	*Enterococcus species* *Klebsiella pneumonia* *Candida species*	*Acinetobacter species*	*Pseudomonas aerugin*
	3rd	*Acinetobacter* species	*Pseudomonas aeruginosa*	*Klebsiella pneumoniaosa*

Table 2: Organisms isolated from various health care associated infections from study subjects.

Organisms	Urine N (%)	Blood N (%)	Tracheal N (%)
Acinetobacter species	3 (10.34)	9 (29.03)	6 (40.0)
Pseudomonas aeruginosa	10 (34.48)	5 (16.13)	5 (33.33)
Enterococcus species	4 (13.79)	2 (6.45)	1 (6.67)
Klebsiella pneumonia	4 (13.79)	10 (32.26)	2 (13.33)
Escherichia coli	3 (10.34)	1 (3.23)	1 (6.67)
Candida species	4 (13.79)	1 (3.23)	0 (0.0)
Staphylococcus aureus	0 (0.0)	3 (9.68)	0 (0.0)
Morganella morganii	1 (3.45)	0 (0.0)	0 (0.0)
Total	29	31	15

The type and number of organisms designated as the causes for various types of hospital acquired infection is shown in Table 2. Most common organisms isolated from urine were *Pseudomonas aeruginosa* (34.48%), *Enterococcus* species (13.79%), *Klebsiella pneumonia* (13.79%) and *Candida species* (13.79%). Similarly three topmost organisms isolated from blood were *Klebsiella pneumoniae* (32.26%), *Acinetobacter species* (29.03%) and *Pseudomonas aeruginosa* (16.13%). *Acinetobacter spp.* (40.0%), *Pseudomonas aeruginosa* (33.33%) and *Klebsiella pneumonia* (13.33%) were most commonly responsible for tracheal infections (Table 2).

Comparison of various risk factors for acquiring health-care-associated infections in our ICU is shown in Table 3. The presence of diabetes and COPD as well as length of ICU stay ≥8 days was found to be significantly associated with health-care-associated infections. Age, male sex, previous hospitalization, and postoperative state were not significant associations for acquiring health-care-associated infections. Similarly by calculating the odd's ratio, the strength of association of these three risk factors (diabetes and COPD as well as length of ICU stay ≥8 days) was found to be considerable with health-care-associated infections (Table 3).

Table 3: Risk factors for the development of health-care-associated infections.

Risk factor	Patients with health-care-associated infections N (%)	Patients without health-care-associated infections N %	P value	Odd's ratio
Age ≥60 years	11 (21.15)	28 (16.09)	0.396	1.40
Male sex	32 (61.54)	90 (51.72)	0.212	1.49
Diabetes mellitus type II	4 (7.69)	4 (2.30)	0.021*	6.07
Previous surgery	28 (53.85)	86 (49.43)	0.575	1.19
ICU stay ≥ 8 days	51 (98.08)	82 (47.13)	<0.001**	90.88
Previous hospitalization	4 (7.69)	9 (5.17)	0.347	1.53
COPD	27 (51.92)	54 (31.03)	0.009*	2.40
*P<0.05, Statistically significant; **p<0.001, Statistically highly significant				

DISCUSSION

Nosocomial infections are seen worldwide but are less studied and are given less emphasis in developing countries. This study evaluated the rates, infection sites, pathogens and risk factors of health-care-associated infections in ICUs of a tertiary care hospital. Infection Control Committee, of any hospital, serves as a major tool for the surveillance of such infections. It's known a fact that routine surveillance of these infections can reduce the incidence by as much as 30%.[6] These results are cohort with others.[7]

In the current study it was revealed that incidence rates of health-care-associated infections were 9.06/1000 urinary catheter days, 13.35/1000 central venous pressure line days and 5.42/1000 ventilator days. Another study from Chandigarh is also in concordance with our observations.[8] Another study from New Delhi reported the incidence rates of health-care-associated infections to be 11.3/1000 urinary catheter days, 3.4/1000 central venous pressure line days and 31.4/1000 ventilator days.[9] In the ICU's of seven hospital members of the international infection control consortium (INICC) of seven Indian cities the overall infection rates were 1.41/1000 catheter days for CAUTI, 7.92/1000 catheter days for CLABSI and 10.46/1000 ventilator days for VAP.[10]

In this study we found that the most common organisms isolated from urine were *Pseudomonas aeruginosa* (34.48%), *Enterococcus* species (13.79%), *Klebsiella pneumonia* (13.79%) and *Candida species* (13.79%). Similarly three topmost organisms isolated from blood were *Klebsiella pneumoniae* (32.26%), *Acinetobacter species* (29.03%) and *Pseudomonas aeruginosa* (16.13%). *Acinetobacter spp.* (40.0%), *Pseudomonas aeruginosa* (33.33%) and *Klebsiella pneumonia* (13.33%) were most commonly responsible for tracheal infections.

We can say that as compared to gram-positive bacteria, gram-negative bacteria were more commonly isolated from cases of health-care-associated infections. *P. aeruginosa* and *Acinetobacter* species that are widely known to be the most common cause of health-care-associated infections were also found to be the most culpable organisms in our ICUs. The result of this study is in agreement with previous studies.[9,11] Our findings confirm the results of another study from northern India. Agarwal et al. found majority of infections with gram-negative bacilli in respiratory ICU. Moreover, *Acinetobacter* species followed by *P. aeruginosa* were found to be the most common cause of pneumonia.[12]

Regarding risk factors for the development of health-care-associated infections, we found that the presence of diabetes and COPD as well as length of ICU stay ≥8 days

was significantly associated with health-care-associated infections. The result of this study is in agreement with previous studies from India, Turkey and Italy.[12-14] The longer the patients stays in ICU more are the chances of getting colonized with multidrug-resistant bacteria and longer will be the time period of insertion of devices.

In our study, diabetes and COPD were significant associations in patients with infections. This is in contrast to the study by Agarwal et al[12] They observed that two factors were not e related with development of health-care-associated infections. This may be because patients with diabetes and COPD come at terminal stage when they are highly immunosuppressed making them highly susceptible to health-care-associated infections and multidrug-resistant bacteria present in the ICU environment.

This study has several strengths. First, to our knowledge, assessment of risk factors of health-care-associated infections in ICUs from tertiary care hospital of India has not been extensively investigated. Very few similar studies are available in the literature. The study has some limitations as well. Severity of illness (SOFA or APACHE) scores as important risk factors were not assessed. Large scale multicentric studies are warranted to validate the results.

CONCLUSION

The findings of the study highlight the high prevalence rate of CLABSI in our ICUs and high frequency of multidrug-resistant *P. aeruginosa* and *Acinetobacter* species. Diabetes, COPD, and ICU stay for ≥8 days were found to be significantly associated with device-associated infections in our ICU. Data thus generated can be used to plan and modulate the potential intervention measures while managing device-associated infections. Knowledge of the important risk factors predisposing to device-associated infections may prove to be useful in implementing effective preventive measures.

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