Prevalence of common nosocomial organisms in surgical Intensive Care Unit in North India: A hospital-based study

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ABSTRACT

Background: Nosocomial infection presents with high mortality rate, and it remains a diagnostic and treatment challenge for health-care providers, with developing countries having the highest incidence and mortality rates.[4]

Aim: The present study was undertaken to evaluate prevalence of commonly isolated nosocomial organisms in patients admitted in Surgical Intensive Care Unit (ICU) in Government Medical College Srinagar.

Materials and Methods: The study was proposed to be conducted in surgical ICU of Shri Maharaja Hari Singh – a Tertiary Care Hospital in Jammu and Kashmir (India) from March 2015 to March 2016. The patients developing ICU infections within 48 h of admission in ICU or within 48 h of transfer from ICU were included in the study.

Results: Forty patients showing different types of infections were included, 92 samples were collected which included 39.13%, 27.17%, 7.61%, 10.87%, and 6.52% blood, urine, swab, sputum, pus, and endotracheal tube (ETT) samples, respectively. From these samples, 27.78%, 76.0%, 87.5%, 71.43%, 80.0%, and 33.33% samples of blood, urine, swab, sputum, pus, and ETT, respectively, were found positive, i.e. showed the growth of microorganisms. A total of 10 types of microorganisms were isolated (Escherichia coli, Pseudomonas spp., Klebsiella spp., Acinetobacter spp., Staphylococcus aureus, Enterococcus, Enterobacter spp., Proteus spp., Citrobacter spp., and Candida spp.) from six types of samples among which maximum number of microorganisms were isolated from swab which was followed by blood and urine, while minimum number of microorganisms were isolated from ETT. Further, among ten microorganisms isolated, the highest percentage was recorded for Pseudomonas spp., which was followed by Klebsiella spp. and E. coli, while the lowest percentage was recorded for Proteus spp.

Conclusion: There was a predominance of Gram-negative bacilli than Gram-positive bacilli.

Key Words: Escherichia coli, Gram-negative bacilli, Gram-positive bacilli, Klebsiella spp., Proteus spp., Pseudomonas aeruginosa

INTRODUCTION

Infections are frequent complications of hospitalization.[1] This issue has been recognized for more than a century as a critical problem affecting the quality of health care and principal source of adverse outcomes, and today, nosocomial infections affect more than 2 million patients annually at a cost of US 4.5 billion.[2] Intensive
Care Units’ (ICUs) patients are more vulnerable for the development of these infections compared with an average patient. It has been reported that an ICU patient has five- to seven-fold higher risk of nosocomial infections and contributes to 20%–25% of all nosocomial infections in hospitals.\(^3\)\(^,\)\(^4\) Factors such as the increased use of invasive devices, immunosuppressive drugs, and immunocompromised status as well as irrational use of antibiotic therapy in ICUs are all contributions for this cause.\(^5\) Over 80% of nosocomial infections are related to utilize utilization needed for patients’ life support but responsible for such complications as ventilator-associated bloodstream infection (BSI), surgical site infection (SSI), and urinary tract infection (UTI).\(^6\)

The pattern of organisms causing infections varies widely from one country to another as well as from one hospital to another and even ICUs within a hospital. Local surveillance data should play an integral role in developing effective intervention studies. Therefore, the present study is aimed to know the prevalence of commonly isolated organisms in patients admitted in ICUs of Shri Maharaja Hari Singh (SMHS) (a tertiary care hospital in J and K, Northern India) after seeking requisite prior Ethical Committee clearance.

**MATERIALS AND METHODS**

The prospective study was conducted in surgical ICU of SMHS – a Tertiary Care Hospital in Jammu and Kashmir (India) from March 2015 to March 2016. The patients developing ICU infections within 48 h of admission in ICU or within 48 h of transfer from ICU were included after seeking requisite prior Ethical Committee clearance. However, patients showing clinical signs of infection on or before admission or transfer to ICU were ignored. Depending on the clinical suspension laboratory samples such as urine, pus, blood, endotracheal suction catheters samples, and central line tip culture samples will be collected. The samples collected from ICU unit were inoculated on 5% sheep blood agar and MacConkey agar plates and incubated overnight at 37°C aerobically. Bacterial pathogens were identified by conventional biochemical methods according to standard microbial techniques.\(^7\)

**RESULTS**

The data presented in Table 1 exhibited the age distribution across age groups. The age of the study population ranged from 28 to 76 years, with the mean age being 51.43 ± 12.87 years. Among the six age groups, majority of the patients (32.5%) were found in the age group of 51–60 years, while minimum number of patients (5.0%) observed in the age group of <70 years.

Next forty patients showing different types of infections were included in this study which comprised 26 males (65.0%) and 14 females (35.0%) [Table 2].

Among the forty patients, 62.5% of the patients were directly admitted to ICU, while 37.5% of patients were transferred from inpatient department to ICU [Table 3].

It was seen 62.5% came directly to surgical ICU and 37.5% from other hospital wards as depicted in Table 3.

Perusal of the Table 4 revealed that 92 samples were collected from these 40 patients in which 39.13% were blood samples, 27.17%, 8.70%, 7.61%, 10.87%, and 6.52% were urine, swab, sputum, pus, and endotracheal tube (ETT) samples, respectively. From 36 blood samples collected, only 10 samples, i.e. 27.75% of samples were found positive (showed growth of microorganisms). Similarly, in urine, swab, sputum, pus, and ETT, 76.0%, 87.5%, 71.43%, 80.0%, and 33.33% samples yielded growth of microorganisms, respectively.

Table 5 depicts the pattern of organisms isolated from different samples. Perusal of the table revealed that ten types of microorganisms were isolated (*Escherichia coli*, *Pseudomonas* spp., *Klebsiella* spp., *Acinetobacter* spp., *Staphylococcus aureus*, *Staphylococcus* *aureus* spp., *Enterococcus* spp., *Streptococcus* spp., *Klebsiella* *pneumoniae*, *Pseudomonas* *aeruginosa*).

**Table 1: Age distribution of patients**

| Age groups (years) | Number of patients (%) |
|-------------------|------------------------|
| ≤ 30              | 3 (7.5)                |
| 31–40             | 6 (15.0)               |
| 41–50             | 10 (25.0)              |
| 51–60             | 13 (32.5)              |
| 61–70             | 6 (15.0)               |
| < 70              | 2 (5.0)                |
| Mean age ± SD     | 51.43 ± 12.87          |

**Table 2: Sex distribution of patients**

| Sex distribution | Number of patients (%) |
|------------------|------------------------|
| Male             | 26 (65.0)              |
| Female           | 14 (35.0)              |

**Table 3: Admission of patients to Intensive Care Unit**

| Admission     | Number of patients (%) |
|---------------|------------------------|
| Direct        | 25 (62.5)              |
| Transferred   | 15 (37.5)              |

**Table 4: Sample profile and rate of positive cultures**

| Samples      | Number of samples, n (%) | Samples yielding growth of micro-organisms, n (%) |
|--------------|--------------------------|-----------------------------------------------|
| Blood        | 36 (39.13)               | 10 (27.78)                                   |
| Urine        | 25 (25.17)               | 19 (76.00)                                   |
| Swab         | 8 (39.13)                | 7 (87.50)                                    |
| Sputum       | 7 (7.61)                 | 5 (71.43)                                    |
| Pus          | 10 (10.87)               | 8 (80.00)                                    |
| ETT          | 6 (6.52)                 | 2 (33.33)                                    |
| Total        | 92 (-)                   | 53 (-)                                       |

ETT: Endotracheal tubes
**Table 5: Microbiological data (pattern of organisms isolated from different samples)**

| Organism                  | Blood | Urine | Swab | Sputum | Pus | ETT | Total (%) |
|---------------------------|-------|-------|------|--------|-----|-----|-----------|
| *Escherichia coli*        | 3 (13.64) | 4 (21.05) | 3 (10.00) | 2 (12.50) | 4 (28.57) | 3 (25.00) | 19 (16.81) | 1 (4.55) |
| *Pseudomonas spp.*        | 8 (36.36) | 6 (31.58) | 9 (30.00) | 6 (37.50) | 4 (28.57) | 2 (16.67) | 29 (30.97) |
| *Klebsiella spp.*         | 5 (22.73) | 5 (26.32) | 11 (36.67) | 5 (31.25) | 2 (14.29) | 1 (8.33) | 29 (25.66) |
| *Acinetobacter spp.*      | 1 (4.55) | 0 (0.00) | 1 (3.33) | 0 (0.00) | 1 (7.14) | 0 (0.00) | 4 (3.54) |
| *Staphylococcus Aureus*   | 1 (4.55) | 1 (5.26) | 1 (3.33) | 0 (0.00) | 1 (7.14) | 0 (0.00) | 5 (4.42) |
| *Enterococcus*            | 1 (4.55) | 1 (5.26) | 2 (6.67) | 0 (0.00) | 1 (7.14) | 0 (0.00) | 5 (4.42) |
| *Enterobacter spp.*       | 1 (4.55) | 0 (0.00) | 1 (3.33) | 0 (0.00) | 1 (7.14) | 0 (0.00) | 3 (2.65) |
| *Proteus spp.*            | 1 (4.55) | 0 (0.00) | 0 (0.00) | 1 (6.25) | 0 (0.00) | 0 (0.00) | 2 (1.77) |
| *Citrobacter spp.*        | 0 (0.00) | 1 (5.26) | 1 (3.33) | 2 (12.50) | 0 (0.00) | 0 (0.00) | 4 (3.54) |
| *Candida spp.*            | 1 (4.55) | 1 (5.26) | 1 (3.33) | 0 (0.00) | 0 (0.00) | 0 (0.00) | 3 (2.65) |
| **Total**                 | 22     | 19     | 30    | 16     | 14   | 12   | 113       |

ETT: Endotracheal tubes

**Staphylococcus aureus, Enterococcus, Enterobacter spp., Proteus spp., Citrobacter spp., and Candida spp.** from six types of samples, namely, blood, urine, swab, sputum, pus, and ETT. Among these samples, a maximum number of microorganisms (30) were isolated from swab which was followed by blood (22) and urine (19), while minimum number of microorganisms were isolated from ETT (12). The data also revealed that, among ten microorganisms isolated, the highest percentage (30.97%) was recorded for *Pseudomonas* spp. which was followed by *Klebsiella* spp. (25.66%) and *E. coli* (16.81%), while the lowest percentage was recorded for *Proteus* spp. (1.77%).

**DISCUSSION**

Surgical ICU-related nosocomial infection presents with high mortality rate. It remains a diagnostic and treatment challenge for health-care providers, with developing countries having the highest incidence and mortality rates Nosocomial infections or healthcare-associated infections encompass all clinically evident infections that do not originate from patient’s original admitting diagnosis.[8] The incidence of nosocomial infections is about 5%-10% in most developed nations, while in India, one in four patients admitted into hospital-acquired nosocomial infection.[9] Common nosocomial infections in surgical patients include SSIs, UTIs, pneumonias, and BSIs. In 1986, National Nosocomial Infections Surveillance report, the overall incidence of nosocomial infections was 33.5/1000 discharges, the range extended from 13.3/1000 discharges to 46.7/1000 discharges in surgical patients. The higher incidence of infections among surgical patients was largely attributable to SSIs.[10] SSIs account for approximately a quarter of all nosocomial infections. These infections can range from superficial wound infections, which have minimal mortality rates but add a considerable cost to patient care, to necrotizing soft-tissue infections, which are associated with prolonged hospitalization, significant health-care expense, and a high mortality rate.[11] The incidence of infection varies from surgeon to surgeon, from hospital to hospital, from one surgical procedure to another, and most importantly from one patient to another. In clean surgical procedures, in which the gastrointestinal, gynecologic, and respiratory tracts have not been entered, *S. aureus* from the exogenous environment or the patient’s skin flora is the usual cause of infection. In other categories of surgical procedures including clean contaminated, contaminated, and dirty, the polymicrobial aerobic and anaerobic flora closely resembling the normal endogenous microflora of the surgically resected organ are the most frequently isolated pathogens.[12] It has been observed that UTIs account for a large number of nosocomial infections in surgical patients. The single most important factor for nosocomial bacteriuria and UTI is the presence of indwelling urinary catheter.[13]

In the present study, a total of 92 samples were recovered from 40 patients over a period of 1 year out of which 53 (57.61%) showed growth of microorganisms. Among these 53 samples (in which growth of microorganisms was observed), the highest frequency was noticed for swab (87.50%) which was followed by pus (76.00%) and urine (71.43%), while lowest percentage was noticed in blood samples (27.78%) [Table 4]. The results of the present study are in agreement with the earlier reports of Saghati *et al.* who also reported that samples which showed growth of microorganisms were recovered from swab.[14] In another study by Aggarwal *et al.*, the major source of infection was from sputum and tracheostomy specimen (28.57%), followed by pus (24.13%), urine (19.04%), cerebrospinal fluid and other sterile body fluids (15.38%), and blood (7.14%).[15]

In the current study, 10 types of microorganisms were isolated, namely, *E. coli, Pseudomonas spp., Klebsiella spp., Acinetobacter spp., Staphylococcus Aureus, Enterococcus, Enterobacter spp., Proteus spp., Citrobacter spp., and Candida spp.* among which the highest percentage (30.97%) was recorded for *Pseudomonas* spp. which was followed by *Klebsiella* spp. (25.66%) and *E. coli* (16.81%), while the lowest percentage was recorded for *Proteus* spp. (1.77%). This is in agreement with previous studies from Pakistan and other countries.[16-19] These findings are similar to
those reported from India and Turkey. In the study carried out in India, among the 60 patients, 35 (58.3%) had microbiological confirmation and the organisms isolated were Klebsiella pneumoniae, Pseudomonas aeruginosa, Stenotrophomonas maltophilia, and Citrobacter freundii. In another study carried out over a period of 12 months in a tertiary care teaching hospital located in the southeastern part of Turkey, the percentages of most frequently isolated microorganisms in ICU were P. aeruginosa 20.3%, Candida species 15%, S. aureus 12.9%, Acinetobacter baumannii 9.6%, and coagulase-negative staphylococci 8.9%. In an ICU of Fatmawati Hospital, Indonesia, during January 2009 to March 2010, the most predominant isolates were P. aeruginosa followed by Klebsiella pneumoniae and Staphylococcus epidermidis which supports the present findings.

Rungruanghiranya et al. in a review of nosocomial infections in the ICU at Srinakharinwirot University, Thailand, found that most of the outbreaks indicated that hospital personnel were the most important reservoir of these highly resistant pathogens in the ICU and have led to cross-contamination during patient care. ICU environmental contamination appeared to be another important source. Moreover, that the significant environmental reservoirs in the ICU included room surfaces, ventilator tubing, resuscitation bags, mattresses, hand-washing sinks, gowns, and gloves. The study also noted that it was also possible that airborne dispersal was an indirect source, especially during hospital outbreaks.

The study also revealed that, among 10 microorganisms isolated, P. aeruginosa, E. coli, Klebsiella pneumoniae, and Acinetobacter were found in all types of samples and were most frequent. These findings are in close agreement with the earlier reports of Jones et al. They reported that six microorganisms, namely, S. aureus, P. aeruginosa, Klebsiella species, E. coli, Acinetobacter species, and Enterobacter cause approximately 80% of infections with lower prevalence of Serratia species, Stenotrophomonas maltophilia, and community-acquired pathogens, such as Pneumococci and Haemophilus influenzae. The results tabulated across all areas showed that the top six pathogens caused nearly 80% of all cases, and only 5.6% of patients had community-acquired bacterial pneumonia-causing pathogens (for example Streptococcus pneumoniae and H. influenzae). Regional variation in pathogen rank was encountered, but the same top six organisms prevailed (75.8% of cases in Europe and 85.4% of cases in Latin America). A significant change in rank was that P. aeruginosa was the most frequent pathogen causing VABP in Latin America (28.2%), with Acinetobacter species ranked third. In another prospective, observational, and multicenter study in 27 ICUs in nine European countries to compare risk factors, pathogens, and outcomes between bacteremic nosocomial pneumonia, the most prevalent pathogen was A. baumannii followed by Methicillin-resistant S. aureus. Another study in ICU at Birdem also showed growth obtained from 34% of the samples yielding 632 organisms with major organism isolates as Pseudomonas spp., Acinetobacter spp., Candida spp., E. coli, and Klebsiella spp., S. aureus, Enterobacter spp., Citrobacter spp., Providentia spp., and Serratia spp. of isolates.

**CONCLUSION**

In our study, there is a predominance of Gram-negative bacilli than Gram-positive bacilli, with P. aeruginosa, Klebsiella spp., and E. coli being the most common isolates in our SICU. The highest percentage being for Pseudomonas spp. which was followed by Klebsiella spp. and E. coli, while the lowest percentage was recorded for Proteus spp.

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**Conflicts of interest**

There are no conflicts of interest.

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