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Original article

Device-associated infection rates with microbiological profile and antibiogram pattern from an adult medical-surgical intensive care unit of a tertiary care hospital

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ABSTRACT

Introduction: Ubiquitous medical devices are major cause of health care associated infections. Surveillance of these infections plays a key role in control of hospital-acquired infections.
Materials and methods: In a prospective surveillance in medical surgical intensive care unit, device-associated health care associated infection rates were calculated using the National Nosocomial Infection Surveillance System and National Healthcare Safety Network guidelines.
Results: Fifty-four episodes of device-associated infections were documented among 563 patients. Rates for ventilator-associated pneumonia, central line-associated bloodstream infections and catheter-associated urinary tract infections were 16.7, 10.3 and 7.3 respectively with the overall device-associated nosocomial infection rate of 24.6/1000 days. The device utilization ratio was maximum for urinary catheter (0.99:1) followed by 0.68:1 for ventilator and 0.57:1 for central line. An overall crude excess mortality of 30.3% was observed. 40.7% of device-associated health care associated infections were caused by *Klebsiella* species. Imipenem and vancomycin showed maximum sensitivity to gram negative and positive organisms respectively.
Conclusion: Device-associated health care associated infections, the principal threat to patient safety in the intensive care unit, are among the predominant causes of patient morbidity and mortality. Surveillance of these infections allows estimation of infection control measures adopted.

1. Introduction

Over the years hospital epidemiology has witnessed a major change in terms of (a) potential reservoirs of infections due to patients clustered in specialized units under greater variety of caregivers, (b) newer varieties of microorganisms with increased resistance to standard antibiotic therapies responsible for even wider spectrum of nosocomial infections and (c) increased longevity of patients despite more compromising underlying diseases due to more invasive procedures and better treatments. An intensive care unit is frequently considered the epicentre for health care associated infections (HAIs) due to the underlying disease severity and comorbidities, increased use of invasive interventions and frequent use of wide spectrum antibiotics. An intensive care unit has been reported to account for 25% of HAIs despite occupying only approximately 10% of the bed capacity of a hospital [1].

The ubiquitous medical devices, though continuing to be essential in permitting lifesaving treatment and ensuring physiologic monitoring among critically ill patients, unfortunately are a major cause of hospital acquired infections especially in the intensive care units. Device-associated infections (DAIs) are severe nosocomial infections, which can significantly worsen the prognosis of patients hospitalized in intensive care units.

Device-associated health care associated infections (DA-HAIs), the principal threat to patient safety in the intensive care unit, are among the predominant causes of patient morbidity and mortality [2]. Device utilization among patients under such settings is responsible for increased risk of infections, such as catheter-associated urinary tract infections (CAUTIs), central line-associated bloodstream infections (CLABSIs) and ventilator-associated pneumonia (VAP) [3]. Such infections are associated with an increased

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length of stay of patients in intensive care unit and thus add to the hospital costs [4]. Routine surveillance of DA-HAI in the intensive care unit hence has become an integral part of hospital infection control and quality assurance [5].

Surveillance of DA-HAIs can ensure continual monitoring of the infection rate and provide baseline infection rate of any hospital. This would facilitate timely recognition of any potential outbreak and alert the hospital for prompt intervention with appropriate measures. In addition surveillance further allows a valid estimation of the effectiveness of quality improvement activities or any new infection control measure adopted. Criteria for DA-HAI surveillance have been standardized by the Center for Disease Control's (CDC's) National Nosocomial Infection Surveillance System and National Healthcare Safety Network. The adoption of such criteria provides us with DA-HAI rates that can be used as benchmark comparison among health care facilities and thus facilitate the infection control practitioners to have an in-depth look at the institutional problems so as to effectively manage them. Though effective infection control measures is reported to prevent 20–30% HAI, HAI still appears to be a hidden, cross-cutting problem due to lack of uniformity of the surveillance systems for HAI in most countries [6]. This study was undertaken to study the prevalence of device-associated infections from a medical surgical intensive care unit of a tertiary care teaching hospital along with the bacteriological profile and antibiogram pattern of such infections.

2. Materials and methods

A prospective surveillance was implemented in a 15-bedded adult medical surgical intensive care unit of a 2500-bedded tertiary care hospital from March 2015 to August 2015. Data were collected during the infection control rounds from all the patients admitted to the intensive care unit on specifically designed Performa by the infection control team consisting of the microbiologist and infection control nurse. The Performa included patient demographics, clinical background, indication of device application and daily record of device-associated infections, investigations and treatment. On a daily basis the infection control team by active surveillance collected data on mechanical ventilation, placement of central venous catheter and urinary catheters, fever, blood pressure, antibiotic use, and the results of cultures on each patient admitted to the intensive care unit.

CLABSI, VAP and CAUTI were defined and the DA-HAI rates were calculated using the CDC National Nosocomial Infections Surveillance System and National Healthcare Safety Network guidelines [7–9]. VAP is suspected in a mechanically ventilated patient with new or progressive infiltrates, consolidation, cavitation, or pleural effusion on chest radiograph and at least having one of the following criteria: (1) new onset of purulent sputum or change in character of sputum; (2) organisms cultured from blood; or (3) isolation of an aetiologic agent from a specimen obtained by tracheal aspirate, bronchial brushing or bronchoalveolar lavage, or biopsy. CLABSI is laboratory-confirmed when a patient with a central venous catheter has a recognized pathogen that is isolated from one or more percutaneous blood cultures after 48 h of vascular catheterization and which is not related to an infection at another site with at least one of the following signs or symptoms: fever (temperature $\geq$38 °C), chills, or hypotension. CAUTI can be defined as a urinary tract infection where an indwelling urinary catheter was in place for >2 calendar days on the date of event, with day of device placement being day 1, and an indwelling urinary catheter was in place on the date of event or the day before. If an indwelling urinary catheter was in place for >2 calendar days and then removed, the date of event for the urinary tract infection must be the day of discontinuation or the next day for the urinary tract infection to be catheter-associated.

Culture for CLABSI, VAP and CAUTI were done following the standard protocol [2]. For CLABSI, central lines were aseptically removed and the distal 5 cm of the catheter was amputated and cultured using a standardized semiquantitative method paralleled with percutaneous blood cultures. For VAP a tracheal aspirate from the endotracheal tube was cultured aerobically and Gram-stained. For CAUTI, aseptically aspirated urine sample from the sampling port of the urinary catheter was cultured quantitatively. Bacterial identification was done using the standard protocol and antimicrobial susceptibility was performed using the CLSI guidelines.

Outcomes measured during the study period included the incidence density rates of CLABSI (number of cases per 1000 central line-days), CAUTI (number of cases per 1000 urinary catheter-days), and VAP (number of cases per 1000 mechanical ventilator-days). DA-HAI rates for VAP, CLABSI, and CAUTI per 1000 device-days were calculated by dividing the total number of DA-HAI by the total number of specific device-days and multiplying the result by 1000. Device utilization ratios were calculated by dividing the total number of device-days by the total number of patient-days where device-days are the total number of days of exposure to the device (central line, ventilator, or urinary catheter) for all the patients in the selected population during the selected time period and patient days are the total number of days that patients are in the intensive care unit during the selected time period. The device-associated nosocomial infection rate was calculated as (device-associated nosocomial infection/patient day) $\times$ 1000. The average length of stay for patients admitted to intensive care unit was obtained by dividing the monthly number of intensive care unit patient-days by the number of intensive care unit discharges each month. For the determination of risk factors associated with intensive care unit acquired nosocomial infection, the following putative risk factors were recorded: age, gender, site from where the patient was transferred to the intensive care unit, and cause of intensive care unit admission.

2.1. Statistical analysis

T-test for independent samples was applied for the comparison of distribution of age and duration of stay in intensive care unit in two groups; one group included patients who developed DA-HAI during their stay in intensive care unit and other group included those patients who did not develop DA-HAI. 95% CI for VAP, CLABSI and CAUTI were determined by using the Poisson distribution assuming rare events. Pearson chi-square was used for the analysis of distribution of sex, admission status, outcome and reason of admission. Kaplan–Meier plot has been used to show the survival over time considering intensive care unit stay as time and mortality as event of occurrence for all DAI patients combined and then separately for each of VAP, CLABSI and CAUTI.

3. Results

During the study period 563 patients were admitted for 2192 days with 331 (58.79%) discharges and 232 (41.2%) fatalities (Fig. 1). The average length of stay for patients in intensive care unit was 3.9 days (2192/563). The overall male to female ratio was 1.6:1. Fifty-four (9.6%) episodes of DAI were documented. No multiple episodes of DAI were seen in any patient. No significant difference was present between the distribution of age in two groups ($p > 0.05$). Mean age in patients with DA-HAI was higher than the cases without DA-HAI (Table 1). Amongst DAI cases majority belonged to age group 31–60 years. A significant difference was present in the distribution of length of stay in intensive care unit amongst two study groups ($p < 0.05$). Mean length of stay in patients without DA-HAI was 6.4 (SD 4.7) days and in cases that developed DAI was 13.1 (SD 9.1) days. A significant

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