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Original Research Article

A study on common pathogens associated with nosocomial infections and their antibiotic sensitivity

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ABSTRACT

Background: *S. aureus*, coagulase negative *staphylococci*, *enterococci*, a variety of gram-negative bacilli, and Candida spp. are responsible for the vast majority of infections. Coagulase negative staphylococcal infections have increased dramatically in past 2 decades, almost entirely because of increase in the frequency of blood stream infections caused by these organisms.
Methods: Appropriate microbiological samples were taken from the site of infection from all the patients included in the study. Whenever necessary, required serological examinations are sent.
Results: Of 30 episodes of nosocomial infections from which any pathogen was isolated, three episodes were polymicrobial. Gram-negative organisms were more frequently (76.67%) isolated than gram-positive organisms (20%), and fungi (3.33%).
Conclusions: Almost all gram-negative bacteria showed 100% sensitivity to Imipenem. Pseudomonas isolates showed sensitivity of 100% to Imipenem, 83.33% to Piperacillin+Tazobactum. Klebsiella showed sensitivity of 83.33% to Ciprofloxacin and Amikacin.

Keywords: Antibiotic Sensitivity, Nosocomial infection, Pathogens

INTRODUCTION

The better equipped an ICU is for invasive procedures, the more frequently these procedures are performed for patient care and greater is the nosocomial infection.[1] It is a closed milieu constantly full of patients with life threatening illnesses. It has constant faculty of staff nurses and doctors who over prolonged periods are in contact with an environment containing antibiotic resistant pathogens.

In this closed milieu the major reservoir of nosocomial organisms are infected or colonized patients. They spread via human personnel, aspiration of the infected pharyngeal or mouth secretions, exposure to invasive devices and procedures, surgery, impairment of immune mechanisms or overwhelming illness amplify colonized patients vulnerability to nosocomial infections and promote their transmission. Antibiotic use eventually promotes antibiotic resistance to a number of organisms that prevail in a particular ICU. These organisms contaminate the completely closed environment.

Gram-negative bacilli predominate over gram-positive bacilli in nosocomial infection in most studies.[2] In 1995 study done by Mehta A in a private hospital showed the

vascular line infection rates being 9%. UTI was 11.7%. Commonest nosocomial isolates were:

- Pseudomonas - 30%
- MRSA - 15%
- E. coli - 13%
- Klebsiella - 10%
- Enterobacter - 9%
- Acinetobacter - 6%.

Amongst the above pathogens, MRSA is becoming an important pathogen. Once established, it is difficult to eradicate it from the hospital environment. Healthy hospital staff can be chronic nasal carriers of the organisms and help perpetuate its presence.

S.aureus, coagulase negative *staphylococci, enterococci*, a variety of gram-negative bacilli, and Candida spp. are responsible for the vast majority of infections. Coagulase negative staphylococcal infections have increased dramatically in past 2 decades, almost entirely because of increase in the frequency of blood stream infections caused by these organisms. The frequency of infections caused by S. aureus, Enterococci, Pseudomonas aeruginosa, and Enterobacter spp. has increased slightly. The frequency of Candida spp. has increased for all major sites of infection.

More alarming is the dramatic increase in the antibiotic resistance in common nosocomial pathogen. According to ICARE 2001 report, the overall prevalence of MRSA strains causing nosocomial infection was 55% and that of vancomycin resistant enterococci was 26%. Resistance to third generation cephalosporin is common in gram negative rods such as E. coli, Klebsiella pneumoniae, Enterobacter spp., and pseudomonas aeruginosa, and resistance to imipenem and quinolones is a rapidly growing problem with P.aeruginosa.[1]

METHODS

Inclusion criteria

Children in age group of one month to twelve years are admitted to our PICU.

- All the patients admitted in PICU with PICU stay of more than 48 hours were daily monitored for fever or any other symptoms or sign suggestive of any infection
- The patients who developed the same 48 hours after admission, which was not present at the time of admission, were included.

Exclusion criteria

- Patients with any clinical feature or laboratory investigation, suggesting concerned infection being prior to the admission to the PICU.

Patients were suspected to have developed nosocomial infections in the PICU, if they developed any one of the following of the clinical features 48 hours after admission to the PICU.

- Unexplained fever (>380C)
- Leukocytosis(>=10,000)
- New infiltrate on the chest X-ray
- Persistent tracheal aspirates or secretions
- Turbid urine, suprapubic tenderness, dysuria, burning micturition
- Thrombophlebitis.

Detailed examination of all patients included in the study was done as follows:

- Temperature, pulse, blood pressure
- Respiratory system was examined for breath sounds and any other abnormal sounds
- Abdominal examination was done for localised tenderness or tenderness over peritoneal dialysis catheter site
- Purulent secretions for endotracheal tube
- Features suggestive of thrombophlebitis.

Laboratory investigations that were done are listed below:

- Routine investigations:
- CBC
- Chest X-ray
- LFT
- RFT
- Urine routine examination

Specific site related investigations:

Appropriate microbiological samples were taken from the site of infection from all the patients included in the study. Whenever necessary, required serological examinations are sent.

- Blood cultures from all infected cases
- Urine culture and sensitivity in suspected UTI
- Quantitative estimation of endotracheal aspirate or sputum for microbial growth
- Peritoneal fluid for routine examination, culture, and sensitivity in a patient with peritoneal dialysis.

Proper aseptic measures were observed during collection of various samples. Urine was aspirated from the Foley's catheter after clamping and cleaning catheter with cetavalon, iodine, and spirit. Collected urinary sample was sent in the sterile test tube for culture and antibiotic sensitivity

Blood was collected from the separate site and not from the intravenous catheter. Skin site of the blood collection was cleaned with cetavalon, iodine and spirit in that order

and antiseptics were kept over the skin for one minute. 5ml of blood was collected for each 20 ml broth.

RESULTS

Table 1: Common sites of nosocomial infection.

Sites	Number	Percentage
BSI	17	34.69
UTI	12	24.48
PNEU	17	34.69
Others	3	6.12

BSIs (bloodstream infections) (34.69%), pneumonia (34.69%), and UTIs (urinary tract infections) (24.48%) were the most frequent nosocomial infections observed. Others include one patient with peritonitis, one with decubitus ulcer, and one with Hepatitis A.

Most common nosocomial infection observed in age group from 1 month to 3 month was pneumonia followed by BSIs. UTI was not seen in this age group in our study.

Most common Nosocomial Infection observed in age group from 4 month to 5 year was BSIs seen in 42.8% followed by pneumonia, which was seen in 32.1% of all infections in this age group. UTIs were seen less commonly i.e. 25% of all infections in this age group.

Table 2: Site distribution of nosocomial infection in PICU by age.

Age	BSI	UTI	PNEU	Others	Total
1 month to 3 month	1	0	4	0	5
4 month to 5 year	12	7	9	0	28
6 year to 12 year	4	5	4	3	16
Total	**17**	**12**	**17**	**3**	**49**

UTI was the most frequent (31.2% of all nosocomial infections in this age group) nosocomial infection seen in age group from 6 year to 12 year followed by BSI and pneumonia, each with 25% of the total nosocomial infections in this age group.

UTI was seen more commonly in the children above 5 years of age compared to other two age groups. Nosocomial pneumonia formed a larger proportion of nosocomial infections in children below 5 years of age. However this difference in the site of distribution in different age group was not statistically significant (p value > 0.05).

Table 3: Distribution of pathogen among nosocomial infections in PICU.

Pathogen isolated	BSI	UTI	PNEU	PER	Total	Percentage
Pseudomonas A	2	3	1	0	6	20
E. coli	0	4	1	0	5	16.67
Klebsiella	0	5	1	0	6	20
Proteus	0	1	0	0	1	3.33
Enterobacter	2	1	0	0	3	10
Acinetobacter	1	0	0	1	2	6.67
Enterococci	0	0	1	0	1	3.33
Staphylococcus A.	5	0	0	0	5	16.67
Candida	1	0	0	0	1	3.33
Total	**12**	**14**	**4**	**1**	**30**	

Of 30 episodes of nosocomial infections from which any pathogen was isolated, three episodes were polymicrobial. Gram-negative organisms were more frequently (76.67%) isolated than gram-positive organisms (20%), and fungi (3.33%).

Klebsiella pneumoniae (20%) and pseudomonas aeruginosa (20%) were most frequent organisms isolated followed by *E. coli* (16.67%), *staphylococcus aureus* (16.67%), enterobacter (10%). Other nosocomial organisms included *proteus*, *acinetobacter*, *enterococci*, and *candida*.

Out of 17 bsis observed, pathogens were isolated from 12 patients. Pathogens were isolated from all cases of uti. Of 17 patients with pneumonia, pathogens were isolated from tracheal aspirate samples of only four patients.

In blood stream infections, *staphylococcus aureus* (5/12 i.e. 41.66%) was most frequently isolated pathogen followed by pseudomonas and enterobacter.

Most of utis were caused by *Klebsiella* (5/14 i.e. 35.71%) followed by E. coli (4/14 i.e. 28.57%), pseudomonas (3/14 i.e.21.42%). Proteus and enterobacter were other organisms isolated.

Pseudomonas, E. coli, enterococci and K*lebsiella* were the organisms isolated from tracheal aspirates in patients with nosocomial pneumonia.

DISCUSSION

Gram-negative organisms (76.67%) were most commonly reported organisms from nosocomial infection. Gram-positive organisms were reported in 20% and fungus i.e. Candida was reported in 3.33%. This observation is in accordance to the study done by Marcelac et al.[4] The study found gram-negative organisms being the most common organisms (54.5%) isolated from nosocomial infections.

In contrast, study done by Urrea M et al found gram-positive organisms (78.6%) being most commonly isolated from nosocomial infection, mostly coagulase negative staphylococcus. Coagulase negative staphylococcus was not isolated from patients with nosocomial infections in our study.[5]

Pseudomonas Aeruginosa (20%) and *Klebsiella Pneumoniae* (20%) were the most frequent organisms reported from nosocomial infections followed by E. Coli (16.67%), *Staphylococcus aureus* (16.67%) and *Enterobacter* (10%).

Primary bloodstream infection

Staphylococcus aureus (41.66%) was the most common bloodstream isolates. Gram-negative bacilli including Pseudomonas aeruginosa, Klebsiella P, Enterobacter, Acinetobacter were reported frequently (50% of all isolates reported in BSI). Candida was the other organism isolated from primary BSI. Coagulase negative staphylococci (38%) were the most common pathogen reported in the study done by Richard MJ et al.[6] As seen in our studies, gram-negative aerobic bacilli were reported frequently (25% of all isolates from all species) in their study.

Urinary tract infections: Klebsiella P. was the most frequently reported isolate (35.71%) followed by E. coli (28.57%) and Pseudomonas A. (21.42%). Proteus and Enterobacter were other organisms isolated. E. coli was frequently reported isolate as in studies done by Richard MJ et al.[6]

Nosocomial pneumonia

Gram-negative bacilli were reported more frequently including *Pseudomonas A., E. coli and Klebsiella*. This is similar to the study done by Richards MJ et al in which, 77% of reported isolates were Gram-negative aerobic bacilli.[6]

Mortality in patients in the ICUs strongly correlates with nosocomial infections. Mortality in patients with nosocomial infections was 37.14%. It was higher than the mortality rate of 30.50% reported by Akash Deep et al, 20% reported by Tullu et al and 21.3% reported by Marcelo L et al.[4,7,8]

Mortality in patient without nosocomial infection was 16.24%. Mortality was significantly greater in patients with nosocomial infection as compared to those without nosocomial infections (P<0.01). The risk of mortality was three times greater in patients with nosocomial infection than in patient without nosocomial infection (odds ratio = 3).

The result was similar to the following studies. Bowen - Jones et al analyzed mortality rates in children admitted to the ICU and found 41% rate in the presence of nosocomial infection and a mortality rate of 18% in children without nosocomial infection.[9] Avilla Figuerosa et al showed that patients with Nosocomial Infections had twice the risk of dying as non-infected children.[10] Bueno Cavanillas A et al showed the mortality risk to be 2.38 times higher in patients with a Nosocomial infection than in non-infected patients.[11]

92.3% of patients with nosocomial infection, who died, had their PICU stay more than 7 days. Mortality in patients with PICU stay more than 7 days was greater i.e. 42.8% as compared to the patients with PICU stay less than 7 days (14.28%). Chance of survival was 4.2 times better if the PICU stay was less than 7 days (odds ratio = 4.5). Higher mortality seen in patient with longer stay is similar to that seen in study done by Bueno Cavanillas et al.[11]

The mortality associated with nosocomial infection is multifactorial. It depends on the patients' characteristics, severity of underlying illness, the number of affected organs, and duration of PICU stay and the microorganisms. The increased mortality in our study was probably because very critically sick children got admitted to the PICU with an increased duration of hospitalization.

Although mortality in females with nosocomial infection appeared to be more, this difference was not statistically significant. In contrast, Dinkel RH et al found that males

outnumbered females in patients with nosocomial infection who expired.[12]

Mortality associated with nosocomial BSI and nosocomial pneumonia was high 47.1% and 52.94% respectively. In the study by Marcelo et al in which BSI associated mortality rate was 33.3% and the pneumonia associated mortality rate was 11.4%.[4]

In our study, nosocomial UTI associated mortality rate was low (18.18%).

In our study, the most common organism associated with BSI was Staphylococcus aureus (41.66%), followed *Pseudomonas*, *Enterobacter* and *Candida*.

In the epidemiological overview of nosocomial bacteremia in 1960s and 1970s, *Staphylococcus aureus* was reported as a causative organism in more than half of the cases along with *E. coli* and *Klebsiella.* In the 1980s, gram-negative sepsis declined as a cause of IVC related bacteraemia with concurrent rise in staphylococcal infection.

Hampton et al reviewed studies on vascular access infections conducted from 1980 to 1987.[13] In the analysis, CONS was the most common pathogen isolated from blood culture. Almost similar pattern prevailed till 1992 as reported by Mori E et al.[14] They also suspected a role of nasal carriers in the high incidence of staph. Aureus bacteremia related to IVC. Similar predomince of Staphylococcus aureus bacteremia was also seen in our study.

Fungal infection accounted for 8.33% of the IVC related infection. Others centers have reported candidal growth from IVC related sepsis in 4.12% of the patients.[24]

CONCLUSION

Gram-negative organisms (76.67%) were the most commonly reported organisms. *Pseudomonas Aeruginosa* (20%) and *Klebsiella* (20%) were the two most common nosocomial isolates followed by *E. coli*, *Staphylococcus aureus* and *Enterobacter*. *Staphylococcus aureus* was the predominant pathogen isolated from bloodstream infections and *Klebsiella* from urinary tract infections. *Pseudomonas*, *E. coli*, *Klebsiella*, and *Enterococci* were isolated from patients with nosocomial pneumonia.

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