

## ORIGINAL ARTICLE

# Nosocomial Infections in the Medical ICU : A Retrospective Study Highlighting their Prevalence, Microbiological Profile and Impact on ICU Stay and Mortality

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### Abstract

#### Objectives:

1. To study the prevalence of nosocomial infections in the Medical ICU.
2. To determine common microorganisms causing nosocomial infections in the ICU and their antibiotic-sensitivity profile.
3. To study the impact of nosocomial infections on ICU stay and mortality.

**Methods:** A retrospective 1 year analysis of nosocomial infections in the Medical ICU at Smt. Kashibai Navale Medical College and Hospital, Pune, between January and December 2011 was carried out. Prevalence of nosocomial infections was determined; sites of nosocomial infections and common causative microorganisms were identified; their antibiotic-sensitivity profiles were studied. The group of patients with nosocomial infections was matched with a control group drawn from the pool of patients without nosocomial infections; this matching was done with respect to age, gender and clinical diagnosis. Period of ICU stay and patient mortality rates in the two groups were analysed.

**Results:** A total of 366 ICU patient records were analysed. Of these, 32 patients were found to have developed 35 nosocomial infections (9.6% prevalence), of which respiratory infections were the commonest (65.8%), followed by urinary infections (17.1%) and dual infections (urinary plus respiratory) (17.1%). The most frequently isolated microorganism causing respiratory infections was Acinetobacter (40.4%), 21% isolates of which were multidrug resistant; whereas the most frequently isolated microorganism causing urinary tract infections was Pseudomonas (38.4%).

Average ICU stay in patients with and without nosocomial infections was 16.5 and 6.4 days respectively; whereas mortality in the two groups was 28.1% and 31.2% respectively. Overall ICU mortality was 19.9%.

**Conclusion:** The nosocomial infection rate in our ICU was in keeping with the rate in many industrialised countries. The most common site of nosocomial infection was the respiratory tract, followed by the urinary tract. Acinetobacter was the commonest respiratory isolate, whereas Pseudomonas was the commonest urinary isolate. One fourth of Acinetobacter isolates were multidrug resistant. Nosocomial infections resulted in a statistically significant increase in ICU stay; whereas there was no impact on ICU mortality.

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## Introduction

Nosocomial infection, also called healthcare acquired infection, is defined by the CDC as a localised or systemic condition resulting from an adverse reaction to the presence of an infectious agent(s) or toxin(s), without any evidence that the infection was present or incubating at the time of admission to the acute care setting.<sup>1</sup> Patients admitted to the ICU are especially susceptible

**Table 1 : Types of nosocomial infections**

Total ICU patients with ICU stay more than 48 hours: 366		
Patients with nosocomial infections: 32 (9.6% prevalence)		
Nosocomial Infections	Number	Percentage
1. Respiratory infections	23	65.8%
2. Urinary infections	6	17.1%
3. Dual infections (Respiratory + urinary)	3 (3+3)	17.1%
Total number of infections	35	

**Table 2 : Causative organisms for nosocomial infections**

Organism	Percentage
Acinetobacter	34.5%
Pseudomonas	32.8%
Klebsiella	13.9%
E Coli	12.1%
Citrobacter	5.0%
Candida	1.7%

to nosocomial infections in view of significant risk factors such as central venous catheterisation, urinary catheterization, mechanical ventilation, stress ulcer prophylaxis and increasing length of ICU stay.<sup>2-5</sup> Since ICU patients are frequently exposed to broad spectrum antimicrobials, they are susceptible to infections by multidrug-resistant microorganisms like Pseudomonas, Acinetobacter and MRSA.<sup>2,6-13</sup> Despite adequate antimicrobial treatment, nosocomial ICU infections can significantly affect ICU stay<sup>7,14-18</sup> and can cause an increase in patient mortality.<sup>7,11,14,16-18</sup> The aim of this study was to determine the prevalence of nosocomial infections in our ICU.

The study also analysed common microorganisms associated with these infections; their antibiotic sensitivity profile and the impact of these infections on ICU stay and patient mortality.

## Material and Methods

The study involved a retrospective analysis of medical records of medical ICU patients at Smt. Kashibai Navale Medical College and Hospital, Pune during a one year period between January and December 2011.

Patient data was collected with reference to evidence of new infection after 48 hours of ICU admission, site of infection, microorganisms isolated if any, and their antibiotic sensitivity profile. Pattern of antibiotic usage in the ICU patients was documented. The group of patients with nosocomial infections was matched with a control group drawn from the pool of patients without nosocomial infections; matching was done with respect to age, gender and clinical diagnosis. Period of ICU stay and patient mortality rates in the two groups were studied. Statistical analysis of result was conducted.

**Table 3 : Causative micro-organisms**

Respiratory infections		Urinary infections	
Organism	Percentage	Organism	Percentage
Acinetobacter	40.4%	Pseudomonas	38.4%
Pseudomonas	29.8%	E Coli	23.1%
Klebsiella	19.2%	Citrobacter	15.4%
E Coli	8.5%	Acinetobacter	7.7%
Citrobacter	2.1%	Candida	7.7%
		Klebsiella	7.7%

## Results

During the said one year period, a total of 537 Medical ICU patient-records were reviewed. Of these, 366 medical records of patients with more than 48 hours of ICU stay, were analysed. Of these 366 patients, 232 patients (63.7%) were males. Average patient age was 52 years (13-97 years). Of the 366 patients, 32 patients were found to have developed 35 nosocomial infections (9.6% prevalence) (Table 1). Respiratory tract infections were the commonest (65.8%), followed by urinary tract infections and dual infections (17.1% each) (Table 1).

Nosocomial infections in our study were most frequently caused by Acinetobacter (34.5%), followed by Pseudomonas (32.8%), Klebsiella (13.9%), E Coli (12.1%), Citrobacter (5%) and Candida (1.7%) (Table 2).

Respiratory infections were most frequently caused by Acinetobacter (40.4%), followed by Pseudomonas (29.8%), Klebsiella (19.2%), E Coli (8.5%) and Citrobacter (2.1%) (Table 3). 21% of Acinetobacter isolates were multidrug resistant; the others were sensitive to imipenem, piperacillin, cefoperazone, tigecycline, colistin, tetracycline and doxycycline. 7.1% of Pseudomonas isolates were multidrug resistant; the other isolates were sensitive to imipenem, piperacillin, gentamycin and amikacin. E Coli isolates were sensitive to gentamycin, amikacin and imipenem. Klebsiella isolates were sensitive to imipenem, gentamycin and amikacin.

Urinary infections were most frequently caused by Pseudomonas (38.4%), followed by E Coli (23.1%), Citrobacter (15.4%), Acinetobacter, Candida and Klebsiella (7.7% each) (Table 3). Pseudomonas isolates were sensitive to imipenem, piperacillin, gentamycin and amikacin; E Coli isolates were sensitive to gentamycin and nitrofurantoin; Acinetobacter isolates were sensitive to gentamycin, cefotaxim, norfloxacin and TMP/SMX.

Penicillins were the most commonly used antibiotic (37.9%), followed by cephalosporins (29.7%), macrolides (11.3%), aminoglycosides (9.2%), vancomycin and quinolones (5% each) and carbapenems (1.9%) (Table 4).

The average ICU stay of patients with and without nosocomial Infections was 16.5 days (4-41 days) and

**Table 4: Antibiotic usage in the medical ICU**

Antibiotic Class	Percentage
Penicillins	37.9%
Cephalosporins	29.7%
Macrolides	11.3%
Aminoglycosides	9.2%
Quinolones	5%
Vancomycin	5%
Carbapenems	1.9%

**Table 5 : Average duration of ICU stay**

Patient group	No. of days
Study Group (Patients with nosocomial infections)	16.5days
Matched Control Group (Patients without nosocomial infections)	6.4 days

Increase in ICU stay in Study Group: Statistically significant ( $p < 0.001$ ).

6.4 days (3-24 days) respectively (Table5); mortality in the two groups was 28.1% and 31.2% respectively (Table 6). (Overall ICU mortality was 19.9%).

## Discussion

In the present study, the ICU nosocomial infection rate was 9.6%. The EPIC study<sup>2</sup> conducted across Europe documented an infection rate of 20.6%,<sup>2</sup> whereas other studies have observed rates varying between 9.1% and 48.7%.<sup>4,5,11-13,15,17</sup> A study from a hospital in North India observed an infection rate of 33.5% in their respiratory ICU.<sup>15</sup> The infection rate observed in our ICU indicates a relatively low prevalence of nosocomial infections, suggestive of good aseptic practices, hand hygiene principles and good ventilatory and urinary catheter care.

The most commonly observed nosocomial infections in our study were respiratory (65.8%) in origin, followed by urinary tract infections and dual infections (17.1% each). This was similar to observations of the EPIC study,<sup>2</sup> the EPIC II study<sup>7</sup> and other studies,<sup>4,5,11-16</sup> which found maximum incidence of respiratory infections; but was at variance with studies from Brazil<sup>19</sup> and USA<sup>20</sup> which found higher frequency of urinary infections followed by respiratory and blood stream infections. The increased occurrence of respiratory nosocomial infections in our study could possibly be due to advanced average patient age and associated respiratory co-morbidities.

Nosocomial infections in our study were most frequently caused by *Acinetobacter* (34.5%), followed by *Pseudomonas* (32.8%), *Klebsiella* (13.9%), *E Coli* (12.1%), *Citrobacter* (5%) and *Candida* (1.7%); our study documented a predominance of gram-negative organisms in nosocomial ICU infections. A similar predominance of gram-negative organisms was found in the EPIC study,<sup>2</sup> the EPIC II study,<sup>7</sup> and other studies.<sup>3,6,11,13,15</sup>

**Table 6 : Percent mortality**

Patient Group	Total patients	No. of deaths	Percentage
Study Group (Patients with nosocomial infections)	32	9	28.1%
Matched Control Group (Patients without nosocomial infections)	32	10	31.2%

Overall ICU mortality: 19.9%

But a predominance of gram-positive organisms was noted in the SOAP study.<sup>14</sup>

Respiratory infections in our study were most frequently associated with isolates of *Acinetobacter* (40.4%), followed by *Pseudomonas* (29.8%), *Klebsiella* (19.2%), *E Coli* (8.5%) and *Citrobacter* (2.1%). 21% isolates of *Acinetobacter* in our study were multi-drug resistant, whereas the rest were sensitive to imipenem, piperacillin, cefoperazone, tigecycline and colistin, tetracycline and doxycycline. Multidrug resistant *Acinetobacter* isolates varying between 62-70% have been reported in other studies.<sup>8-10</sup> Our study highlights the predominance of *Acinetobacter* isolates in causation of nosocomial respiratory infections in our ICU and their frequent multidrug-resistance profile. The antibiotic sensitivity of *Acinetobacter* isolates will guide empirical antibiotic treatment in nosocomial respiratory infections in our ICU.

Urinary infections in our study were most frequently associated with isolates of *Pseudomonas* (38.4%), followed by *E Coli* (23.1%), *Citrobacter* (15.4%), and *Acinetobacter*, *Klebsiella* and *Candida* (7.7% each). This was in contrast to other studies in China<sup>13</sup> and USA<sup>20</sup> which found greatest frequency of *Candida* isolates causing urinary infections. The *Pseudomonas* isolates were sensitive to imipenem, piperacillin-tazobactam, gentamycin and amikacin. This antibiotic-sensitivity profile will again guide empirical antibiotic treatment of nosocomial urinary infections in our ICU.

In our study, penicillins were the most commonly used antibiotic (37.9%), followed by cephalosporins (29.7%), macrolides (11.3%), aminoglycosides (9.2%), vancomycin and quinolones (5% each) and carbapenems (1.9%). This demonstrates judicious antibiotic usage in our ICU.

The average ICU stay of patients with and without nosocomial infections in our study was 16.5 and 6.4 days respectively. The mean duration of ICU stay of patients in these two groups after excluding patients with mortality in each group was 17.2 and 7 days respectively. This increase in ICU stay in patients with nosocomial infections was found to be statistically significant (Table 7).

A study from North India noted an average ICU stay of 13 and 4 days in patients with and without nosocomial infections respectively.<sup>15</sup> A similar increase

**Table 7 : Statistical analysis (Mean duration of ICU stay in the two groups)**

Nosocomial infection	Number of patients who survived	Mean ICU Stay (days)	Variance	SD (days)
Yes	23	17.2	115.60	10.75
No	22	7.0	28.19	5.30

$t = -10.1739$ ,  $d.f = 43$ ,  $p = 0.00025$ . Interpretation: Highly significant difference seen in ICU stay in the two groups.

in ICU stay due to nosocomial infections has been noted in other studies.<sup>7,13-18</sup>

In our study, ICU mortality in patients with and without nosocomial infections was 28.1% and 31.2% respectively. (The overall ICU mortality rate in our ICU was 19.9%). Various studies have documented ICU mortality rates varying between 9.3% and 39.5% in patients with nosocomial infections.<sup>4,12,13,19</sup> In our study, there was no statistically significant change in mortality in the two groups.

## Conclusions

1. The nosocomial infection rate in our ICU suggests a relatively low prevalence of ICU-acquired infections.
2. Respiratory infections were the commonest, followed by urinary and dual (respiratory and urinary) infections.
3. Acinetobacter was the commonest respiratory isolate, whereas Pseudomonas was the commonest urinary isolate. 21% of Acinetobacter isolates were multidrug resistant.
4. Nosocomial infections in the ICU caused a statistically significant increase in length of stay in the ICU.
5. Nosocomial infections in the ICU did not adversely affect ICU mortality.

## Limitations of Study

The sample size of our study group was relatively small. A similar study with a larger study group size would be desirable.

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