Research Article

Nosocomial infections among patients admitted in general ICU: study from a tertiary-care hospital in South India

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Abstract

Background: Nosocomial infections (NI) are also called hospital-associated infections that comprise almost all clinically apparent infections that are not arising as a result of patients' original admitting diagnosis. NI defined as localized and systemic conditions that result from adverse reaction owing to the presence of an infectious agents and was not present or incubating at the time of admission to the hospital. The rate of NI varies from 2.85% to 34.6% among the hospitalized patients.

Objective: To investigate NIs among the patients admitted in intensive care unit (ICU) and to evaluate the prevalence, risk factors, the causative bacteria, and their resistance pattern to antimicrobial agents.

Materials and Methods: The study was carried out over a period of 12 months from July 2014 to June 2015. Patients admitted in the general ICU were monitored for the development of NIs. Samples were collected from suspected patients depending on the type of NI, to detect the causative organisms and their antimicrobial susceptibility. Extended spectrum beta-lactamase (ESBL)-positive isolates were tested by double disc synergy test for ESBL production.

Result: The study included 260 patients admitted into general ICU. The prevalence of NI was 19.2%. Female subjects were more affected (60%) than male subjects (40%). Risk factors identified were urinary catheterization, female sex, advanced age, mechanical ventilation, and increased hospitalization. Ventilator-associated pneumonia was the most common NI, constituting 36%, followed by urinary tract infections (26%). *Esherichia coli* were the predominant organisms among the Gram-negative bacteria. Imipenem was majorly used antibiotic for empirical treatment of ICU infections before getting the antibiotic sensitivity report.

Conclusion: Indiscriminate use of antibiotics should be avoided in order to curtail the emergence and the spread of drug resistance among nosocomial pathogens. This study gives insight into the incidence of NIs and in revising antibiotic policy and guiding clinicians in preventing emergence of carbapenem resistance among the patients.

KEY WORDS: Nosocomial infections, ICU, ESBL, carbapenem

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Introduction

Nosocomial infections (NIs) are a major global safety concern for both patients and health-care professionals.[1,2] NI is defined as infection arising in a patient at the time of care in the hospital or other health-care facility, which was not evident or incubating at the time of admission. This comprises infections developed in hospital and any other places where patients obtain health care and may appear even after discharge. NI also comprises occupational infections that are found among staffs working in the health-care facility.[1] NIs, also called health care-associated infections, is defined by the CDC as a localized or systemic condition resulting from an adverse reaction to the presence of an infectious agent(s) or its toxin(s), without any evidence that the infection was present or incubating at the time of admission to the acute care setting.[3]

Patients in intensive care units (ICUs) experience a higher risk of acquiring hospital-associated infections (HAIs) than those in noncritical care areas. The acute severity of illness of ICU patients, prolonged hospital stay, immunosuppression, increased use of antimicrobial agents.[4] ICU nosocomial infections are primarily related to the patients' health status; invasive device utilization such as venous central line, urinary catheterization, and mechanical ventilation; use of immunosuppressors; prolonged hospitalization; colonization by resistant microorganisms; and indiscriminate use of antibiotics.[9,12] Commonly observed HAIs in the ICU patients include respiratory tract infections, urinary tract infections (UTIs), and bloodstream infections (BSIs) and are frequently linked to the use of invasive devices.[13] Recently, reports have established that Gram-negative bacilli infection occur frequently than Gram-positive bacteria in the setting.[6] Because the ICU is an area of extensive antibiotic use, antibiotic-resistant organisms may emerge. Their prevalence and rates of resistance differ vastly based on geographic location and location among ICU types.[14,16]

For appropriate control of ICU infections, it is necessary to possess updated awareness about occurrence of the causative agents and their antimicrobial vulnerability patterns in institution-specific ICUs. Therefore, this study was carried out to determine the prevalent microorganisms in medical ICU patients and antimicrobial susceptibility profile of the isolates to the commonly used older and newer antibiotics in a health-care facility. Infections with *Acinetobacter* species are increasing with longer duration of ICU stay. Appearance of multidrug resistant (MDR) *Acinetobacter* species is worrying and devastating for already strained health-care economics.[17] This study aimed to determine the incidence of NIs in an ICU set up, its association with risk factors (gender, age, medical profile, length-of-stay in ICU, type of infection, colonization by resistant microorganisms, and use of invasive devices) and site of occurrence.

Materials and Methods

The study was carried out from July 2014 to June 2015. The study was conducted in Department of Microbiology, Narayana Medical College, Andhra Pradesh, India, in association with Department of Emergency Medicine. Patients of either sex admitted in general ICU for more than 48 h with different complaints and revealed evidence for clinically apparent infections after 48 h were included in the study. Clinical data were collected to exclude the signs and symptoms of infection at the time of admission along with the basic hematological parameters. Patients admitted in ICU for less than 48 h were excluded from the study. A questionnaire according to WHO/CDC guidelines was designed and used for data collection. Inquiry was made of complaints after 48 h of admission, and clinical samples were collected depending upon the site of infection. Diagnostic criteria for defining NI was followed according to CDC guidelines.

Sample Collection and Processing

Samples were collected in the sample containers that were labeled with the date, name, IP number of the patients, and the time collection and immediately transported to Microbiology Laboratory without any delay. Samples were inoculated onto nutrient agar, McConkey's agar, blood agar, and chocolate agar immediately and were incubated at 37°c for 24 h. Blood samples were collected into blood culture bottle (bioMerieux Company) and processed in BacT Alert-3D blood culture system (bioMerieux Company). All the isolates were identified by standard laboratory methods. Antibiotics sensitivity testing was performed by Kirby–Bauer disc diffusion method by using ampicillin (10 μg), gentamicin (10 μg), ceftazidime (30 μg), ciprofloxacin (5 μg), co-trimoxazole (25 μg), doxycycline (10 μg), ceftriaxone (30 μg), amikacin (30 μg), imipenem (10 μg), ofloxacin (5 μg), piperacillin + tazobactam (100/10 μg), oxacillin (5 μg), vancomycin (30 μg), linezolid (30μg), colistin (10 μg), amoxicillin + clavulanic acid (20/10 μg). Extended spectrum beta-lactamase (ESBL)-producing organisms were identified observing the resistance to ceftazidime disc. Among them, a set of antibiotic discs separately for Gram-positive and Gram-negative organisms were kept and tested. All ceftazidime-resistance isolates were confirmed by double disc synergy test by using ceftazidime + clavulanic acid (30/10 μg).

Results

This prospective study was carried out in Department of Microbiology, Narayana Medical College, during the period July 2014 to June 2015 [Table 1]. Female subjects' preponderance (60%) was observed when compared with male subjects in this study. The most common age group affected in the study was older than 66 years [Table 2].

High risk factors associated with clinical condition are urinary catheterization (37), followed by mechanical ventilation (11) and hospitalization for more than a week (17), and underlying disease such as diabetes mellitus (7) [Table 3].

Table 1: Age distribution among the study group

Age (year)	Female (*n* = 60), *n* (%)	Male (*n* = 40), *n* (%)	Total (*n* = 100), *n* (%)
15–25	4 (6.6)	4 (10)	8 (8)
26–35	4 (6.6)	4 (10)	8 (8)
36–45	8 (13.3)	4 (10)	12 (12)
46–55	8 (13.3)	4 (10)	12 (12)
55–65	8 (13.3)	8 (20)	16 (16)
>66	28 (46.6)	16 (40)	22 (44)

Table 2: Associated risk factors among the affected patients (*n* = 100)

Risk factors	With nosocomial infections, *n* (%)	Without nosocomial infections, *n* (%)	Total (100), *n* (%)
Mechanical ventilation	11 (55)	9 (45)	20 (20)
Urinary catheterization	37 (74)	13 (26)	50 (50)
>1-week stay	17 (80.9)	4 (19)	21 (21)
Diabetes mellitus	7 (77.7)	2 (22.2)	9 (9)

Table 3: Organisms isolated from different clinical specimens

Organism	Urine (*n* = 64), *n* (%)	Blood (*n* = 10), *n* (%)	Sputum (*n* = 20), *n* (%)	Skin (*n* = 6), *n* (%)	Total (*n* = 100), %
E. coli	40 (62.5)	4 (40)	0	0	44
Klebsiella sp.	12 (18.7)	4 (40)	4 (20)	0	22
Acinetobacter sp.	4 (6.25)	4 (40)	4 (20)	0	12
Pseudomonas	2 (3.1)	0	6 (30)	2 (33.3)	10
Citrobacter sp.	0	2 (20)	0	0	2
Enterococci	3 (4.6)	0	0	0	3
CoNS	2 (3.1)	0	0	0	2
S. aureus	0	0	2 (10)	3 (50)	5

Table 4: Type of infections among the infected group (*n* = 100)

Type of NI	Culture positive (*n* = 100)	Percentage
Urinary tract infections	26	26
Bloodstream infections	22	22
Ventilator-associated pneumonia	36	36
Surgical site infection	16	16

Table 5: Antibiotic sensitivity pattern of all clinical isolates from study group

Antibiotic	*E. coli* (*n* = 44), *n* (%)	*Klebsiella* (*n* = 22), *n* (%)	*Pseudomonas* (*n* = 10), *n* (%)	*S. aureus* (*n* = 5), *n* (%)	*Enterococci* (*n* = 3), *n* (%)	CoNS (*n* = 2), *n* (%)	*Acinetobacter* (*n* = 12), *n* (%)	*Citrobacter* (*n* = 2), *n* (%)
Ampicillin	7 (16)	4 (18)	NT	2 (40)	1 (33.3)	0	3 (25)	0
Piperacillin + tazobactam	34 (77)	17 (77)	6 (60)	3 (60)	3 (100)	2 (100)	10 (83)	1 (50)
Ceftazidime	25 (57)	12 (55)	6 (60)	NT	NT	NT	5 (40)	0
Imipenem	35 (80)	18 (82)	8 (80)	NT	NT	NT	9 (75)	2 (100)
Amikacin	32 (73)	14 (64)	8 (80)	2 (40)	8 (80)	0	9 (75)	1 (50)
Gentamicin	31 (70)	15 (68)	3 (33)	2 (20)	1 (33)	0	7 (58)	0
Ciprofloxacin	30 (68)	14 (67)	6 (60)	3 (60)	1 (33)	0	8 (67)	1 (50)
Co-trimoxazole	21 (48)	8 (36)	6 (60)	2 (40)	2 (67)	0	6 (50)	0
Colistin	40 (83)	16 (73)	8 (80)	NT	2 (67)	NT	9 (75)	2 (100)
Linozolid	NT	NT	NT	4 (80)	3 (100)	2 (100)	NT	NT
Vancomycin	NT	NT	NT	4 (80)	3 (100)	2 (100)	NT	NT
Oxacillin	NT	NT	NT	2 (40)	NT	1 (50)	NT	NT
Doxycycline	8 (18)	5 (23)	0	1 (10)	0	0	0	1 (50)
Ceftriaxone	16 (36)	9 (41)	4 (40)	NT	1 (33)	0	4 (33)	0
Ofloxacin	30 (61)	13 (59)	6 (60)	2 (40)	2 (67)	1 (50)	6 (50)	1 (50)

Table 6: Prevalence of ESBL producing isolates among the infected cases

Organism	Sensitive to ceftazidime, *n* (%)	Resistance ceftazidime, *n* (%)	Percentage of ESBL positive isolates
E. coli (*n* = 44)	14 (31.8)	30 (68.1)	68
Klebsiella sp. (*n* = 22)	6 (27.2)	16 (72.7)	72
Acinetobacter sp. (*n* = 12)	5 (41.6)	7 (58.3)	58
Pseudomonas sp. (*n* = 10)	3 (30)	7 (58.3)	70

Escherichia coli (44.4%) were the most commonly isolated organism from the urine, followed by *Klebsiella* species (22%). Commonest isolate among the sputum samples was *Pseudomonas*. Other bacteria such as *Acinetobacter* sp. and *Citrobacter* sp. were isolated. Gram-positive isolates included enterococci, coagulase-negative staphylococci (CoNS), and *Staphylococcus aureus* [Table 4].

Ventilator-associated pneumonia (VAP) was the most common type of NI among the study group, followed by UTI [Table 5]. Other isolates were not included for this test because less number of isolates from the clinical cases may give false impression about their ESBL production [Table 6].

Discussion

This study was conducted to determine the incidence of HAIs among ICU patients. ICUs are associated with usage of many antibiotics and device utilization, and ICU environment itself favors the colonization of the patient's body with MDR organisms. This prospective study was conducted in the Department of Microbiology, Narayana Medical College, during the period July 2014 to June 2015. Total number of patients included in this study was 520, of which 100 (19.2%) cases were presented with HAIs. Patients aged from 15 to 78 years were included in this study; results showed female preponderance. Clinical samples were processed and isolates identified by following the standard microbiological procedures. *E. coli* was the commonest organism from urine samples (62%), followed by *Klebsiella* sp. (30%). *Pseudomonas* was the commonest organism isolated from sputum samples (50%). Most predominant isolate from surgical site infections (SSIs) was *S. aureus* (50%). But, when we calculated the predominant isolate from all the NIs, *E. coli* was the predominant organism (44%), followed by *Klebsiella* sp. (22%) *Acinetobacter* (12%), and *Pseudomonas* (10%).

All ICU infections were associated with certain risk factors such as mechanical ventilation, catheterization, diabetes mellitus, and hospital stay for more than seven days. Of 20 mechanical ventilation cases, 11 cases were associated with VAP. This is correlating with the study done by Chelazzi et al.[18] (9.3%). Among 50 urinary catheterized patients, 37 exhibited UTI, comprising 37% of NIs, correlating with the study by Izzo et al., 2015 (40%). Prolonged hospital stay contributed for 17% of NIs. Metabolic disorder such as diabetes mellitus was responsible for 7% of NIs according to this study, which is in accordance with the study conducted by Santo et al., 2008 (9%). Study on type of infections among the infected group (100) showed VAP as the most common type of NI (36%), followed by UTI. According to the study by Kaur et al., 2015, BSIs among ICU patients were 21%, which is in correlation with this study (22%). In this study, catheter-associated UTI was 26%, which was in near correlation with the study by Bhatia et al., 2010 (22%). The study by Rajan et al., 2014, showed VAP among ICU patients to be 31.7%, which is little less than this study (36%). SSI in our study was 16%, which is almost correlating with the study conducted by Nwankwo Eo et al., 2012.

Of 95 Gram-negative bacilli isolates from ICU Nis, 41 were ESBL producers based on the disc diffusion method. But, confirmation was done only for few organisms because of less number of other isolates. Antibiotic sensitivity pattern revealed that maximum sensitivity was seen for imipenem (82%), followed by piperacillin + tazobactam (76%), amikacin (71%), ciprofloxacin (63%), gentamycin (58%), and ofloxacin (63%). High resistance was identified with co-trimoxazole (54%), ceftriaxone (66%), and doxycycline (85%).

Most frequent Gram-positive isolates in this study were *S. aureus*, CoNS, and enterococci; 80% of Gram-positive cocci (GPC) were sensitive to linezolid and 90% of GPC showed sensitivity to vancomycin by disc diffusion method, which may be altered by MIC-based methods.

Limitation for this study was not able to follow-up each and every case related to its outcome. So, further studies are required to confirm our results owing to many limitations such as clinical sampling, antibiotic testing method, and type of sampling where we used only swabs in this study without considering the tissue bits. Main strength of this study is that, before getting the results of antibiotic sensitivity testing, we may consider and suggest either imipenem or piperacillin + tazobactam for empiric treatment in case of life-threatening bacterial infections.

Conclusion

Nosocomial ICU infections are common with Gram-negative bacteria, which produce heavy burden to health-care facility. Just medical admission and antifungal prophylaxis are associated with these infections in many instances. While prescribing the antibiotics for SSI, a clinician must consider antibiotic-resistant pathogens, GPC, and fungi. Delay in initial antibiotic treatment may influence the outcome of the patient. Dosage and intervals of administration are also to be considered to avoid the treatment failures. Patterns of microbial agents and their drug-resistant pattern also vary from hospital to hospital and from unit to unit in the same hospital. Vancomycin screen agar must be used always to rule out the occurrence of vancomycin-resistant *S. aureus*. Strict hospital infection control practices may limit the incidence of ICU-associated NIs.

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