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Clinico-microbiological study of infections in the intensive care unit and study of antimicrobial resistance in bacterial isolates

Vijaya[1], Dominic R.M. Saldanha[2], Shalini Shenoy[3]

Abstract:

Infectious disease specialists have long recognized that the risk of ICU patients acquiring nosocomial infections is 5-10 times greater than those in general wards. Several factors such as severe underlying disease, multiple illnesses, malnutrition, extremes of age, immunosuppression, use of invasive medical devices, ICU crowding and animate reservoirs increase the risk of acquiring infections in the ICU. Out of 113 isolates obtained in our study, 32.7% were from ventilator-associated pneumonia patients and 17.7% from urinary tract infection patients. The major isolates were *Staphylococcus aureus* (21.2%) and *Klebsiella spp.* (20.4%). Methicillin resistant *Staphylococcus aureus* (MRSA) and ESBL producing *Klebsiella* and *E. coli* were the major drug resistant bacteria isolated and associated with significant mortality. Control of these infections poses a major problem in treating the patients because of the rising trend of drug resistance among these bacteria.

Key words: ESBL, MRSA, Ventilator- associated pneumonia

Introduction:

Since the 1980s, infectious disease specialists have recognized that ICU patients acquire nosocomial infections at a much higher rate than patients elsewhere in the hospital. For ICU patients, the risk is as much as 5 to 10 times greater than for those in general medical wards[1].

Intrinsic factors like severe underlying disease, multiple illnesses, malnutrition, extremes of age, and immunosuppression, invasive medical devices, crowding (*e.g.* neonatal ICU) and animate reservoirs (*e.g.* colonized or infected patients) contribute towards increased risk of nosocomial infection.

Ninety percent of the nosocomial infections are caused by bacteria- *Klebsiella pneumoniae, Staphylococcus aureus, Escherichia coli, Proteus spp,* and *Pseudomonas aeruginosa* which are among the most common causative agents. Control of these infections poses a major problem in treating the patients because the incidence of drug resistance is on the rising trend among these bacterial isolates.

The present study focuses on clinico-microbiological aspects of infection in the ICU with emphasis on antimicrobial resistance among the bacterial isolates of ICU infections.

Materials and methods:

Specimens were collected from patients admitted to the Intensive Care Unit of Government Wenlock Hospital, Mangalore. Clinical and microbiological data obtained with regards to each patient included the following information: age, sex, duration of hospital stay, underlying diseases, predisposing factors, previous antibiotic or anticancer therapy, surgical procedures, trauma, exposure to indwelling catheters, the clinical course and outcome. Infection was considered nosocomial if it developed more than 48 hours after admission to the hospital[2].

Pus or exudates was collected either by aspiration or using at least two sterile dry cotton swabs after cleaning the surrounding area with 70% ethyl alcohol. The swabs were transported in sterile cotton plugged test tube.

Urine was used for diagnosis of UTI. Whenever possible, clean catch midstream urine was collected. In case of patients with indwelling or Foley's catheter, urine was collected directly from the catheter. 5-10 ml of blood under strict aseptic conditions was collected by venipuncture, transferred into brain heart infusion broth and transported to the laboratory.

Two segments of intravascular catheters in each patient (skin interface and within blood vessel) after proper decontamination were aseptically placed in sterile wide-mouthed containers and transported immediately to the laboratory.

Expectorated sputum was collected by asking the patient to cough deeply and then expectorate into a sterile, dry, wide necked leak proof container. The tip of the endotracheal tube containing endotracheal aspirate was cut with a sterile blade after extubation and sent to the laboratory in a sterile container.

Body fluids were collected under aseptic precautions into a dry sterile screw capped tube or bottle. All the samples were transported to the laboratory immediately.

The specimens were processed, investigated and growth identified by standard microbiological techniques. Antimicrobial susceptibility testing was done by disk diffusion test described by Kirby-Bauer for non-fastidious bacteria and modifications of the standard method were used for fastidious bacteria. Each of the isolated organisms was tested for antibiotic sensitivity. Detection of MRSA was done by oxacillin agar screen method and ESBL producers by combined disc method.

Results:

A total of 113 bacterial isolates were obtained from 100 culture positive clinical specimens collected from Government Wenlock Hospital ICU.

Out of the 113 isolates obtained, 37 (32.7%) were isolated from Ventilator Associated Pneumonia, 20(17.7%) from Urinary Tract Infection, 17(15.0%) from skin and soft tissue infection, 16(14.2%) from Blood Stream Infection, 14 (12.4%) from Surgical Site Infection and 9 (8.0%)from other Respiratory Tract Infections (Table I).

All the 24 (100%) isolates were sensitive to Vancomycin, Rifampicin, Teicoplanin and Linezolid; MRSA was detected in 58.3% of the strains (Image I). Of the two isolates of *Coagulase Negative Staphylococci*, both the isolates (100%) were sensitive to Netillin, Ciprofloxacin and Methicillin and 50% of the isolates were resistant to Gentamicin, Penicillin, Amoxyclav, Cotrimoxazole and Erythromycin (Table II). Among the 4 isolates of *Enterococcus* species 2(50%) isolates were resistant to Ciprofloxacin(Cf) and Amoxyclav(Ac) and 3(75%) isolates were resistant to Penicillin(P), Ampicillin(A) and Chloramphenicol(C). All the isolates of were sensitive (100%) to Vancomycin(Va).

Out of the 16 isolates of *E.coli*, 14(87.5%) isolates were resistant to Cefuroxime, 13(81.3%) isolates to Cefotaxime and Ciprofloxacin, 12(75%) isolates to Gentamicin, Cotrimoxazole and Ceftazidime, 10(62.5%) isolates to Ceftriaxone, 9(56.3%) isolates to Netillin and 4 (25%) isolates to Amikacin.

Out of 23 isolates of *Klebsiella spp*., 21 isolates (91.3%) were resistant to Ceftazidime, 18(78.3%) isolates to Gentamicin and Cefuroxime, 17(73.9%) isolates to Cefotaxime and Cotrimoxazole, 13(56.5%) isolates to Ciprofloxacin, 12(52.2%) isolates to Ceftriaxone, 11(47.8%) isolates to Netillin and 10(43.5%) isolates to Amikacin.

Table I: Bacterial isolates from various clinical specimens obtained from ICU

Clinical specimens	No.of samples	*S.aureus*	CONS	*S.pneumoniae*	*Enterococci*	*E.coli*	*Klebsiella*	*Pseudomonas*	*Acinetobacter*	*Citrobacter*	*Proteus*	Total no. of isolates.
ET Aspirate	30	6	-	4	-	4	11	6	6	-	-	37
Urine	13	-	-	-	2	4	3	-	3	1	2	15
Foley's catheter tip	5	2	-	-	-		-	1	2	-	-	5
Pus	14	7	-	-	-	3	3	3	-	-	-	16
Wound swab	14	3	-	-	-	3	4	2	2	1	-	15
Blood	10	2	2	-	1	-	1	1	1	2	-	10
IV catheter tip	2	1	-	-	-	-	-	1	-	-	-	2
Peritoneal dialysis Catheter tip	1	1	-	-	-	-	-	-	-	-	-	1
Central venous catheter tip	3	2	-	-	-	-	1	-	-	-	-	3
Pleural fluid	4	-	-	-	-	2	-	1		1	-	4
Sputum	4	-	-	-	1	-	-	2	2	-	-	5
Total	**100**	24	2	4	4	16	23	17	16	5	2	**113**
%		21.2	1.8	3.5	3.5	14.2	20.4	15	14.2	4.4	1.8	

Table II: Distribution of organisms according to the site of infection

Isolates	VAP	Other respiratory infections	UTI	SSI	BSI	Skin and soft tissue infection	Total no. of isolates
S. aureus	6	-	2	3	6	7	24
E.coli	4	2	4	3	-	3	16
Klebsiella spp.	11	-	3	3	2	4	23
Pseudomonas spp.	6	3	1	3	2	2	17
Acinetobacter spp.	6	2	5	2	1	-	16
Citrobacter spp.	-	1	1	-	2	1	5
S.pneumoniae	4	-	-	-	-	-	4
Proteus spp.	-	-	2	-	-	-	2
Enterococcus spp.	-	1	2	-	1	-	4
CONS	-	-	-	-	2	-	2
Total no. of isolates	**37**	**9**	**20**	**14**	**16**	**17**	**113**

Both the *E.coli* and *Klebsiella spp.* were 100% resistant to Ampicillin. Nine (56.3%) out of 16 isolates of *E. coli* and 13(56.5%) out of 23 isolates of *Klebsiella spp.* were ESBL producers (Image II).

Among 16 isolates of *Acinetobacter spp.*, there was 100% resistance to Cefotaxime and Ceftazidime. Fifteen (93.8%) isolates were resistant to Cotrimoxazole, 13(81.3%) isolates were resistant to Gentamicin, Ceftriaxone and Cefuroxime, 11(68.8%) isolates to Ciprofloxacin, 9(56.3%) isolates to Amikacin and 8(50%) isolates to Netillin.

Out of 17 isolates of *Pseudomonas spp.* there was maximum resistance to Netillin (52.9%). Eight (47.1%) isolates were resistant to Gentamicin and Ceftriaxone, 6(35.3%) isolates to Ciprofloxacin and Ceftazidime and 3 isolates (17.6%) were resistant to Amikacin.

Out of 5 isolates of *Citrobacter spp.*, there was 100% resistance to Cefuroxime and Cotrimoxazole, followed by 80% (4 isolates) of resistance to Cefotaxime and Ciprofloxacin and there was least resistance to Netillin shown by 1(20%) isolate.

Both (100%) the isolates of *Proteus spp.* were resistant to Cotrimoxazole and 1(50%) isolate was resistant to Gentamicin, Ceftriaxone, Cefuroxime and Ciprofloxacin. Both the isolates were (100%) sensitive to Amikacin and Netillin.

Graph I: Distribution of risk factors

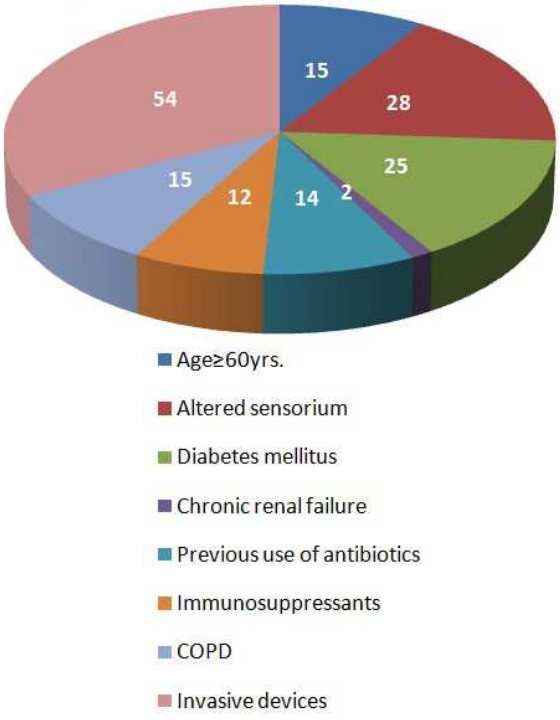

Table III: Risk factors distribution

Risk factors	No. of patients
Age≥60yrs.	15
Altered sensorium	28
Diabetes mellitus	25
Chronic renal failure	2
Previous use of antibiotics	14
Immunosuppressants (steroids, cytotoxic therapy)	12
COPD	15
Invasive devices	54

For β-lactam/β-lactamase inhibitors, *E.coli* and *Klebsiella* had shown maximum resistance to Amoxyclav 81% and 87% respectively, followed by resistance to Ampicillin sulbactum 68.8% and 34.8% respectively. Fifty percent of *Acinetobacter spp.* and 41.2% of *Pseudomonas spp.* were resistant to Ampicillin sulbactum. There was least resistance to Piperacillin tazobactum ranging from 11.8% -25% among all the Gram negative bacteria. and for Cefoperazone sulbactum all the Gram negative isolates were sensitive except 5.9% isolates of *Pseudomonas spp.* and 18.8% isolates of *Acinetobacter spp.*

All the gram negative bacteria were 100% sensitive to Carbapenems except *Acinetobacter spp.* 18.8% and *Pseudomonas spp.* 11.8% were resistant to Meropenem.

As per the risk factors related to infection in our study (Table III, graph I), the commonest risk factor was presence of invasive devices followed by altered sensorium. Most of the patients admitted to ICU during our study were male patients belonging to the age group of 41-60 years (Table IV).

Mortality rates were significantly higher for infections caused by MRSA (35.7%) and ESBL producing *E.coli* and *Klebsiella* spp. (45.5%) with most death occurring in patients with ventilator-associated pneumonia.

Table IV: Age and sex-wise distribution of infection in ICU

Age	Male	Female
≤20 years	11	15
>20-40 years	10	2
41-60 years	33	14
≥60 years	5	10
Total	**59**	**41**

Discussion:

Nosocomial infections are becoming an increasing problem for hospitalized patients, especially in the ICU. In our study, out of 100 patients with culture positive reports, 30% of patients had Ventilator associated pneumonia, 18% of patients had catheter related urinary tract infection, 12% patients had surgical site infection and 10% patients had catheter related blood stream infections. Among rest of the patients, 16% of patients had skin and soft tissue infections such as abscesses, burn wound infection, bed sores, 6% of patients had got admitted with septicemia, and another 8% of patients were admitted with other respiratory tract infections. In our study, VAP was the leading infection which may be due to high proportion of mechanical ventilation accounting for higher incidence of nosocomial pneumonia. The relatively high incidence of nosocomial infection observed in our study may be a reflection of the higher severity of illness, poorer immunological status, more interventions, multiple predisposing factors and prolonged duration of hospital stay.

The common culture isolates obtained in our study were *S.aureus* 21.2%, *Klebsiella spp*.20.4%, *Pseudomonas spp*.15%, *E. coli* 14.2%, Acinetobacter *spp*.14.2%, *Citrobacter spp*.4.4%, *Coagulase Negative Staphylococci* and *S.pneumoniae* 3.5% each, followed by *Proteus spp*. 1.8%.

The incidence rate of VAP in our study was 30% with altered sensorium as the most significant predisposing factor for the development of VAP. These patients had impaired consciousness and inadequate cough reflexes which predisposed them for developing VAP. The similar observation was seen in a study done by Noyal Mariya Joseph et al[3].

Furthermore, prior antibiotic therapy and COPD, leading to colonization with Gram-negative aerobic pathogens and the presence of a naso-gastric tube was found to be a risk factor in our study population.

In our study, the culture isolates obtained from the urine were *Acinetobacter spp*. 25%, *E.coli* 20%, *Klebsiella spp*. 15%, *Proteus spp*., *Enterococcus spp*., *S.aureus* 10% each and *Pseudomonas spp* 10%. However, we found that *Acinetobacter spp.* to be the predominant cause of nosocomial UTI in contrast to *Candida albicans* reported by Richards et al[4]. The higher incidence of *Acinetobacter* may be because of the influence of microbial flora prevalent in hospital environment. The maximum number of catheter related urinary tract infection was found in females in the age group of 45-60yrs. In all the cases of urinary tract infection, patients had catheterization for more than 5 days.

In our study, 40% of blood stream infections were caused by *S.aureus* and 20% by *Coagulase Negative Staphylococci* which is similar to study done by Maite Garrouste-Orgeas et al[5]. Debilitated condition of the patient due to underlying diseases, invasive diagnostic and therapeutic procedures and contaminated life support equipment predispose these patients to life threatening blood stream infections.

In our study, the surgical site infection rate was 12% which is consistent with the study done by Suchitra Joyce B et al[6]. A prolonged preoperative stay with exposure to hospital environment and its ubiquitous diagnostic procedures, therapies and

microflora have been shown to increase the rate of surgical site infection. Excessive and injudicious use of broad spectrum and higher antibiotics adds to the growing problem.

In our study, the MRSA rate was 58.3% which was higher than the some studies done earlier[7]. Since complete eradication of MRSA may not be possible, control of transmission seems to be the appropriate goal. The first and the most effective way among these are to avoid transmission through hand contamination by the person responsible for caring the infected patients. The use of broad-spectrum antibiotics for treating infections also increases the rate of MRSA and other resistant bacteria. Therefore chemotherapy should be guided by sensitivity of the probable causative organism.

The results of this study emphasize the importance of local surveillance programmes to correctly guide empiric therapy. Strategies to control these infections must therefore include knowledge of infection rates, common pathogens, their antibiograms and risk factors for acquiring these infections. This will assist clinicians in choosing appropriate empiric antibiotics to maximize the patient's chances of receiving early and effective therapy.

References:

1. Weber DJ, Raasch R, Rutala WA et al. Nosocomial Infections in the ICU. The Growing Importance of Antibiotic-Resistant Pathogen. Chest 1999; 115: 34S-41S.
2. Nosocomial Infections in Geriatric Patients Admitted in ICU. Tirthankar Mukherjee, Pramod K, Gita Srinivasan, Medha Y Rao. Journal of Indian Academy of Geriatrics, 2005; 2: 61-64.
3. Joseph NM, Sistla S, Dutta TK et al. Ventilator-associated pneumonia in a tertiary care hospital in India: incidence and risk factors. J Assoc Phys India 2009; 3(10):771-777.
4. Richards MJ, Edwards JR, Culver DH, Gaynes RP. Nosocomial infections in combined medical-surgical intensive care units in the United States. Infect Control Hosp Epidemiol 2000; 21: 510–5.
5. Orgeas MG Timsit JF, Tafflet M et al. Excess Risk of Death from Intensive Care Unit–Acquired Nosocomial Bloodstream Infections: A Reappraisal. Clin Infect Dis 2006; 42:1118–26.
6. Suchitra JB, Lakshmidevi N. Surgical site infections: Assessing risk factors outcomes and antimicrobial sensitivity patterns Indian J Med Res 2009; 3(4): 175-179.
7. Tiwari HK, Sapkota D, Sen MR. High prevalence of multidrug-resistant MRSA in a tertiary care hospital of northern India. Infection and Drug Resistance 2008; 1: 57–61.

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Authors details:

1- Assistant Professor, Department of Microbiology, Srinivas Institute of Medical Sciences and Research Centre, Srinivasnagar, Surathkal, Mangalore- 575021

2- **Corresponding author**: Dr. Dominic R.M. Saldanha, Professor and Head, Department of Microbiology, Kannur Medical College, Kannur- 670612; email: drdoms@gmail.com

3- Professor, Department of Microbiology, Kasturba Medical College, Manipal University, Mangalore- 575001