Nosocomial infections in surgical intensive care unit: A retrospective single-center study

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ABSTRACT

Aims: This study aims to study the incidence, microbiological and antibiotic sensitivity and resistance profile and impact on intensive care units (ICUs) stay and mortality of nosocomial infections in patients admitted to surgical ICU of our hospital.

Methods: A retrospective analysis of all patients admitted, over the course of 1 year, in the surgical ICU was undertaken. All patients who developed nosocomial infections were included in the study. Incidence, sites, common organisms of nosocomial infection were identified. The antibiotic sensitivity pattern of the microorganisms which were cultured was identified. This group of patients with nosocomial infections was matched with group of patients without nosocomial infections with respect to age, gender, and clinical diagnosis and the impact of nosocomial infections on ICU stay, and mortality was studied.

Results: Of 1051 patients admitted to the ICU during the study, 350 patients developed nosocomial infections and were included in the study group. Of the remaining patients, 350 patients matching the patients in the study group were included in the control group. The prevalence of nosocomial infections in our study was 33.30%. Skin and soft tissue infections (36.30%), including postoperative wound infections were the most common nosocomial infection, followed by respiratory infections (24.46%) and genitourinary infections (23.40%). The most common organisms causing nosocomial infections were Escherichia coli (26.59%) and Acinetobacter species (18.08%). About 40% of all Gram-negative organisms isolated were multidrug resistant. The average length of stay in ICU was 14.4 days for patients with nosocomial infections and 5.4 days (P < 0.05) for matched patients without nosocomial infections. The mortality in patients with nosocomial infections was 25.14% while that in patients without nosocomial infections was 10.57% (P < 0.05). Overall ICU mortality was 14.27%.

Conclusions: Nosocomial infections in surgical ICU patients significantly increase ICU length of stay and mortality.

Key Words: Acinetobacter, Klebsiella, nosocomial infections, Pseudomonas aeruginosa, surgical intensive care unit

INTRODUCTION

Nosocomial infections are common complications in patients hospitalized to intensive care units (ICUs), with reported incidences of 5%–10% in developed European and American countries and about 25% in India. The common nosocomial infections are respiratory tract infections (bronchitis, pneumonia),
urinary tract infections (UTI) (cystitis, pyelonephritis), bloodstream infections (BSI) (sepsis), skin and soft tissue infections (SSTIs) including surgical site infections. The prevalence of individual nosocomial infections will depend on many factors including the type of health-care facility (primary care vs. tertiary care), type of ICU (medical vs. surgical vs. medical-surgical vs. burns vs. cardiac surgical), and patient load of the facility.[6,10-12] Patients in Surgical ICUs have a predilection to develop nosocomial infections because of some unique characteristic such as type of surgery, type of wound (orthopedic or abdominal or cardiac or obstetric, etc., major, minor, infective, time taken for surgery), duration of preoperative hospitalization, and necessity of blood transfusions.[13]

The treatment of nosocomial infections is further complicated by antibiotic resistance and polymicrobial nature of the infections in some patients. Hence, knowledge of the microbial profile and antibiotic sensitivity pattern of prevalent microorganisms is essential. Nosocomial infections cause morbidity and increase mortality in hospitalized patients.[14-16] Hence, the understanding and efforts to reduce the prevalence of nosocomial infections are important. The aim of our study was to determine the prevalence of nosocomial infections in our ICU and to analyze the common microorganisms causing nosocomial infections and their antibiotic sensitivity and resistance profile. The impact of nosocomial infections on the length of stay in ICU and mortality of ICU patients was also studied.

METHODS

A retrospective analysis of medical records of all adult (age more than 18 years) patients admitted to Surgical ICU of our hospital over 1 year (January–December 2017) was done. The study was approved by the Institutional Ethical Committee, and the need for consent was waived. Patients admitted to ICU for more than 48 h were analyzed further. Those with evidence of new infection after 48 h of ICU admission (nosocomial infection) were included in the study (study group). Demographic characteristics (age, gender, and admission diagnosis), site of infection (skin and soft tissue including surgical site infections, respiratory tract, genitourinary system, abdominal infections, BSI, central nervous system infections), microorganisms isolated from the site or blood (Escherichia coli, Acinetobacter, Pseudomonas, Klebsiella, Methicillin-resistant Staphylococcus aureus, Citrobacter, Candida spp., and others), antibiotic sensitivity profile and resistance pattern were noted. The study group was matched (age, gender, admission diagnosis) with ICU patients during the study that did not have nosocomial infections. The primary outcome was ICU mortality. The secondary outcome was number of days spent in ICU. The duration of ICU stay and mortality in both groups was statistically analyzed using Chi-square test.

RESULTS

A total of 1408 patients were admitted to the surgical ICU during the study. Of these, 1051 patients were admitted for more than 48 h and medical records of these patients were analyzed. Three hundred and fifty patients had evidence of nosocomial infections (prevalence rate 33.30%). These patients comprised the study group. SSTIs were the most common (36.30%) followed by respiratory tract infections (24.46%) and genitourinary infections (23.4%) [Table 1]. The most common causative microorganism for nosocomial infection was E. coli, Acinetobacter, Klebsiella, and Pseudomonas [Table 2]. The common microorganisms according to the site of infections are as per [Table 3]. Approximately half of the patients are more than 60 years of age with 3/4th being male. Two-third of the patients had a clinical diagnosis of acute abdomen or had abdominal surgery. The demographic characteristics of these patients are presented in Table 4. Gram-negative bacteria were the most common microorganism cultured from the samples collected in patients with nosocomial infections. The antibiotic sensitivity and resistance profile of the various microorganisms isolated are given in Tables 5 and 6. The average ICU stays of patients with and without nosocomial infections were 14.4 and 5.4 days, respectively \((P < 0.05)\). The mortality rate of patients with and without nosocomial infections was 25.14 and 10.57 days, respectively \((P < 0.05)\) (see Table 7). The site of nosocomial infection and microorganism causing nosocomial infections in the patients who died are given in Table 8.

### Table 1: Types of nosocomial infections

| Site of nosocomial infections | Number of patients (%) |
|------------------------------|------------------------|
| Skin and soft tissue (including surgical site infections) | 170 (36.30) |
| Respiratory tract | 115 (24.46) |
| Genitourinary system | 110 (23.40) |
| Abdomen | 40 (8.51) |
| Bloodstream | 30 (6.40) |
| Central nervous system | 5 (1.10) |
| Total | 470 (100) |

Total ICU patients with ICU stay > 48 h = 1051. Patients with nosocomial infections = 350 (prevalence = 33.30%). Some patients had more than one nosocomial infections. ICU: Intensive care unit

### Table 2: Causative organisms for nosocomial infections

| Organisms | Number of patients (%) |
|-----------|------------------------|
| Escherichia coli | 125 (26.59) |
| Acinetobacter | 85 (18.08) |
| Pseudomonas | 75 (15.95) |
| Klebsiella | 55 (11.69) |
| MRSA | 30 (6.38) |
| Citrobacter | 25 (5.31) |
| Candida spp. | 10 (2.12) |
| Others | 65 (13.82) |
| Total | 470 (100) |

Some patients had polymicrobial infections. MRSA: Methicillin-resistant Staphylococcus aureus
Our study documented ICU nosocomial infection rate of 33.30%. This is similar to the ICU nosocomial infection rate (26.8%) reported from China and a study from North India (33.5) but higher than the EPIC study (20.6%). A lower rate of nosocomial infections was documented in a study from Kuwait among mixed medical and surgical ICU patients (10.6%) and a previous study conducted in our institute in 2011, conducted among medical ICU patients (9.6%). Another study among patients admitted to a high volume cardiac surgical ICU documented a low rate of nosocomial infections (4.6%). The difference could be due to different patient demographic characteristics (predominantly elderly, associated comorbidities, predominantly only surgical patients, majority patients with admission diagnosis of abdominal disease/surgery in our study). The study conducted in our institute previously was conducted in a 6 bedded medical ICU. Our ICU has expanded, and now, we have separate 20 bedded Surgical ICU and 20 bedded Medical plus cardiac ICU in an ICU complex, along with other ICU for respiratory diseases, obstetrics, etc. A study from tertiary care ICU in north India in mixed medical-surgical ICU patients documented a nosocomial infection rate of 58.86%.

The most common nosocomial infection was SSTI followed by respiratory infections followed by genitourinary infections. This is similar to the study from North India in patients admitted to a surgical ward. However, this is at variance with the studies from AIIMS and a study from Kuwait. The AIIMS study was in patients of high volume cardiac surgical unit (adult plus neonatal) who had lower respiratory tract infection (LRTI) as the most common nosocomial infection followed by SSTI and then BSI and UTI. The Kuwait study was conducted in a mixed medical and surgical care ICU. When compared to the study in

### Table 3: Causative microorganisms according to site of nosocomial infections

| Microorganisms | Skin and soft tissue (including surgical site infections) (%) | Respiratory tract (%) | Genitourinary system (%) |
|----------------|-------------------------------------------------------------|-----------------------|--------------------------|
| Escherichia coli | 33.33                                                       | 8.69                  | 36.36                    |
| Acinetobacter   | 16.66                                                       | 26.08                 | 9.09                     |
| Pseudomonas     | 4.16                                                        | 30.43                 | 27.27                    |
| Klebsiella      | 12.5                                                        | 17.39                 | 4.54                     |
| MRSA            | 4.16                                                        |                       |                          |
| Citrobacter     | -                                                           | 8.69                  | 4.54                     |
| Candida spp.    | -                                                           | -                     | 4.54                     |

MRSA: Methicillin-resistant *Staphylococcus aureus*

### Table 4: Demographic characteristics of the study group

| Age (years) | Number of patients (%) |
|-------------|------------------------|
| 18-40       | 49 (14)                |
| 40-60       | 140 (40)               |
| > 60        | 161 (46)               |

### Table 5: Gram-negative microorganisms and their resistance profile

| Antibiotic drug | Acinetobacter (%) | Escherichia coli (%) | Klebsiella (%) | Pseudomonas (%) |
|-----------------|-------------------|----------------------|----------------|-----------------|
| Imipenem        | 0                 | 5.45                 | 5.45           | 5.45            |
| Amikacin        | 5                 | 34.54                | 16.12          | 28.57           |
| Gentamicin      | 10                | 25.45                | 12.90          | 22.85           |
| Doxycycline     | 10                | 18.18                | 16.12          | 0               |
| Piperacillin    | 0                 | 5.45                 | 9.67           | 14.28           |
| Tazobactam      | 10                | 3.63                 | 9.67           | 17.14           |

### Table 6: Gram-negative microorganisms resistant to more than three classes of antibiotics

| Microorganism | Percentage |
|---------------|------------|
| Acinetobacter | 65         |
| Escherichia coli | 7.27     |
| Klebsiella    | 12.9       |
| Pseudomonas   | 5.71       |
| Citrobacter   | 15.38      |

### Table 7: Average duration of intensive care units stay and percentage mortality in patients with and without nosocomial infections

| Patient group | Average number of days in ICU | Percentage mortality |
|---------------|------------------------------|----------------------|
| Study group (with nosocomial infections) | 14.4 | 25.14 |
| Control group (without nosocomial infections) | 5.4 | 10.57 |

Increase in ICU stay and percentage mortality in study group statistically significant P<0.05. ICU: Intensive care unit

### Table 8: Types of infections (site and agent) in patients who died (n=88)

| Site/agent | Number of patients (%) |
|------------|------------------------|
| Skin and soft tissue (including surgical site infections) | 10 (11.36) |
| Respiratory tract | 41 (46.59) |
| Genitourinary system | 14 (15.90) |
| Abdomen | 15 (17.04) |
| Bloodstream | 18 (20.45) |
| Central nervous system | 2 (2.27) |

Agent (microorganism) causing nosocomial infection

| Escherichia coli | 38 (43.18) |
| Acinetobacter | 24 (27.27) |
| Pseudomonas | 21 (23.86) |
| Klebsiella | 13 (14.77) |
| MRSA | 4 (4.54) |
| Citrobacter | 3 (3.40) |
| Candida spp. | 2 (2.27) |

Patients may have more than one infection site or microorganism. MRSA: Methicillin-resistant *Staphylococcus aureus*
our institute conducted previously, LRTI followed by UTI were common among the medical ICU patients in that study. A high number of patients with abdominal surgeries/acute abdomen in the study group may explain the high number of SSTIs, including postoperative wound infections. These patients present and are operated in emergency situations with suboptimal bowel preparation leading to wound contamination.

The main microorganism causing nosocomial infections in our study were Gram-negative bacilli (72.31%) (E. coli > Acinetobacter > Pseudomonas > Klebsiella). Majority of studies have reported predominance of Gram-negative bacilli in nosocomial infections in and out of ICU.(3,8,10,12,14-16) These studies have been reported in a variety of settings, i.e., medical, surgical, mixed medical-surgical, and respiratory. Very rarely have Gram-positive bacteria been reported to be the predominant microorganism in nosocomial infections, as in the SOAP study.(9) In this study, S. aureus was the most common organism, of which 50% were methicillin resistant.

In our study, 65% of Acinetobacter isolated were resistant to more than three classes of antibiotics, i.e., multidrug resistant (MDR). Various studies have reported a similar occurrence of MDR state in two-thirds of Acinetobacter isolated in patients.17-19 About 37% of E. coli isolated in our study were MDR. The reported rate of MDR state in E. coli isolates from 22% to almost 80%.20,21 MDR microorganisms are a major threat to ICU patients. These patients are at increased risk of morbidity and mortality with limited treatment options.

The impact of nosocomial infections on the hospital morbidity and mortality of patients is controversial. Underlying patient demographics and seriousness of illness that brought the patient to ICU have a major impact on patient outcome. However, some recent reports supplement the theory that nosocomial infections increase morbidity and mortality in ICU patients.22-24 In our ICU, nosocomial infections significantly increased ICU stay and mortality. Several studies including some Indian studies have reported increase in ICU stay in patients with nosocomial infections as compared to patients without nosocomial infections.3,4,6,8,20,22 Mortality rates in ICU patients who develop nosocomial infections vary from 10% to 40%. In our ICU, the mortality rate was 25.14% which was significantly higher as compared to patients without nosocomial infections. Hence, measures to reduce the occurrence of nosocomial infection should be undertaken zealously.

Our study had some limitations. The study was conducted in the surgical ICU of a teaching hospital. It is a single center study. Extrapolation and generalization of our findings to the general population should be done with caution. A multicentric study involving multiple specialities ICU such as neurosurgical ICU and cardiovascular surgical ICU would add more value to such findings, besides serving to enlighten about nosocomial infections in these specific study populations. The sample size of our study was also modest. A study with larger sample size will be adequately powered to bring out the nuances of nosocomial infections in the surgical ICU population and also provide a base to study factors associated with mortality in this population.

Furthermore, bacterial patterns in one ICU (even within a large hospital) might be very different than in a different ICU, and this should be kept in mind whenever extrapolating our finding to other ICUs.

The strength of our study was that it demonstrated statistical significance of the impact of nosocomial infections in surgical ICU patients.

CONCLUSIONS

Nosocomial infections occur in one-third of all surgical ICU patients. MDR Acinetobacter and E. coli are major microorganisms isolated in these patients. Nosocomial infections significantly increase the hospital morbidity and mortality of these patients.

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Conflicts of interest
There are no conflicts of interest.

REFERENCES

1. Saranya NK. Nosocomial Infections. Available from: http://www.medscape.com/viewarticle/535488. [Last accessed on 2009 Oct 24].
2. Rosenthal VD, Al-Abdely HM, El-Kholy AA, AlKhawaja SA, Leblebicioglu H, Mehta Y, et al. International Nosocomial Infection Control Consortium report, data summary of 50 countries for 2010-2015: Device-associated module. Am J Infect Control 2016;44:1495-504.
3. Ding JG, Sun QF, Li KC, Zheng MH, Miao XH, Ni W, et al. Retrospective analysis of nosocomial infections in the intensive care unit of a tertiary hospital in China during 2003 and 2007. BMC Infect Dis 2009;9:115.
4. Agarwal R, Gupta D, Ray P, Aggarwal AN, Jindal SK. Epidemiology, risk factors and outcome of nosocomial infections in a respiratory intensive care unit in North India. J Infect 2006;53:98-105.
5. Vincent JL, Bihari DJ, Suter PM, Bruining HA, White J, Nicolas-Chanoin MH, et al. The prevalence of nosocomial infection in intensive care units in Europe. Results of the European prevalence of infection in intensive care (EPIC) study. EPIC international advisory committee. JAMA 1995;274:639-44.
6. Pradhan NP, Bhat SM, Ghandage DP. Nosocomial infections in the medical ICU: A retrospective study highlighting their prevalence, microbiological profile and impact on ICU stay and mortality. J Assoc Physicians India 2014;62:18-21.
7. Aly NY, Al-Mousa HH, Al Asar el SM. Nosocomial infections in a medical-surgical intensive care unit. Med Princ Pract 2008;17:373-7.
8. Choudhuri AH, Chakravarty M, Uppal R. Epidemiology and characteristics of nosocomial infections in critically ill patients in a
tertiary care intensive care unit of Northern India. Saudi J Anaesth 2017;11:402-7.

9. Vincent JL, Sakr Y, Sprung CL, Ranieri VM, Reinhart K, Gerlach H, \textit{et al.} Sepsis in European intensive care units: Results of the SOAP study. Crit Care Med 2006;34:344-53.

10. Sikka R, Mann JK, Deep, Vashist MG, Chaudhary U, Deep A. Prevalence and antibiotic sensitivity pattern of bacteria isolated from nosocomial infections in a surgical ward. Indian J Clin Pract 2012;22:519-25.

11. Sahu MK, Siddharth B, Choudhury A, Vishnubhatla S, Singh SP, Menon R, \textit{et al.} Incidence, microbiological profile of nosocomial infections, and their antibiotic resistance patterns in a high volume cardiac surgical intensive care unit. Ann Card Anaesth 2016;19:281-7.

12. Mir M, Anjum S, Mir R, Sheikh G, Mir M, Reshi F. Prevalence of various bacteria and their antibiotic sensitivity pattern in burn unit of government medical college and hospital Srinagar. Internet J Microbiol 2012;10:1.

13. Alexiou K, Drikos I, Terzopoulou M, Sikalias N, Ioannidis A, Economou N, \textit{et al.} A prospective randomised trial of isolated pathogens of surgical site infections (SSI). Ann Med Surg (Lond) 2017;21:25-9.

14. Olaechea PM, Palomar M, Álvarez-Lerma F, Otal JJ, Insauti J, López-Pueyo MJ, \textit{et al.} Morbidity and mortality associated with primary and catheter-related bloodstream infections in critically ill patients. Rev Esp Quimioter 2013;26:21-9.

15. Dasgupta S, Das S, Chawan NS, Hazra A. Nosocomial infections in the intensive care unit: Incidence, risk factors, outcome and associated pathogens in a public tertiary teaching hospital of Eastern India. Indian J Crit Care Med 2015;19:14-20.

16. Ott E, Saathoff S, Graf K, Schwab F, Chaberny IF. The prevalence of nosocomial and community acquired infections in a university hospital: An observational study. Dtsch Arztebl Int 2013;110:533-40.

17. Mathai AS, Oberoi A, Madhavan S, Kaur P. \textit{Acinetobacter} infections in a tertiary level intensive care unit in Northern India: Epidemiology, clinical profiles and outcomes. J Infect Public Health 2012;5:145-52.

18. Lemos EV, De la Hoz Restrepo F, Alvis N, Quevedo E, Cañón O, León Y. \textit{Acinetobacter baumannii} – Related mortality in intensive care units in Colombia. Rev Panam Salud Publica 2011;30:287-94.

19. Bacakoglu F, Korkmaz Ekren P, Taşbakan MS, Başarik B, Pulukçu H, Aydemir S, \textit{et al.} Multidrug-resistant \textit{Acinetobacter baumannii} infection in respiratory intensive care unit. Mikrobiyol Bul 2009;43:575-85.

20. Girou E, Stephan F, Novara A, Safar M, Fagon JY. Risk factors and outcome of nosocomial infections: Results of a matched case-control study of ICU patients. Am J Respir Crit Care Med 1998;157:1151-8.