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Original Article

Microbiology Section

Active Surveillance of Health Care Associated Infections in Neurosurgical Patients

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ABSTRACT

Introduction: Health Care Associated Infections (HCAI) are frequent complications in neurosurgery. There is limited data available on the incidence and burden of HCAI in neurosurgical patients of Southeast Asian region.

Aim: To identify various HCAIs, associated aetiological agents and their antimicrobial susceptibility pattern among the patients admitted in the neurosurgery unit.

Materials and Methods: An observational prospective study was carried out for three months duration on all neurosurgical patients admitted to a tertiary-care center. The site-specific nosocomial infection rates and device utilization ratios were calculated. Data on demographic profiles, invasive procedures, HCAI, isolated microorganisms and antimicrobial susceptibilities were recorded. Statistical analysis of all the variables was done. The association between categorical variables was assessed by Chi-square/Fisher-exact test. Continuous variables such as infected and non-infected were compared by Wilcoxon rank-sum test. A p-value of less than 0.05 was considered significant.

Results: A total of 330 patients with 4054 patient-days were analysed for HCAI. Twenty-two HCAIs were identified in 21 patients. The overall rate of HCAI was 6.67% and 5.42 per 1000 patient-days. Urinary Tract Infection (UTI) was most common (71.4%) followed by Laboratory Confirmed Blood-Stream Infection (LCBI) (28.5%) and pneumonia (4.7%). No central line-associated blood stream infection was identified. *Klebsiella pneumoniae* and *Escherichia coli* were the most common organisms causing UTI and LCBI. All the isolates (100%) were found to be multidrug resistant.

Conclusion: This study generates a baseline data for records of device-associated infection in neurocritical care patients, which will further help monitoring its trend of infection and antimicrobial resistance pattern. Moreover, it will help in the formulation of the antibiotic policy and the preventive measures which may reduce morbidity and mortality.

Keywords: Device associated infection, Infection control, Nosocomial infection, Neurosurgery

INTRODUCTION

Health Care Associated Infections (HCAIs) pose a serious problem in hospital settings. They lead to increased morbidity, mortality and resource expenditure in different healthcare settings. Incidence of HCAI has been reported in different hospitals from various parts of the world. More than 20% of patients in Intensive Care Unit (ICU) may be infected with various HCAI with mortality rate of >30% [1]. Moreover, pathogens associated with these infections are often Multi-Drug Resistant (MDR) due to selective antibiotic pressure [2]. Patients admitted in neurosurgical units are at higher risk of developing one or more infections due to severity of the underlying illness, impaired protective reflexes, increased utilization of invasive medical devices, increased duration of hospital stay, and altered consciousness [3]. During hospitalization, various HCAI directly related to different invasive procedures such as urinary tract infection, pneumonia, blood stream infection, surgical site infection are often encountered [4]. Surveillance is an essential element so as to know the current prevalence of the condition, to identify potential risk factors and to implement various preventive strategies. Data regarding various HCAI among neurosurgical patients from India is limited. Hence, this study was carried out to generate baseline data on various HCAI among patients admitted in the neurosurgery unit, and to identify microbiological spectrum of different HCAI with their antibiotic susceptibility pattern.

MATERIALS AND METHODS

Setting and study period: An observational prospective study was carried out in a 70-bed neurosurgery ward at All India Institute of Medical Sciences, New Delhi, India, over a period of three months from November 2015 to January 2016. Ethical clearance from the Institute Ethical Committee, had been taken for this study. The nurse to patient ratio is 0.97. A total of 330 patients were surveyed during this period. All patients admitted to neurosurgery unit for more than 48 hours were included in the study.

Definition of infection: Presence or absence of infections during the study period was classified into specific infection sites as per standard definition of Centers for Disease Control and Prevention (CDC) [5]. Infections occurring at more than one site in the same patient were reported as two separate infection episodes.

Data collection: One microbiologist along with the infection control nurse visited the neurosurgery unit (ward/ICU) daily. The inclusion criteria of the study was patients admitted in neurosurgery unit (ward/ICU) for more than 48 hours and exclusion criteria was patients admitted in neurosurgery unit (ward/ICU) for less than 48 hours. Detailed history of the patients fulfilling the inclusion criteria was taken for the record. The information included demographic characteristics, surgery, antibiotic prophylaxis and final outcome of the patient at discharge. Potential risk factors like age, gender, underlying condition etc., were also recorded. The duration of different device utilization (urinary catheters/ventilators/shunts/central line catheters) was recorded in days. Different test samples (blood/urine/broncho alveolar lavage/tracheal aspirate/CSF/pus/wound swab/catheter tip) from the patients fulfilling the infection criteria were collected and sent to the Department of Microbiology for further processing. All the samples were cultured on blood agar, MacConkey agar and Cysteine Lactose Electrolyte Deficient (CLED) media (in case of urine specimen). Growth obtained after 16-18 hours of aerobic incubation at 37°C was identified further by Gram stain and biochemical tests. Antimicrobial susceptibility testing of the isolated organism was done by Kirby Bauer disc diffusion

method as per Clinical and Laboratory Standards Institute (CLSI) guidelines 2015 [6].

STATISTICAL ANALYSIS

Statistical analysis was done using Stata 11.2 (Stata Corp., College Station, TX, USA) and presented in frequency and mean. The association of categorical variables was assessed by Chi-square/ Fisher exact test. Continuous variables such as infected and non-infected were compared by Wilcoxon rank-sum test. A p-value of less than 0.05 was considered significant.

Infection rates: Device utilization ratios and site-specific infection rates (urinary catheter, central line and ventilator) per 1000 patient days were calculated using the following formulas:

Device utilization ratio (DU) = Number of device days/Number of patient days.

Device associated infection rates = Number of device associated infections for specific site/Number of device days × 1000.

RESULTS

Demographic Details

Three hundred thirty patients with 4054 total patient days were under observation during the study period; out of which 201 (60.9%) were males and 129 (39.1%) were females. The mean age and mean length of hospital stay were 30.3 years (range: 1 month-69 years) and 20.1 days (range: 3-87 days), respectively [Table/Fig-1]. The space occupying lesions were found to be the most common underlying condition among these patients followed by congenital malformation. In the present study, total 22 HCAI were identified among 21 patients. A single patient presented with two different infection episodes. Among them, 10 were male and 11 were female with mean age of 42.4 years (range: 1-69 years). The mean length of stay was 38.7 days (range: 9-87 days). Among non-infected group, 191 were male and 118 were female. The mean age and length of stay were 29.7 years and 18.8 days respectively. The mean age and length of hospital stay of infected group were higher than non-infected group and were statistically significant (p<0.05) [Table/Fig-1]. The most common underlying disease among infected group was intracranial tumors (10/21, 47.6%) followed by aneurysm (4/21, 19%) and subarachnoid hemorrhage (2/21, 9.5%) [Table/Fig-2].

Characteristics	Non-infected patients (n=309)	Infected patients (n=21)	p-value
Sex Male Female	 191 118	 10 11	0.197
Age (years) Mean	29.69	42.4	0.018*
Length of stay (days) Mean	18.84	38.7	0.001*
Perioperative prophylaxis	100%	100%	
Mortality	03/309 (0.97%)	0	0.991

[Table/Fig-1]: Characteristics of the patients admitted in neurosurgery unit.
* p-value significant <0.05 (Wilcoxon rank-sum test)

Diagnosis	Percentage (Number)
Intracranial tumours	47.6% (10)
ACom aneurysm	19% (4)
Subarachnoid hemorrhage	9.5% (2)
Atlanto-axial junction dysfunction	9.5% (2)
Epilepsy	4.7% (1)
Moya Moya disease	4.7% (1)
Meningoencephalitis	4.7% (1)

[Table/Fig-2]: Clinical diagnosis of the infected patients.

Parameters	Device utilization ratio	Device associated infection rate (per 1000 device days)
Urinary catheters	0.20	17.77
Ventilators	0.15	1.70
Central line catheters	0.06	Nil

[Table/Fig-3]: Different device associated infection rate and their utilization ratio.

Pathogens	CAUTI	VAP	LCBI
Klebsiella pneumoniae (n=08)	5	-	3
Escherichia coli (n=08)	6	-	2
Pseudomonas spp. (n=02)	1	1	-
Proteus vulgaris (n=01)	1	-	-
Enterococcus faecium (n=03)	2	-	1

[Table/Fig-4]: Incidence of various aetiological agents in the causation of different HCAI.

HCAI Rate

The overall HCAI incidence rate (HCAI/100) and incidence density (HCAI/1000 patient days) in the current study were 6.67% and 5.42/1000 patient days, respectively. The device utilization ratio of urinary catheters was observed to highest (0.20) followed by ventilators and central line [Table/Fig-3]. Urinary tract infection was the most common (71.4%) infection followed by Laboratory Confirmed Blood Stream Infection (LCBI) (28.5%) and pneumonia (4.7%). All urinary tract infections were found to be catheter associated. The device utilization ratio of urinary catheter, ventilator were 17.77 and 1.7 respectively. However, no infection was proven caused due to central line catheter.

Microbiological Spectrum with Antimicrobial Susceptibility Pattern

A total of 22 pathogenic microorganisms were isolated from the suspected patients. *Escherichia coli, Klebsiella pneumoniae* and *Enterococcus faecium* were the common pathogens causing Catheter Associated Urinary Tract Infection (CAUTI). LCBI was commonly caused by *Klebsiella pneumoniae* followed by *Escherichia coli.* A single event of Ventilator Associated Pneumonia (VAP) caused by *Pseudomonas* species was identified [Table/Fig-4]. *Escherichia coli* showed complete resistance to fluoroquinolones and third generation cephalosoporins followed by other group of antimicrobial agents [Table/Fig-5]. All isolates of *Pseudomonas* spp. and *Proteus* spp. exhibited complete resistance to the panel of antimicrobials tested [Table/Fig-5]. Nitrofurantoin resistance was found in 66.6% (8/12) of the total urinary isolates tested. All Gram-Negative Bacilli (GNB) isolates (100%) were Multidrug Resistant (MDR) [Table/Fig-5]. Three out of 22 isolates identified as *E. faecium* were isolated from CAUTI (n=02) and Blood Stream Infection (BSI) (n=01). High Level Aminoglycoside Resistance (HLAR) was observed in 66.6% (2/3) of the isolates. One isolate of *E. faecium* was observed resistant to vancomycin and teicoplanin. However, all the isolates of *E. faecium* were susceptible to linezolid.

DISCUSSION

Information regarding HCAI in the neurosurgical setting is limited [7-13]. High incidence of HCAI is a common problem in patients of neurosurgical unit due to altered sensorium, frequent and prolonged use of medical devices. Therefore, this study was planned to assess data on incidence of nosocomial infections, associated risk factors, aetiological agents and their antimicrobial resistance pattern.

The incidence of HCAI among neurosurgical patients varies from hospital to hospital. A study from India reported 39% of the infection rate in neurology/neurosurgery ICU [13]. Another retrospective study by Laborde G et al., reported the infection rate to be 36.3% from 314 patients treated longer than 48 hours in neurosurgical ICU

GNB	Aminoglycosides	Third generation cephalosporins	Beta lactamase inhibitors		Carbapenems	Fluroquinolones	Nitrofurantoin	MDR
			Cefoperazone sulbactum	Piperacillin tazobactum				
Klebsiella pneumoniae	100%	100%	87.5%	87.5%	50%	100%	100%	100%
Escherichia coli	75%	100%	62.5%	62.5%	37.5%	100%	50%	100%
Pseudomonas spp.	100%	100%	100%	100%	100%	100%	-	100%
Proteus vulgaris	100%	100%	100%	100%	100%	100%	-	100%
GPC	**Ciprofloxacin**	**Erythromycin**	**High level gentamicin resistance**	**Linezolid**	**Vancomycin**	**Teicoplanin**		
Enterococcus faecium	66.6%	66.6%	66.6%	0%	33.3%	33.3%		

[Table/Fig-5]: Antimicrobial resistance pattern of the isolated pathogens causing different HCAIs.

[14]. Incidence rate of HCAI in the present study was 6.67% among patients admitted in neurosurgery unit; which was relatively low in comparison to above mentioned studies. However, Walaszek et al., and Gocmez C et al., had also reported a lower incidence of 3.86% and 3.65% among patients in neurosurgical unit respectively [4,15]. Device utilization ratio has a strong impact on development of device-associated infection. Higher the device utilization ratio is, more are the chances of acquiring infection. Urinary catheter utilization ratio was the highest in our study. Also, UTI found to be the most common HCAI followed by LCBI among our patients. In contrast, an earlier study in neurology/neurosurgery ICU from India, pneumonia was reported as the most common site-specific infection followed by UTI [13]. However, incidence of VAP was noticed to be very less in the present study. This might be due to the modified CDC/NHSN surveillance definition used in the current study [5]. A single event of increase in daily minimum FiO_2 of ≥ 0.20 over the daily minimum FiO_2 in the baseline period, sustaining for ≥ 2 calendar days was recorded in a patient and was classified under VAC [5]. In study by Walaszek M et al., Surgical Site Infection (SSI), BSI and pneumonia to be the three most common infections among patients admitted in the neurosurgery ward [4]. BSI was proven in six patients out of 22. Although LCBI constitutes the second most infection in our study, Central Line Associated Blood Stream Infection (CLABSI) could not be established. This may be due to absence of simultaneous collection of blood from periphery and central line catheter in some cases.

It is a well-known fact that HCAI are an important predictor of morbidity and mortality among hospitalized patients. However, a lot of controversies are there in published literature regarding neurosurgical patients. Similarly, another study conducted in neurology ICU reported mortality rate of 23.5% with none of the deaths attributed to the infections [16]. In the present study, no mortality was observed among infected patients compared to 03/309 (<1%) in non infected groups. Hence, no statistically significant correlation between HCAI and mortality could be established (p-value=0.991). This may be due to the varied incidence of different HCAI in different hospital settings, infection control activities, treatment protocol and the preventive measures taken. Consistent with the findings of previous studies, length of the hospital stay and age are associated with a higher risk of developing HCAI [1,11]. High prevalence of GNB was reported for the majority of HCAI in neurosurgery ICU [1,11]. Our result was also in accordance to other studies. In the present study, Gram-negative organisms were most frequently isolated followed by Gram-positive. *Klebsiella pneumoniae* and *Escherichia coli* were the most common among GNB. All Gram-positive were identified as *Enterococcus faecium*. Few studies also reported *Staphylococcus aureus* as the most prevalent pathogens among the Gram-positives [17]. All the Gram-negative isolates (18/22) in the current study were MDR. So, overall the HCAI rate in our hospital found to be much lower than what published earlier from India. Moreover, no mortality associated with hospital acquired infections was observed in the studied population.

LIMITATION

The study has certain limitations. Firstly, it was conducted for a shorter duration in a tertiary referral center, where infection control practices are being followed. Hence, the data might not be the true representative of HCAI rates in this group of patients for other healthcare settings. Secondly, postoperative follow up could not be performed up to three months for identification of SSIs due to the lack of resources.

CONCLUSION

This study shows a low incidence of HCAI and their associated risk factors among patients admitted in the neurosurgery unit. It might be either due to strict adherence to the preventive measures or due to shorter duration of the study. However, to evaluate the efficacy of preventive measures, periodic active surveillance over a longer period is warranted.

DISCLOSURE

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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