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Study of Nosocomial Infections among the Patients Admitted in the Intensive Care Units of a Tertiary Care Centre in North East India

Microbiology

KEYWORDS: Antibiotic Resistance, Infection Control Practices, Intensive Care Units, Nosocomial Infections, Pseudomonas aeruginosa,

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ABSTRACT

BACKGROUND AND OBJECTIVES: Nosocomial Infections (NI) lead to disabling conditions, reduce the quality of life and may even lead to death. The intensive care units (ICU) are the flash point of NI due to the unique environment, use of various antimicrobials and invasive monitoring devices. The study was conducted to detect the NI in the ICUs, to determine the distribution and diversity of micro-organisms and their antimicrobial susceptibility pattern.

MATERIALS AND METHODS : The prospective study was conducted for a period of 1 year (Jan 2011 to Dec 2011). The ICUs included were – Anesthesiology ICU (AICU), Pediatric ICU (PICU), Intensive Coronary Care Unit (ICCU) and Cardio Thoracic and Vascular Surgery (CTVS) ICU. The various clinical specimens received from patients with suspected NI, were subjected to microscopic examination, culture, and biochemical tests, as per standard protocols.

RESULTS : Of 2017 patients admitted, 276 patients [126 (AICU), 47 (ICCU), 101 (PICU), 2 (CTVS ICU)] were included in the study of which 8% developed NI. Respiratory Tract Infections (RTI; 43%) were highest followed by Urinary Tract Infections (UTI; 34%), Blood Stream Infections (BSI; 11%), Wound Infections (WI; 10%), Sterile Site Infections (SSI; 2%). The incidences of NI were – AICU – 14%, ICCU – 4% and PICU – 8%. *Pseudomonas aeruginosa* was the predominant organism isolated.

CONCLUSION : The possibility of reducing resistance by controlling the use of antibiotics is a logical approach, but implementation of effective policies is difficult. Hence, community awareness, antibiotic restriction, effective surveillance and good infection control practices are essential to overcome resistance.

INTRODUCTION

Nosocomial Infection (NI), also called Hospital Acquired Infection or Healthcare - Associated Infection (HAI), is defined by The Center for Disease Control and Prevention (CDC), as a localized or systemic condition resulting from an adverse reaction due 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[1].

The history of nosocomial infections began with an attempt to assist the poor by providing charitable institutions to care for the sick. But collecting the sick in semi-closed populations resulted in the transmission of infections, which quickened the mortality rate of those already dying. When health care professionals such as Holmes, Semmelweis and Florence Nightingale introduced hygienic and sanitation practices as hand-washing, aseptic techniques etc. in the middle 1800s, the infections were curtailed to some extent and later with the discovery of penicillin in 1928, the expectations were ambitiously raised to the belief that infections could now be controlled without dealing with the constraining details of previously essential methods. But within two decades, however the error of this thinking would surface; penicillin-resistant *Staphylococci* resulted in the extensive hospital epidemics of 1950s and 1960s. Newly built nurseries and surgical suites were closed and health-care workers were identified as carriers of epidemic strains of microorganisms[2].

In the day to day health scenario, nosocomial infections have become an important issue worldwide. Hospital acquired infections not only add to functional disability and emotional stress of the patient but in some cases, also lead to disabling conditions that reduce the quality of life and may lead to death. To make it worse, the costs of such infections are also immense. The increased period of stay, increased use of drugs, the need for isolation, and the use of additional laboratory and other diagnostic studies contribute to the high costs[3].

The intensive care units remain, in every hospital, at the flash point of nosocomial infection outbreak owing to its unique environment, diversity in the nature of diseases and the status of the patients admitted. This is also related to the use of large numbers of invasive monitoring devices, endo-tracheal and tracheostomy tubes; patient factors including extremes of age, immunocompromised state, malnutrition and severe underlying disease; and to a high incidence of cross infection[4, 5]. This area of the hospital thus is a focus for the emergence and spread of many antimicrobial-resistant pathogens[6].

There is wide diversity between institutions in the prevalence of pathogens and in their antimicrobial susceptibility. There is also variation in the frequency and types of infections among different subsets of patients within the same ICU[6, 7]. The three most common nosocomial infections are ventilator-associated pneumonias and other respiratory tract infections, urinary tract infections and bloodstream infections[4-10].

Nosocomial infections occur world-wide and affect both developed and resource-limited countries, posing a significant burden both for patient and for public health. In industrialized countries, nosocomial infections occurs in 2–18% of hospitalized patients, with the rates being up to 54% in Intensive Care Units (ICUs)[11-13] and are highest in surgical and burns ICUs and lowest in coronary care units[14].

A study from Pune showed that the common nosocomial infections in ICU were in the urinary tract (44.4%), followed by wound infections (29.4%), pneumonia (10.7%) and bronchitis (7.4%), with *Acinetobacter baumannii, Escherichia coli, Klebsiella pneumoniae, Pseudomonas aeruginosa, Staphylococcus aureus* and *Streptococcus pyogenes* being the common isolates[15]. Another study from Gujarat, revealed the overall prevalence of nosocomial infections to be 21.90% including 10.9% of surgical wound infection, 8% of local blood stream infection, 2% of urinary tract infection and 1% of other infection like bed sore[16]. A higher prevalence of gram negative bacilli (GNB; 92.23%) of which *Pseudomonas aeruginosa* and *Klebsiella spp* were the commonly isolated GNB, with 6.6% multidrug resistance pattern in the Non-fermenter GNB and 5% in *Pseudomonas aeruginosa*, was reported from another study[17]. Antimicrobial resistance in nosocomial infections is also increasing with greater morbidity and mortality when infection is caused by drug resistant organisms[18]. In the study from NIMHANS, Bangalore the highest mean resistance was to cefazolin (98.8%) and ampicillin (97.6%) while the lowest was to amikacin (48.5%)[17]. To produce effective empirical antibiotic protocols for individual ICUs, knowledge of common organisms and their sensitivity patterns is essential.

In spite of the invaluable and well established role of the ICU in patient care, ICU acquired infections bring some degree of morbidity and mortality to patients in the ICU as well as causing significant increases in costs[19-22].

As far as the North Eastern region of India is concerned, there is dearth of published data about the ICU related nosocomial infections, and in view of the relevance and impact of the above observations, the present study was conducted to determine with the following aims and objectives:

i) Detection of the various nosocomial infections in the different intensive care units of our hospital
ii) Pattern of distribution of the various organisms in the different intensive care units
iii) Determination of the diversity of the micro-organisms and their antimicrobial susceptibility pattern

MATERIALS AND METHODS

Our hospital is a multi-specialty apex medical institute with 500 beds that caters specialized tertiary health care to the people of the North Eastern Region of India. This prospective study was conducted in the Department of Microbiology, for a period of one (1) year from January 2011 to December 2011, on various samples received from four (4) ICUs, Anesthesiology ICU (AICU, under the Department of Anesthesiology), Pediatric ICU(PICU), Intensive Coronary Care Unit (ICCU), Cardio Thoracic and Vascular Surgery (CTVS) ICU. The approval from the Institute Ethical Committee was duly obtained for conducting the study.

Inclusion criterion:

Clinical specimens received from the patients who had crossed 48 hours of ICU admission, were included in this study. Among these, the specimens that showed a positive finding were considered as ICU acquired infections. A **positive finding** was defined as identification of organisms on staining procedures and growth of the organism in the appropriate culture medium and also identification through various biochemical tests according to standard protocols[23-25].

Clinical Specimens:

The various clinical specimens received from the different ICUs included –

I. **Urine Specimens**

The urine samples received for the study for suspected Urinary Tract Infection (UTI) included aspirated and clear catch mid-stream urine collected under aseptic conditions in sterile, dry, wide-necked leak proof containers.

II. **Respiratory Specimens**

The samples received for suspected Respiratory Tract Infection (RTI) included sputum and tracheal aspirate which were collected aseptically and transported to the laboratory in sterile wide mouth containers or test tubes.

III. **Blood Specimens**

The samples for blood culture for suspected Central and Peripheral Blood Stream Infection (BSI) were received in sterile blood culture broths. Suspected intra-vascular catheter tips were also received.

IV. **Exudates**

The samples received for Wound Infection (WI) included wound swabs, pus, discharges, etc. in sterile test tubes and containers.

V. **Sterile Fluid Specimens**

Cerebrospinal, Pleural, Peritoneal and Pericardial fluids were received as samples for suspected Sterile Site Infection (SSI).

Processing of Specimens:

All specimens were subjected to microscopic examination, culture, and biochemical tests, as per standard protocols[23-25]. Antimicrobial susceptibility testing was done by Kirby-Bauer Method using commercial antimicrobial disks and the results were interpreted as per the manufacturer's instructions which were based on Clinical Laboratory Standards Institute (CLSI) guidelines[26].

STATISTICAL ANALYSIS

Significance was evaluated by Fisher's exact test and/or $\chi 2$ test and 'p' value less than 0.05 was considered as significant.

RESULTS

Out of 2017 patients admitted in the four (4) different ICUs during the study period, clinical specimens from 276 patients were included in the study as per the inclusion criterion, which included 126 patients from AICU, 47 from ICCU, 101 from PICU and 2 from CTVS ICU. Among these, specimens of 94 patients in AICU, 23 patients in ICCU and 50 patients in PICU were diagnosed to have had one or more nosocomial infection(s). The overall nosocomial infections were detected in 167 (8%) patients admitted in the different ICUs and the individual incidence of nosocomial infections in AICU, ICCU and PICU respectively was 14%, 4% and 8%,. However, no such infection was detected in the 2 patients admitted in CTVS ICU.

The maximum number of patients was in the age group of 21 – 40 years (36%) in AICU, 41 – 60 years (48%) in ICCU and 11 – 16 years (24%) in PICU, whereas the maximum numbers of infections were in the age group of 21 – 40 years (36%), 41 – 60 years (52%) and 6 – 10 years (25%) in AICU, ICCU and PICU, respectively. **[Table 1]**

A total of 130, 25 and 68 specimens demonstrated culture positivity in the patients included in the study from AICU, ICCU and PICU, respectively. The study revealed that among the different nosocomial infections, Respiratory Tract Infections (RTI; 43%) were predominant, followed by Urinary Tract Infections (UTI; 34%), Blood Stream Infections and Septicemia (BSI; 11%), Wound Infections (WI; 10%) and Sterile Site Infections (SSI; 2%). As far as the individual ICUs are concerned, RTI (53%) was the commonest infection in AICU among the various infections, whereas in ICCU and PICU, UTI (60% and 56%, respectively) was the most common infection. **[Fig 1]**

The overall incidence of nosocomial infections was more in males in all the ICUs. However, there was no significant difference in incidence of NI between males and females (p = 0.2963 in AICU, p = 0.9203 in ICCU and p = 0.5187 in PICU). **[Table 2]**

A total of 293 organisms were isolated from the different samples, 181 from AICU, 28 from ICCU and 84 from PICU. Among the gram positive isolates, *Enterococcus* species was the commonest, followed by *Staphylococcus*. *Pseudomonas aeruginosa* was the most common isolate from all the ICUs among the gram negative isolates. *Candida* species comprised of about 7% of the isolates. The distribution of the organisms isolated from different infections, in both AICU and ICCU, showed that *Klebsiella* species, *Enterococcus* species and *Escherichia coli* were the commonest isolates from RTI, UTI and WI, respectively. The BSIs were mainly caused by *Acinetobacter* species in AICU. The isolates from the different NIs in PICU were bit diverse from those of AICU and ICCU. *Pseudomonas* was the commonest cause of RTI and WI in PICU; UTI was mainly caused by *E coli*, *Enterococcus* species and *Staphylococcus* were the major isolates from BSI. The SSIs, which were seen only in PICU, were caused mainly by *Staphylococcus*. **[Table 3]**

The antimicrobial resistance pattern of the isolates in the present study was determined using the Kirby-Bauer Disk Diffusion method. The Carbapenems group of antimicrobials proved to be the best drug, in-vitro, against the Gram Negative organisms isolated in the present study. The Gram Negative isolates were also susceptible to Aminoglycosides to some extent in all the ICUs. However, a significant difference existed in the susceptibility between the most sensitive (Carbapenems) and the next most sensitive (Aminoglycosides) group of drugs in AICU ($p = 0.00000000010$) and in PICU ($p = 0.0040$). **[Table 4]**

The Gram Positive organisms showed a high sensitivity to the Glycopeptide antimicrobials and also to Aminoglycosides, in all the ICUs. In ICCU and PICU, the Macrolides group and in AICU, the Lactam Inhibitors, were also effective in-vitro to the Gram Positive isolates. The incidence of Methicillin Resistant *Staphylococcus aureus* (MRSA) was 29% and 20% in AICU and PICU, respectively. There was no incidence of MRSA from ICCU. High Level Aminoglycoside Resistant (HLAR) *Enterococcus* species and Vancomycin Resistant *Enterococcus* (VRE) were isolated from all the ICUs; the incidence of HLAR *Enterococcus* species being 45%, 40% and 46% and that of VRE being 27%, 20% and 23% from AICU, ICCU and PICU, respectively. The isolates from UTI in all the ICUs exhibited high in-vitro sensitivity to Nitrofurantoin. **[Table 4]**

DISCUSSION

Healthcare Associated Infections (HAI) are an important health problem in terms of morbidities, mortalities and economic consequences, world-wide. They are especially important in Intensive Care Units (ICUs) where they have a five-fold higher incidence rate compared to the general inpatient population[27].

The present study conducted was on samples received from different ICU set up in the Institute and hence a diverse patient profile ranging from new born to geriatric population was involved. The study also showed a varied range of disease spectrum, differences in incidence rates of infections and subsequently a varied microbiological profile. There are very few reports of similar kind of studies worldwide as most reports in literature were confined to a specific type of ICU[10,28].

Rate of Nosocomial Infections in the ICUs

Nosocomial infections in the ICU have become exponentially problematic in the recent years and hence it has become essential to keep a track of the incidence of such infections in every health-care set-up. In the present study, it was found that the overall incidence rate of nosocomial infections in all ICUs was 8%. The finding was in concordance with a similar study by Gikas *et al*, who reported an incidence of 9.3%[10].

The individual incidence rates of infections in the different ICUs were – AICU (14%), ICCU (4%) and PICU (8%). The incidence rate of nosocomial infections in the ICUs was found to be lower than that of other similar studies which showed an incidence rate ranging from 19% - 38%[28-31]. The lower incidence of infections in the ICUs may be attributed to factors like sufficient and efficient equipment and supplies, good cleaning and sanitary practices, adequate trained personnel in infection control and a sound approach to antimicrobial usage.

A pediatric intensive care unit is a vulnerable haven of intensive care which harbours a population with a less developed immune system and greater susceptibility to infections. In the present study, the incidence rate in the PICU was only 8%, which was lower than similar studies where the incidence rate was reported to be between 23% - 28%[28,32].

Age and Sex distribution

Reports from different studies showed that hospital acquired infections can affect almost all age groups of patients who require intensive care during their stay in hospitals. The present study conducted in three ICUs with different patient profiles showed that in the ICU, the most common age group with infection was between 21 – 40 years; in ICCU it was between 41 – 60 years, while in PICU 11 – 16 years were the most commonly affected. The significance of age in acquisition of nosocomial infection could not however be drawn from the findings of this study.

Studies on nosocomial infections, reported variations in the findings regarding the preponderance of infections in a particular gender. In the present study, in all the ICUs, males were affected more than females, with an average male : female ratio being 1.2:1 and the reason for this could be a higher rate of admission in males. Many studies conducted had addressed different patho-mechanisms for the male-female variation in acquiring hospital-acquired infections, including sex-related gene polymorphisms[33], effects of sex hormones[34], or different intensities of care, with males receiving more invasive procedures[35,36]. However, gender as a predisposing factor for high incidence of nosocomial infections could not be convincingly concluded[37].

Types of Nosocomial Infections

According to the National Nosocomial Infections Surveillance (NNIS) system report[12], the commonly prevalent nosocomial infections reported are pneumonia, urinary tract infections and blood stream infections. The present study showed that the most prevalent infections were Respiratory Tract Infections (RTI) (52%) in AICU and Urinary Tract Infections (UTI) in ICCU (60%) and PICU (56%). High incidences of RTIs in ICU had also been reported earlier in other studies[10,31,38], with incidence rates of 23% to 68.4%. The higher incidence of RTI in AICU had been documented in a few studies[39-41], which showed that the environment of the ICU, the interventions and procedures involved with ICU care were the key factors which contribute to such high incidence. Over and above the aforementioned factors, the high incidence of RTI in the present study may be attributed to factors ranging from improper personal health habits such as smoking to other factors like history of prior hospitalization and antimicrobial usage before being referred to our Institute.

A study on nosocomial infections in PICU by Orret *et al*[28] also documented that UTI was the commonest infection, similar to the finding in the present study.

Microbiology of Nosocomial Infections

The threat of nosocomial infection is real and rising. The therapeutic interventions associated with infectious complications, sophisticated life support, prosthetic devices, immunosuppressive therapy, changes in the population at risk and the use of broad spectrum antibiotics, all lead to a spectrum of multidrug resistant pathogens, which contribute to the evolution of the problem of nosocomial infections[42].

Pattern of distribution of Organisms in Various ICUs

The commonest isolated organisms in ICU were *Pseudomonas species* (22%), followed by *Klebsiella* species (20%), *Acinetobacter* species (17%), *Escherichia coli* (12%) and *Staphylococcus aureus* (8%), among others, while in ICCU *Enterococcus* species (36%) was the predominant organism isolated, followed by *Escherichia coli* (21%), *Klebsiella pneumoniae* (14%) and *Candida* species (11%). The isolation pattern of organisms in PICU was *Escherichia coli* (26%) as the commonest organism, followed by *Enterococcus* species (15%), *Pseudomonas aeruginosa* (14%), *S. aureus* (12%), *Candida* species (8%) and *Klebsiella pneumoniae* (7%). Hence the present study showed that the *Pseudomonas aeruginosa, Escherichia coli, Klebsiella* species, *Staphylococcus aureus, Enterococcus* species and *Candida* species were among the common isolates in all the ICUs. Similar findings have been reported in previous studies[11,15,21,31].

Pseudomonas aeruginosa, one of the commonest causes of nosocomial infections was the predominant isolate (18%), from all the ICUs in the present study. This finding was in concordance with the findings of Gikas *et al*, Pittet *et al* and Rosenthal *et al*, who reported isolation rate of around 16%[4,10,11].

The incidence of nosocomial infections due to *Acinetobacter* species is less in India as compared to other South Asian countries[43, 44]. Studies by Tennant *et al*, Rosenthal *et al* and Ji-Guang Ding *et al*[11,21,31], reported isolation of *Acinetobacter* species in the range of 10.6% to 12.3%, which was similar to the findings in the present study (12%).

Among the Enterobacteriaceae, *Escherichia coli* was isolated from 17% of the samples and was found to be concordant with studies by Gupta *et al*, Ji-Guang Ding *et al* and Patwardhan *et al*[15, 29, 31], where the isolation rate was reported to be between 12.46% to 27.21%. A few other studies[10,21,45] however had reported a lower isolation rate of 1.6% to 10.8% of *Escherichia coli*, than the present study.

The isolation rate of *Klebsiella,* the other most common isolated Enterobacteriaceae, was 16%, which was lower than that reported in studies by Patwardhan *et al* and Jamshidi *et al* (19.12% and 22.4% respectively)[15, 45]. However, Tennant *et al* reported a much lower isolation rate of *Klebsiella* species (2.4%) in their study[21].

Among the Gram positive organisms, *Staphylococcus aureus* was one of the commonest isolates in almost all similar studies. The isolation rate (9%) in the present study however was lower than what was reported by Pittet *et al*, Rosenthal *et al*, Patwardhan *et al*, Ji-Guang Ding *et al* and Jamshidi *et al* in which *Staphylococcus aureus* was isolated from different samples at the rate of 12% to 17.28%[15,31,45-47].

Candida species was also a common isolate in our study. Diverse factors may be attributed to this finding like advances in the medical and surgical manipulations and increase in their applications, increase in immunocompromised state of patients, use of broad-spectrum antibiotics and the like. The quandary is whether these infections should be treated with antifungal agents. Institution of measures like removal of central venous line if yeast is isolated from a blood culture or change of urinary catheter if yeast is cultured from urine, often helps. However, in case of severely immunocompromised patients not responding to broad-spectrum antibiotics antifungals should be considered[17].

Relation of Nosocomial Infections with Organisms

In the present study, *Klebsiella* species, *Pseudomonas aeruginosa* and *Acinetobacter* species were predominantly associated with RTI. Veena Kumari *et al*, Rosenthal *et al* and Patwardhan *et al* also reported gram negative bacilli as the predominant organisms among the RTI infection isolates[11,15,17,].

The organisms isolated from patients with UTI in the present study were *Enterococcus* species, *Escherichia coli* and *Candida* species. Gram negative organisms and yeast were reported to have been isolated from urine in studies by Rosenthal *et al*, Patwardhan *et al* and Parvin *et al*[15, 47, 48], while the isolation of gram positive *Enterococcus species*, apart from the gram negative organisms and *Candida* species, as a cause of UTI in the present study was in concordance with a study by Hsueh *et al*[49].

In the present study *Escherichia coli, Pseudomonas aeruginosa* and *Staphylococcus aureus,* were the main organisms isolated from WI and this finding is in concordance with studies by Dy *et al*, Richards *et al* and Patwardhan *et al*[15,50,51].

In the present study, isolation of *Acinetobacter* species and *Pseudomonas aeruginosa* along with *Staphylococcus aureus* in blood cultures, suggests possibilities of hospital acquired sepsis. Studies by Rosenthal *et al* (2006), Patwardhan *et al* (2008) and Parvin *et al* (2009) also reported that the aforementioned microbes were the most prevalent pathogens recovered from BSI in their studies[15,47,48].

Antimicrobial Resistance Pattern of the Isolates

Resistance patterns among nosocomial bacterial pathogens may vary widely from country to country at any given point and within the same country over time. Because of these variations, a surveillance of nosocomial pathogens for resistograms is needed for every country and in fact in every individual hospital, in order to guide appropriate selection of empiric therapy. Resistance monitoring could also be a primary pointer for the emergence of an outbreak. Detection of resistance in a particular pattern may suggest a currently occurring epidemic in the hospital.

In the present study, the isolated organisms were subjected to a battery of different group of antibiotics, as per standard protocols, to detect their resistance patterns and it was found that overall, Carbapenems and Aminoglycosides were the most effective groups of antimicrobials against both the Gram Negative and Gram Positive isolates.

As far as the Non Fermentative Gram Negative isolates were concerned, *Pseudomonas aeruginosa* and *Acinetobacter* species were mostly resistant to Cephalosporins (68% and 57% respectively) and Fluroquinolones (56% and 55%, respectively). High resistance of *Pseudomonas aeruginosa* to Cephalosporins had also been documented in literature, by Parvin *et al* (2009) and Jamshidi *et al* (2009)**,** at 68.5% and 96.6%, respectively[45,48]. Studies by Rosenthal *et al* (2006), Ji-Guang Ding *et al* (2009) and Slama TG (2008), reported that resistance of *Pseudomonas aeruginosa* to Fluoroquinolones was 62%, 54.1% and 30% respectively[31, 47, 52]. Prashanth et al (2004) reported resistance of *Acinetobacter* species to Cephalosporins (58.83%), Fluoroquinolones (58.6%) and Aminoglycosides (43.21%)[53]. Resistance of *Acinetobacter* species to Cephalosporins (63.8% and 80%, respectively) was also reported by Parvin *et al* (2009) and Patwardhan *et al* (2008) in their studies[15,48].

The most effective drug for the Enterobacteriaceae group was also the Carbapenem group, but the high cost of Carbapenems however, are hindrances, at times, to its usage. A noteworthy observation was seen in *Klebsiella* species in particular, which showed quite a high resistance to Aminoglycosides. Respiratory tract was the major site from where *Klebsiella* species was isolated, in the present study, and hence this resistance pattern may be explained by the fact that Aminoglycoside resistant strains are more common at sites with poor penetration of the drugs. The serum therapeutic toxic ratio of Aminoglycosides is low; hence, penetration into infected respiratory tract may be insufficient to act on the infecting organisms[54].

A significant observation in the present study was that Nitrofurantoin proved to be a very effective drug in UTI (average resistance 38%).

Among the Gram Positive isolates, High Level Aminoglycoside Resistance (HLAR; 44%) *Enterococcus* species and Vancomycin Resistant *Enterococccus* (VRE; 23%), were isolated from all he ICUs. High rate of isolation of VRE (38% and 53%) had earlier been reported by Wattal C, 2008 and Karmarkar *et al*., 2004, respectively[55, 56]. The present study thus showed that VRE exists among clinical isolates in our ICUs, though at a lower frequency. This finding highlights the fact that detection is important as clinically Vancomycin resistance has been associated with more frequent episodes of recurrent bacteraemia, persistent isolation of *Enterococci* from primary sites of infection and increased mortality[57].

Staphylococcus aureus has developed resistance to newer antibiotics over the years. In the present study, *Staphylococcus aureus,* showed resistance predominantly to Penicillins and Chloramphenicol (50%),

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Quinolones (45%) and Macrolides (43%). Methicillin resistance is quite frequent nowadays, approaching, and at times, exceeding 50% in tertiary care centres. According to the NNIS data, Methicillin Resistant *Staphylococcus aureus* (MRSA) accounts for 52.3% of *Staphylococcus aureus* nosocomial infections[12]. In the present study, 23% of the *Staphylococcus aureus* isolates were MRSA.

Most of the studies have documented a very low resistance of *Staphylococcus aureus* to Vancomycin (0 – 17%)[31, 47, 48]. There was no incidence, however of Vancomycin resistant *Staphylococcus aureus* in the present study.

The lack of information regarding comprehensive clinical data of the patients, the treatment provided to individual patients and their outcome and the non-performance of tests to determine the Minimum Inhibitory Concentrations (MIC) of the antimicrobials tested, however remains the limitations in the present study.

CONCLUSION

The burgeoning literature on antimicrobial resistance particularly in the recent decades tends to convey the impression that health care–associated infections clearly are a huge and largely unrecognized threat to patient safety, especially in the Intensive Care Units. The possibility of reducing resistance by controlling the use of antibiotics is a logical approach, but the implementation of effective policies is difficult. Hence, a combined approach of community awareness, antibiotic restriction, effective surveillance and good infection control practices is essential if antibiotic resistance is to be overcome. Nosocomial infections in the ICU follow basic epidemiological patterns that can help to direct prevention and control measures. These infections have reservoirs, are transmitted by predictable routes and require susceptible hosts. Thus it is important to take steps to prevent ICU infections, but when they occur, effective and early institution of appropriate antibiotic therapy is crucial. This will improve patient outcome and decrease the incidence of multiple resistant organisms. Studies on the trends in epidemiology of nosocomial infections and also variations in the local situations are required for which multicentre studies need to be carried out in our country to coordinate and arrive at protocols based on local patterns of antibiotic resistance. Judicial use of antibiotics in conjunction with alteration and rotation in antibiotic prescribing patterns might also help to decline the specter of antibiotic resistance.

Table 1: Age-Wise Distribution of Nosocomial Infections in different ICUs
(Figure indicates percentage)

	AICU				ICCU			PICU				
	≤20 YRS	21-40 YRS	41-60 YRS	≥60 YRS	21-40 YRS	41-60 YRS	≥60 YRS	NEW BORN	< 1 YR	1-5 YRS	6-10 YRS	11-16 YRS
RTI	6	34	34	26	29	57	14	14	14	22	36	14
UTI	10	38	28	24	7	53	40	24	11	23	26	16
BSI	13	25	49	13	--	--	--	40	40	--	--	20
WI	18	53	18	11	--	33	67	14	--	14	29	43
SSI	--	--	--	--	--	--	--	--	25	50	--	25

Table 2: Sex wise Distribution of different Nosocomial Infections in the ICUs
(Figure indicates percentage)

	UTI		RTI		BSI		WI		SSI	
	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE
AICU	65	35	55	45	64	36	67	33	--	--
ICCU	69	31	71	21	--	--	33	67	--	--
PICU	45	55	73	27	57	43	100	0	100	0

Table 3: Distribution of Organisms Isolated from the different ICUs

	UTI			RTI			BSI			WI			SSI			TOTAL
	ICU	ICCU	PICU	ICU	ICCU	PICU	ICU	ICCU	PICU	ICU	ICCU	PICU	ICU	ICCU	PICU	
S aureus	3	2	2	3	0	2	3	0	2	5	0	1	0	0	3	26
S pneumoniae	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	2
Enterococcus	7	10	11	2	0	0	1	0	2	1	0	0	0	0	0	34
A baumanii	3	0	0	15	1	3	4	0	0	1	0	0	0	0	0	27
A lwoffii	1	0	0	2	0	0	4	0	0	0	0	0	0	0	0	7
C diversus	0	0	0	7	0	0	1	0	0	1	0	0	0	0	0	9
C freundii	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2
E coli	6	3	15	9	1	3	1	0	1	5	2	3	0	0	0	49
Enterobacter	0	0	3	5	0	3	0	0	0	0	0	0	0	0	0	11
K pneumoniae	2	1	4	25	3	2	3	0	0	1	0	0	0	0	0	41
K oxytoca	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	5
P aeruginosa	4	0	1	27	1	6	4	0	0	4	1	4	0	0	1	53
P mirabilis	0	0	1	2	0	1	0	0	0	0	0	0	0	0	0	4
P vulgaris	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
M morganii	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Candida spp	6	3	7	4	0	0	1	0	0	0	0	0	0	0	0	21
TOTAL	33	19	46	107	6	20	22	0	5	19	3	9	0	0	4	293

Table 4: Resistance of Organisms Isolated from the different ICUs (Figure indicates percentage)

	ICU		ICCU		PICU	
	GRAM POSITIVE	GRAM NEGATIVE	GRAM POSITIVE	GRAM NEGATIVE	GRAM POSITIVE	GRAM NEGATIVE
β Lactams	41.94	94.69	100	86.67	84.62	97.67
Cephalosporins	51.82	92.64	100	79.55	45.65	93.91
Aminoglycosides	37.25	49.58	33.33	0	36.62	28.3
Fluoroquinolones	56.19	64.80	94.44	69.7	51.32	53.19
β Lactamase Inhibitors	9.09	84.47	100	35.14	72.73	59.14
Macrolides	62.79	96.08	20	100	21.95	74.29
Carbapenems	57.14	13.50	40.91	0	66.67	5.48
Glycopeptides	14.29	0	11.11	0	13.13	0
Nitrofurantoin	41.67	59.74	0	30	38.46	24.24

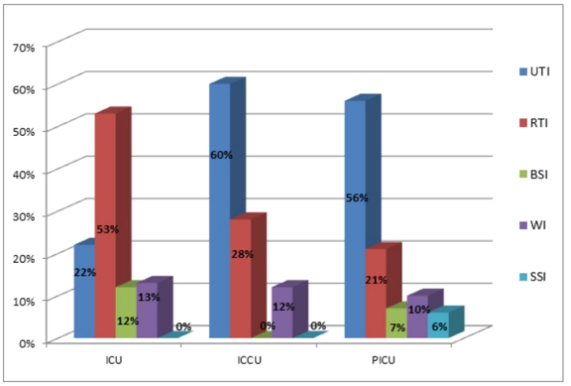

FIG - 1: Incidence of Nosocomial Infections in the different ICUs

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