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SURVEILLANCE OF MEDICAL DEVICE-ASSOCIATED INFECTIONS IN A TERTIARY CARE ACADEMIC HOSPITAL OF MAHARASHTRA.

Microbiology

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ABSTRACT

Background: Medical device-associated infections (MDAI) are one of the greatest threats contributing to morbidity and mortality in patients admitted to intensive care unit (ICU). Surveillance of these infections aid in defining the magnitude and nature of the problem, and therefore is a crucial step towards reducing the risk of MDAI in vulnerable patients. In present study, surveillance of MDAI like catheter associated urinary tract infection (CA-UTI), catheter related blood stream infection (CR-BSI) and ventilator associated pneumonia (VAP) was conducted. **Material and methods:** Patients admitted to Medical Intensive Care Unit (MICU) and having indwelling medical devices for > 48 hours were included in the study. Definitions of CDC's National Nosocomial Infections Surveillance (NNIS) system criteria for surveillance of three common MDAI (CA-UTI, CR-BSI and VAP) were used. **Results:** a total of 135 (7.9%) patient developed MDAI. The rates of CAUTI, CR-BSI and VAP were 5.95/ 1000 catheter associated days, 4.2/1000 catheter associated days and 4.8/1000 ventilator associated days respectively. Patients with MDAI had high length of stay compared to patients with no MDAI. Klebsiella spp. followed by E. coli were major bacterial pathogens isolated from MDAI. Candida spp., was isolated from 26 (19.3%) cases of MDAI. **Conclusion:** The rate of medical device associated infections (MDAI) varies greatly according to the healthcare setup and type of patients cared for. Hence, the surveillance data of particular healthcare setup cannot be generalized similarly the generalized data may not reflect the situation of a particular institute. This surveillance study facilitated us to generate institutional benchmarks for different types of MDAI like CA-UTI, CR-BSI and VAP which will aid to develop strategies to be implemented for reducing the incidence of these infections.

KEYWORDS

Catheter associated urinary tract infection, catheter related blood stream infections, healthcare-associated infections, medical device-associated infections, surveillance, ventilator associated pneumonia.

INTRODUCTION

Hospital being crucial part of developing a health-care system is cherished by many people. However, at times hospitalization may be the cause of harm in patients. These include medication and diagnostic errors, health-care associated infections (HAI), unsafe surgical operations and injection practices, medication errors, radiation errors and sepsis (blood clots).[1]

HAI are one of the most common adverse, iatrogenic events experienced in patient care. According to the definition of Centers for Disease Prevention and Control's (CDC) National Health Safety Network (NHSN), HAI are localized or systemic conditions that results from adverse reactions to the presence of an infection agent(s) or its toxin(s) and that was not present or incubating at the time of hospital admission.[2] These infections are acquired by the patients during their course of treatment in the healthcare setup for other ailments/conditions. Usually HAI are evident ≥48 hours after admission to the healthcare center. At times, HAI may become evident even after discharge of patient from healthcare setup.[2]

Development of HAI in patient is associated with deleterious consequences like complicating the course of therapy, aggravate illness, prolong hospital stay, induce long-term term disabilities and add incrementally to the healthcare cost expected of the patient's underlying diseases alone.[3]

Annually, HAI is reported to occur in more than 1.4 million people across the world. The incidence of HAI ranges from 10% to 30%.[4] In developed nations, HAI concerns 5-15% of hospitalized patients and may lead to complications in 25-50% of patients admitted to intensive care units (ICU) in developed nations (ICU). However no such data is available from developing nations.[5]

Various factors including increased incidence of hospitalization, better adaptation of microbes to the hospital environment by acquiring resistance to disinfectants and advancement in medical technology along with injudicious use of antibiotics contribute to development of HAI.[3]

Nearly half of HAI are known to be associated with presence of indwelling medical devices like mechanical ventilator, central line and urinary catheter.[5] Ventilator associated pneumonia (VAP), intravascular catheter-related blood stream infections (CR-BSI) and catheter associated urinary tract infection (CA-UTI) are important medical device-associated infections (MDAI).[6] As surveillance of HAI aid to determine the magnitude and nature of the problem, is the crucial step towards reducing the risk of infection in vulnerable hospitalized patients, in the present study surveillance MDAI was conducted.

MATERIAL AND METHODS.

The present descriptive cross sectional study was conducted at Department of Microbiology for a period of 1 year. Surveillance of three common MDAI (CA-UTI, CR-BSI, and VAP) in patients admitted to Medical Intensive Care Unit (MICU) was done. The definitions of CDC's National Nosocomial Infections Surveillance (NNIS) system criteria, was used for the surveillance of MDAI.[2]

Following methods and formulae will be used for surveillance of CA-UTI, CR-BSI, and VAP.

1) CA-UTI: The patient was labeled as a case of CA-UTI, when he/she had an indwelling urinary catheter (IUC) in place for > 2 calendar days or if IUC was removed on the day before the date of event (DOE) and develops one or more of the following conditions: temperature (≥38 C), urgency and suprapubic tenderness.[2,3]

With all aseptic precautions, urine sample was collected from sampling port of indwelling urinary catheter with sterile syringe and needle. The sample was then transferred to sterile container and immediately transported to the laboratory. The urine sample was inoculated on blood agar and MacConkey's agar incubated at 35 C for 24 h. Additionally, a Gram stained smear prepared from unspun urine was also examined.[3]

When urine culture showed growth with no more than two bacterial species and at least one of which was ≥ 10^5 colony forming units (CFU) /mL, the organism was identified up to species level as per standard microbiological protocol.

CA-UTI rate was expressed as the number of CA-UTI per 1000 catheter days. Following formula was used for calculating the rate of CA-UTI.

$$\left(\frac{\text{Number of patients developing CA-UTI}}{\text{Total number of catheter days}}\right) \text{X1000}$$

2) CR-BSI: The CR-BSI was suspected when a patient with central venous catheter (CVC) in place for > two consecutive calendar days developed fever or other symptoms of sepsis of unknown origin.[2,3]

Paired blood samples for culture were aseptically collected from these patients. The first blood sample was collected from the catheter itself and the second was obtained from the other arm. Specimens for blood culture were obtained at the time of CVC removal. The CVC was removed by the critical care physician under all aseptic precautions and the distal 2cm segment of the CVC was collected in sterile container with the help of sterile scissor. Inoculated blood culture bottles and CVC tip was transported to the microbiology laboratory without any delay. Blood cultures samples was processed as per standard microbiological protocol.[3] The CVC tip was processed as per semi-quantitative method described by Maki *et al*. (1977). A colony count >15CFU/plate will be considered significant. Isolation of the same bacterial species from CVC tip and blood culture indicated CR-BSI.[7]

CR-BSI rate was expressed as the number of CR-BSI per 1000 device days and calculated using the following formula:

$$\left(\frac{\text{Number of patients developing CR-BSI}}{\text{Total number of CVC days}}\right) \text{X1000}$$

3) VAP: VAP was suspected when a mechanically ventilated patient (for ≥4 calendar days) developed a new fever, cough and purulent expectoration. On radiological examination there is evidence of a new or progressive pulmonary infiltrate and leukocytosis.[2,3]

Any one of the purulent respiratory secretions like bronchoalveolar lavage (BAL), endotracheal aspirate, lung tissue and protected specimen brush was collected in sterile container and transported to the laboratory. Specimens will be inoculated on to blood agar and MacConkey's agar. The plates were incubated overnight at35°C.[2,3]

A colony count $\geq 10^4$ CFU/mL (for BAL and lung tissue), protected specimen brush $\geq 10^3$ and $\geq 10^5$ CFU/mL (for endotracheal aspirate) will be considered as significant.

VAP rate was expressed as the number of VAP per 1000 device days and was calculated using the following formula:

$$\left(\frac{\text{Number of patients developing VAP}}{\text{Total number of ventilator days}}\right) \text{X1000}$$

RESULTS

During the study period a total 1691 patients were admitted to MICU. Out of these, 1326 (78.4%) had one or more indwelling medical devices. The type of indwelling medical devices is shown in table 1. Urinary catheter was the most common indwelling medical device. A total of 391 (23.1%) had all three (mechanical ventilator, central line and urinary catheter) devices.

Table 1: Type of indwelling medical devices.

Indwelling medical device	Frequency (%)
Urinary catheter	825 (48.8)
Mechanical ventilator	486 (28.7)
Central line	378 (22.3)
Urinary catheter and Mechanical ventilator	646 (38.2)
Urinary catheter and central line	484 (28.6)
Mechanical ventilator and central line	571 (33.8)
On all three medical devices	391 (23.1)

In the present study, a total of 135 (7.9%) patient developed MDAI. The rate of MDAI is shown in following table.2. The rates of CAUTI, CR-BSI and VAP were 5.95/ 1000 catheter associated days, 4.2/1000 catheter associated days and 4.8/1000 ventilator associated days respectively. Out of a total 825 patients with urinary catheters, CAUTI was developed in 95 (11.5%) patients. A total of 19 patients with central line out of 486 (3.9%) developed CR-BSI. Out of a total 378 patients on mechanical ventilator, 21(5.6%) developed VAP.

Table 2. Medical device associated infections.

MDAI	Total device days	Number of patients developing infection	Rate/1000 medical device associated days
CAUTI	15950	95	5.95
CR-BSI	4536	19	4.2
VAP	4374	21	4.8

In the present study, the mean Length of stay (LOS) of patients developing HAI (MDAI) was 29.6 (±12.4) days whereas for patients with not developing HAI it was 14.3 (±8.4) days (Figure 1).

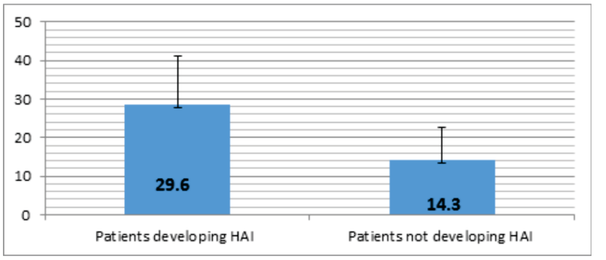

Figure 1: Length of stay of patients developing MDAI (HAI).

As shown in table 3, *Klebsiella* spp. (45.9%) followed by *Candida* (19.3%) and *E.coli* (15.6%) were common pathogens from MDAI. *Klebsiella* spp. was the commonest isolate all types of MDAI.

Pathogen	CA-UTI (%)	CR-BSI (%)	VAP (%)	Total (%)
Klebsiella spp	38 (40)	10 (52.6)	14 (66.7)	62 (45.9)
E. coli	14 (14.7)	04 (21.1)	03 (14.2)	21 (15.6)
Pseudomonas spp.	05 (5.3)	01 (5.3)	02 (9.5)	08 (5.9)
Staphylococcus aureus	05 (5.3)	-	-	05 (3.7)
Acinetobacter spp.	-	-	02 (9.5)	02 (1.5)
Coagulase negative Staphylococci (CONS)	02 (2.1)	01 (5.3)	-	03 (2.2)
Proteus spp.	08 (8.4)	-	-	08 (5.9)
Candida spp.	23 (24.2)	03 (15.8)	-	26 (19.3)
Total	95	19	21	135

DISCUSSION

The very first aim of hospital is to provide care to sick and diseased. The admission to the type of healthcare facility (general ward/critical care area) is determined by various criteria. Admission to critical care areas (ICUs) is depended on various factors inclusive of diagnosis, patient's age, comorbid conditions, prognosis of the disease, resources available for appropriate therapeutic and diagnostic interventions etc.[8]

Over the past few years, the demand for admission in critical care areas have been increased.[9] In the present study, a total of 1691 patients were admitted to MICU. Indwelling medical devices (IMD) are considered essential part of modern medicine and remain the mainstay of management of patients especially in ICUs.[10] Out of these, 1326 (78.4%) had one or more indwelling medical devices. In a study from Maharashtra, conducted in a rural teaching hospital for a period of 2 years (January 2013-December 2014, a total 13456 ICU patents were having different types of IMD.[3] The increased use of IMD in ICU patient is associated with risk of medical device-associated adverse events (MDAAE).[11] MDAI are most common MDAAE. These infections are often more treatment resistant and associated with fatal complications.[3]

In the present study, surveillance of MDAI was conducted. As highlighted in various international and national studies, surveillance is an effective tool to enhance infection prevention and control (IPC) practices and decrease HAI. [3, 6] As per definition surveillance in healthcare system is "the ongoing systematic collection, analysis, and interpretation of health data for planning, implementing and evaluating public health activities."[12]

During the study period, a total of 135 (7.9%) patient developed MDAI. Various researchers have reported the rate of MDAI ranging from 4.9 to 8.5%.[5] The overall rate of MDAI was 6.8 per 1000 device associated days. The rate of MDAI in the present study was higher than that reported by Singh *et al*. (2010) [13] and Deorukhkar *et al*. (2016) [3] whereas it was low as compared to Moreno *et al*. (2006) [14], Vonberg et al. (2006)[15] and Habibi *et al*. (2008) [16]. Rate of MDAI highly is highly depended on the type of healthcare setup and patient-care area.

Various factors including duration and type of indwelling medical device, compliance with IPC policies like hand hygiene, standard precautions and care bundles also determine the MDAI rate in a particular healthcare setup. In different healthcare setup variation prevalence of type of IMD used is common.

In this study, urinary catheter (48.8%) was the commonest IMD in patients. Nearly 12-16% of adult inpatients are reported to have indwelling urinary catheter at some time of their hospitalization.[17, 18] Presence of indwelling catheter is the leading cause of urinary tract infections (UTI). Chances of CA-UTI increase with each day of indwelling urinary catheter.[17,18] Out of a total 825 patients with urinary catheters, CAUTI was developed in 95 patients. The overall rate of CA-UTI was 11.5% or 5.95cases per 1000 catheter days. In a study involving 55 ICUs of 8 different developing countries, the rate of CA-UTI was reported to range between 1.7 to 12.8 cases/1000 catheter days.[19] CA-UTI is associated with many complications including prostatitis, epididymitis, orchitis, cystitis, pyelonephritis, bacteremia, endocarditis, vertebral osteomyelitis, septic arthritis, endophthalmitis and meningitis.[20]

A total 378 patients were on intravascular catheters. Out of these, CR-BSI was developed in 19 patients. The rate of CR-BSI was 3.9% or 4.2 per 1000 catheter associated days. The incidence of CR-BSI varies considerably by type of catheter, frequency of catheter manipulation and patient-related factors like underlying disease and its acuity.[14] CR-BSI is associated with complications like local site infection, CR-BSI, septic thrombophlebitis, endocarditis lung and brain abscess, osteomyelitis and endophthalmitis.[21] The rate of CR-BSI was within the range reported from ICUs of 8 developing countries (7.8 to 18.5 cases per 1000 catheter associated days).[19]

During the study period, a total of 486 patients were on mechanical ventilator support. Out of these, 21 developed VAP. The rate of VAP was 5.6% or 4.8 cases/1000 ventilator associated days. The rate of VAP in this study was lower than other Indian studies.[3,6] VAP is major cause of morbidity and mortality in ICUs and its management remains a major challenge.

The type of pathogen involved in HAI varies as per healthcare setup, but usually it is the microorganism in the hospital environment.[3, 6] In the present study, *Klebsiella* spp. (45.9%) followed by *E. coli* (15.6%) were common bacterial pathogens from MDAI. Similar observation was noted by other Indian researchers.[3, 6] Strict adherence to IPC and disinfection policies is extremely essential to prevent cross transmission of pathogens in hospital environment.

Over the past few decades there is a notable increase in both frequency and severity of HAI due to fungi in general and *Candida* in particular. *Candida* spp., is reported to be 3rd among various leading cause of catheter-associated infections.[3, 22] *Candida* spp. can colonize and form biofilm on almost all medical devices in current use. In the present study, *Candida* spp, was isolated from 26 (19.3%) cases of MDAI. *Candida* MDAI are highly treatment resistant and may lead to serious life-threatening complications.[22]

CONCLUSION

Surveillance is an effective tool that can be utilized to improve infection prevention and control practices and reduce rate of healthcare associated infection. The rate of medical device associated infections (MDAI) varies greatly according to the healthcare setup and type of patients cared for. Hence, the surveillance data of particular healthcare setup cannot be generalized similarly the generalized data may not reflect the situation of a particular institute. This surveillance study facilitated us to generate institutional benchmarks for different types of MDAI like CA-UTI, CR-BSI and VAP which will aid to develop strategies to be implemented for reducing the incidence of these infections.

Conflict of interest: Nil

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