

Clinico-Bacteriological study of Nosocomial Infections in the Paediatric Intensive Care Unit (PICU)

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ABSTRACT

Background: In this study, we wanted to study the incidence, risk factors and clinical and bacteriological pattern of nosocomial infections in PICU.

Methods: This study was conducted in the PICU of 900 bedded Tertiary hospital. 74 suspected cases of nosocomial infections were studied prospectively, identified as per the guidelines laid down by CDC.

Results: The incidence of nosocomial infections was 29% (N=255). Bloodstream infections were the most commonly observed in the present study (43.24%, 32/74) followed by Urinary Tract Infection (UTI) (32.43%, 24/74), Nosocomial pneumonia (16.21%, 12/74), and SSI (8.1%, 6/74). There were two patients with more than one nosocomial infections. The average duration of stay in children with NI the overall length of stay was 589 days with an average of 7.95 days compared to 4.63 days in children without NI.

Conclusions: The risk of nosocomial infection was directly related to the duration of stay in the PICU and the duration of placement of indwelling catheters /tubes. Age and sex were the important independent risk factors for causing nosocomial infections as the incidence was more in the 2 months age group. BSI occurred more commonly in males while UTI in females. Other risk factors like malnutrition, immunocompromised status and underlying illness were also associated with nosocomial infections. The most common organism was E. coli (sensitive to amikacin) followed by klebsiella and maximum sensitivity to piperacillin-tazobactam. Length of stay in PICU more in children with NI. There was no significance in mortality between both groups.

Abbreviations: NI- Nosocomial infections. PICU- Paediatric intensive care unit. UTI- Urinary tract infections.

Keyword: Nosocomial infections; PICU.

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INTRODUCTION

Background

A paediatric intensive care unit (PICU) is an area within a hospital taking care of critically ill infants, children, and teenagers. Nosocomial infections are common in all hospital setup, more so in intensive care units.

Nosocomial infections are the infections that are contracted during treatment in a hospital or a healthcare service unit, but secondary to the patient's original condition. Infections are considered nosocomial if they first appear 48 hours or more after hospital admission or within 30 days after discharge.^{1,2} Nosocomial comes from the Greek word nosokomeion) meaning hospital (nosos = disease, komeion = to take care of). This type of infection is also known as a hospital-acquired infection (or more generically healthcare-associated infections).

There is very little published data on the incidence of nosocomial infection in PICUs in developing countries. Most of the studies are from the United States, because they follow standard protocol for surveillance of nosocomial infections, lay down by NNIS and used CDC criteria for diagnosis.

Each nosocomial infection adds 5-10 days to the affected patient's time in the hospital. Nosocomial infections have increased the morbidity and mortality of hospitalized patients especially the ones who admitted to an intensive care unit. In addition, these infections lead to extra hospital stays and expenditure thus overburdening the already strained health economy. In studies conducted by various authors, the incidence of nosocomial infections ranged from 2.8% to 21.6%.³⁻⁷

AIMS AND OBJECTIVES

- To estimate the incidence of nosocomial infections in the PICU of a tertiary hospital.
- To assess the common sites of infections.
- To determine the common risk factors associated with NI.
- To assess the common bacteria, their biotypes and antibiotic sensitivity patterns.

MATERIALS & METHODS

A prospective study conducted over one year in the 8 bedded PICU of a 900 bedded tertiary hospital.

Inclusion criteria

The study was conducted among 1 months to 12 year age group children admitted in PICU with a stay of more than 48 hours (irrespective of their outcome of discharge; transfer and death) were included in the study.

Exclusion criteria

The children already suffering from nosocomial

infections.

METHODOLOGY

Before initiating the study, ethical approval was obtained from the institutional ethical committee and written informed consent was obtained from the parents. Relative frequencies of known risk factors like age, anemia, and malnutrition, severity of disease and duration of PICU stay were recorded in patients who developed nosocomial infections. Among the admitted children, blood culture and urine culture was done at the time of admission to rule out an already existing infection and as and when a patient developed clinical features suggestive of an infection. CVP or intravenous catheter tips were cultured in those with suspected thrombophlebitis along with simultaneous blood culture from a site different from that of IV catheter after preparing the site with 70% alcohol and 1% betadine. Urine and tips of indwelling catheters were cultured simultaneously in patients with suspected urinary tract infections. Tracheostomy tube (TT) tips along with TT aspirate, gastric lavage, sputum samples or tips of endotracheal tubes (ET) or swabs that were taken from the tips of the endotracheal suction catheter along with the tip of ETs were also cultured. The outcomes were assessed in terms of determining the incidence of nosocomial infections, risk factors associated with NI, duration of hospital stay and mortality. The risk factors were compared among both the groups of those with nosocomial infections and without NI.

Statistical Analysis

All the data were analysed statistically by using the software "Graph Pad In Stat" downloaded from the site www.graphpad.com. The significance of risk factors under study associated with NIs was compared with those without NI and its statistical significance was determined by using the chi-square test and Fisher Exact Test. A probability value ('p' value), relative risk and confidence interval at 95% were calculated from the software mentioned and 'p-value was considered to be significant when it was less than 0.05.

RESULTS

The incidence of NI in the present study was 29.01% (74/255). Children below 2 months suffered more commonly (54.16%) compared to older children. This difference is highly significant (P-value <.0001).

The total number of males in the present study was 151 out of which 48(31.78%) had nosocomial infections, while the total number of females was 104 out of which 26(25%) had nosocomial infections. The incidence in males was higher as compared to females. However, the difference was

not significant.

Bloodstream infections were the most common NI observed in the present study (43.24%) followed by UTI (32.43%), pneumonia (14.86%), and SSI (6.75%) as seen in Table 1.

Table 1: Incidence of Nosocomial Infections (NI)

Study group	Number of children with NI	Number of children admitted	Incidence of NI (%)
< 2 month	26	48	54.16
2 m - < 1 yr	16	58	27.58
1 yr - < 5 yr	20	75	26.66
5 yr - 12 yr	12	74	16.21
Overall	74	255	29.01

Table 2: Distribution of Nosocomial Infection (n=74)

Type of NI	Total no. n= 74	Percentage (%)
BSI	32	43.24
UTI	24	32.43
Pneumonia	11	14.86
SSI	05	6.756
BSI + Pneumonia	01	1.35
BSI + SSI	01	1.35

UTI was seen most frequently between two months and one year age group (37.5%), whereas all other infections were most common in children below two months. UTI (14/26, 53.84%) and pneumonia (7/26, 26.92%) were seen more frequently in females whereas BSI (30/48, 62.5%) and UTI (10/48, 20.83%) were seen more commonly in males.

The sex distribution of BSI shows that it was more common in males compared to females. This difference was found statistically significant (P=.0005). UTI was significantly more common in catheterized females (P=.0084). Analysis of pneumonia in relation to the gender of children did not show a significant difference. SSI was more common in males (10.41%). However, this difference did not reach the level of statistical significance.

It was found that NIs were 2.72 times more common in children with malnutrition as compared to children with normal nutritional status and statistically significant (P=.0001).

Similarly other factors like steroid ingestion >2 wks (70%) and patients with underlying diseases

(77.77%) that alter immunity were also more common in children who developed NI and it was found to be statistically significant (P=<.05). The children on steroids had underlying diseases like Nephrotic Syndrome (2), SLE (1), Bronchial Asthma (1), Tuberculous Meningitis (4) and Neurocysticercosis (2).

Blood culture positive cases were 9.4%(n=255) as mentioned in Table 3. Out of these, 19 samples were from children having peripheral lines and the remaining five samples were from children with a central line. Peripheral line catheter tip culture-positive cases were only 2.7% (n=255). Likewise out of 45 samples of urine from patients with urinary catheters, 21 samples showed growth while 1 sample from other children suspected of UTI showed growth. Samples of Foley’s catheter tip culture positive for organisms were 46.66%. Therefore culture positivity rate for UTI was high for urine culture compared to catheter tip culture. Thus growth rates from various samples sent during the study period were (93/684, 13.59%) as shown in table 1.

Table 3: Growth rates from various samples

Sample	Growth obtained/ Total No.sent	Percentage
Blood cultures	24/255	9.4
The peripheral line catheter tip	7/243	2.8
CVP line catheter tip	3/12	25
Urine	21/71	29.57
Foley's catheter	14/45	31.11
ET/TT aspirate	8/22	36.36
Endotracheal tube	9/22	40.90
Tracheostomy tube	1/2	50
Swab culture from surgical sites	6/12	50
Total	93/684	13.59

Table 4: Culture and sensitivity

Antibiotic	E. Coli (n=24) %	Klebsiella (n=12), %	Pseudomonas (n=13), %	Staph (n=9), %	Total (%)
Amoxicillin	-	-	-	-	-
Amikacin	13/24 (54.16)	-	-	-	13/24(54.16)
Cefotaxime	10/24(41.66)	-	5/13(38.46)	2/9(22.22)	17/46(36.95)
Gentamicin	3/24 (12.5)	8/12(66.66)	2/13(15.38)	1/9(11.11)	14/58(24.13)
Cefoperazone	-/24	-	10/13(76.92)	-	10/37(27)
Ofloxacin	7/24 (29.16)	-	3/13(23.07)	-	10/37(27)
Ceftriaxone	9/24 (37.5)	-	2/13(15.38)	1/9(11.11)	12.46(26)
Piperacillin+ tazobactam	-	11/12(91.66)	9/13(69.23)	2/9(22.22)	22/33(64.7)
Meropenem	-	-	-	-	-
Vancomycin	-	-	-	8/9(88.88)	8/9(88.88)
Imipenem	-	9/12 (75)	-	-	9/12(75)

Table 5: Risk Factors Association

Risk Factor	With NI	Without NI	Total	-
Malnourished	54 (42.5%)	73	127	P value (<.0001). Chi-square (with Yates correction)- 21.099. R. R - 2.721. 95% Confidence Interval is 1.734 to 4.270
Normal nourished	20 (15.62%)	108	128	
On steroid	07 (70%)	003	010	P value (0.0105).
Not On Steroid	67 (27.35)	178	245	R. R = 2.560 with 95% C.I is 1.625 to 4.032.
Cong. Disorder	14	04	18	P value <0.0001. Chi-square (with Yates correction) = 19.878. R. R= 3.072 (95% Confidence Interval: 2.209 to 4.27)
No Cong. Disoreder	60	177	237	

Table 6: Overall outcome of both groups.

Outcome	With NI	Without NI	Total	-
Died	5 (6.75%)	21 (11.60%)	26	P value 0.3511. Chi-square (with Yates correction) = 0.8696, R. R = 0.6382 (95% C. I: 0.2833 to 1.438)
Survived	69	160	229	
Total	74	181	255	

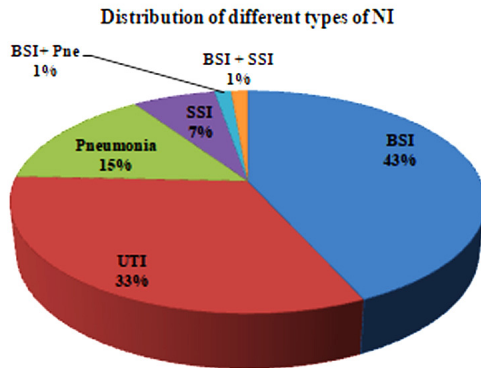


Fig. 1: Distribution of nosocomial infection

The most common organism isolated in our study from various samples was *E. coli* (32%) followed by klebsiella (18.67%). *E. coli* was most sensitive to amikacin (54.16%) while klebsiella showed maximum sensitivity to piperacillin-tazobactam (91.66%). Pseudomonas was highly sensitive for cefoperazone (76.92%) followed by piperacillin-tazobactam while for staphylococcus, vancomycin (88.88%) was the most sensitive antibiotic in the present study.

OBSERVATIONS ON INDIVIDUAL NOSOCOMIAL INFECTIONS

1. Blood Stream Infections

BSI was more common in babies <2 months (31.25%) and it was statistically significant ($P=0.0001$). There was a very strong association between the central line (66.66%) and BSI, compared to the peripheral line catheter (13.33%). Total central line catheter days were 44 days giving a BSI of 181/1000 catheter days. For peripheral line catheters, the data showed a total of 986 days giving a BSI rate of 26.36/1000 catheter days.

The frequency of BSI increased when peripheral catheters were kept at one site for more than five days (17/84, 20.23%) and central line for more than four days (71.42%). This difference was statistically significant for patients with peripheral lines ($P=0.0005$) but it was not significant with the central line. *E. coli* (35.29%) was the most common organism isolated in patients with BSI followed by staphylococcus and klebsiella which were seen with equal frequency (20.59%). *Candida* was also isolated from one patient.

2. Urinary Tract Infections

In the present study, UTI was more common

in catheterized children (51.11%). The calculated relative risk of capturing UTI was 107 with a 95% Confidence Interval of 14.871 to 774.71. The risk of contracting UTI increased immensely when a child had to be catheterized for more than five days (80% vs. 15%). The difference in UTI rate among children with less than five days and more than five days of catheterization was statistically significant. ($P<0.0001$). A total of 226 days of catheters gave a UTI rate of 101.7/1000 catheter days. 21 of the 24 children diagnosed with UTI were urine culture positive and three had catheter tip culture-positive but urine culture negative. 11 also had catheter tip culture positive. *E. coli* was the most common organism isolated that was responsible for 12/24 cases. *Candida* was seen in two cases.

3. Nosocomial Pneumonia

In the present study, VAP (50%) was more common than hospital-acquired pneumonia (HAP), this difference was highly significant statistically ($P<0.0001$). There were two children with early-onset VAP. The remaining 9 cases were of late-onset VAP, five of whom developed VAP after 6 days of ventilation (5/8, 62.5%). Total ventilator days among 22 children were 125 days giving a VAP rate of 88 per 1000 ventilator days. Organism grown from endotracheal aspirate showed the presence of pseudomonas in six (50%) and acinetobacter in three (25%) cases.

4. Nosocomial SSI

It was found that a small number of surgical cases ($n=12$) admitted showed no difference in nosocomial infections rate between elective and emergency surgery cases. There were a total of 6 cases of surgical site infections out of which 1 patient had both surgical site infection as well as BSI. Total 3 babies (out of 6) belonged to the age group <2 months (11.53%) as compared to older children (>2 months) incidence being 6.66% which was not statistically significant. All cases developed SSI between 3rd and 5th day. Coagulase +ve and Coagulase -ve Staphylococci accounted for the majority of (5/6) cases while one child had a pseudomonas infection.

The outcome of children with nosocomial infections was studied in terms of length of stay in PICU and mortality in them. The length of stay of all children admitted to PICU was 1786 days with an average duration of stay as 5.28 days. In children with NI the overall length of stay was 589 days with an average of 7.95 days compared to 4.63 days

in children without NI. This indicates that children who suffered from NI had a increased duration of stay in PICU leading to increased morbidity and the chances of acquiring nosocomial infection.

For BSI with peripheral catheter, average duration of stay was 7.53 days compared to 4.65 days in those without BSI. Length of stay in PICU almost increased to twice in children with nosocomial UTI, VAP and SSL. (Avg. days, 7.21 vs. 3.95, 10.41 vs. 5.60 and 6.83 vs. 3.30 respectively).

Mortality in patients with NIs was 6.75% (5/74) and that without NIs was 11.60% (21/160) which was not significant (P value 0.3511).

DISCUSSION

Age Distribution

In Delgado-Rodriguez et al,⁸ maximum patients (n=31) were less than 1 month old (32.63%) followed by patients between one month and one year (n = 23). These observations are the same as in the present study. In Mumbai study of Deep et al⁵ maximum patients (n = 31) were less than 1 month old (32.63%) followed by patients between one month to one year (n = 23).

Gender Distribution of Nosocomial Infections

In this study, the frequency of NIs in males was higher compared to females (ratio 1.8:1) but it was not significant. Similar observations were made by Freeman and Ganguly et al.^{9,10}

Distribution of NI Infection in Patients with Altered Immune Status

The steroid group had an incidence of 70% NIs whereas it was 77.77% in the congenital anomalies group and 42.5% in malnourished children and all three parameters were found to be statistically significant. In Deep et al study 56.2% of malnourished patients developed a nosocomial infection while 52.8% of normally nourished developed NI (P<0.05). Maximum patients who developed NI were in grade IV malnutrition of IAP classification in their study. In this study, most of the patients were from Grade III to Grade IV category (74/127, 58.26%), Grade III being the commonest (50%, 21/42). Malnourished children had a higher incidence of NI which corroborated with the study by Isaack et al,¹¹ HIV and prolonged steroid treatment in children had significantly reduced immunity which is a major risk factor for acquisition of nosocomial infections. This factor

was corroborated by Donowitz et al.¹²

A total of 684 samples were analyzed. Samples were blood cultures, peripheral lines, CVP lines, urine, Foley's catheters, ET/TT aspirates, ET/TT. Ninety three samples (13.59%) showed growth as shown in Table 1. The growth rate from samples in Deep et al⁵ study from Mumbai was 40.26%. This difference was because samples were from suspected children only in the Mumbai study; routine sampling was done in the present study.

E. coli was the most common pathogen (32%) followed by klebsiella in 18.67%. In Deep et al⁵, Klebsiella was the most common pathogen (33.3%) followed by *E. coli* in 16.7%.

E. coli isolated in our study were found to be more sensitive to amikacin (54.16%) followed by cefotaxime (41.66%) and ceftriaxone (37.5%). Sensitivity pattern of amikacin to *E. coli* in a study by Deep et al⁵ showed that out of 20 isolates of *E. coli*, 11 were sensitive to amikacin (55%).

BLOOD STREAM INFECTIONS

In present study, incidence is 45.96% (34/74) of all NIs which is somewhat similar to a study conducted in Egypt in 2004 of Dennis C et al.¹³ The significance of age as a risk factor was discussed in a large study by Michael J et al.³ He told that primary bloodstream infections were reported more frequently in infants of 2 months or less as compared with older children (386/1145 [33.7%] vs. 1352/5145 [26.3%], P<.001). Similarly present study showed the incidence of BSI in age <2 months as statistically significant. (P = 0.0001)

Observations from the present study showed a much higher frequency of bacteraemia than colonization. In Mumbai study of Deep et al⁵, maximum colonization was (32.63%) and definite bacteraemia (60%) was seen when an IV catheter was left in place for more than 72 hours. In the present study, this duration was found to be 96 hrs for central line catheters and 120 hrs for peripheral catheters.

The present study showed a higher number of BSI in relation to peripheral line catheters as the number of central line catheters inserted was very small (during the study period). However, the incidence of BSI in children with central line catheters was much higher (66.67%) compared to peripheral line catheters (10.69%). Same findings observed in line with the study of Darbyshire et al¹⁴ and Narendaran et al.¹⁵

Duration of catheterization was found to be an important risk factor for vascular access infections as shown by Tacconelli E et al.¹⁶ In our study, we found a cut off time limit for the development of BSI with the central line as 96 hrs.

DISTRIBUTION OF BACTERAEMIA

In the present study, Gram-negative organisms were more common compared to Gram-positive organisms (21 and 11 respectively) in patients with BSI. E-coli predominates (12/21,) among Gram-negative organisms. Study from PGI Chandigarh of Lakshmi KS¹⁷ also found that predominant isolates were Gram-negative (53.5%), but had Klebsiella pneumoniae (n=21) as the commonest isolate. Staphylococcus aureus (n=18) was the most common Gram-positive organism.

Nosocomial UTI

Thus 51.11% of patients with a urinary catheter in situ had an infection and statistically, it was found to be significant. In a study by Lohr et al¹⁸, 92% of nosocomial urinary tract infections in the PICU occurred in catheterized patients.

Our study showed the incidence of colonization of catheter tip to be 33.33% (15/45) and the incidence of bacteriuria [urine culture collected through the catheter to be 46.66% (21/45)]. Colonization and/or bacteriuria (i.e., UCRI) was seen in 24/45 (53.3%). In contrast to the results of the present study and the above-mentioned ones, Tullu MS¹⁹ showed the incidence of colonization of catheter tip to be higher (41.18%) than bacteriuria (19.61%). Colonization and/or bacteriuria (i.e., UCRI) was seen in 47.06% of cases. The present study showed that the risk of contracting UTI increased immensely when a child had to be with a catheter for more than five days. This is comparable to the study at Nair Hospital Mumbai Deep et al.⁵

E. coli was the commonest organism isolated in UCRI in our study (12/24, 50%). This observation is similar to that by Schaeffer et al.²⁰

Nosocomial Pneumonia

In our study, 36.36% developed nosocomial pneumonia. In Patra et al study²¹, the incidence was 30.5%. Data were analyzed using the "Chi-Square method." It was found to be statistically significant. Our data suggest that increasing lengths of endotracheal intubation had a high rate of acquisition of NP.

In a study by Patra,²¹ mean duration of intubation (days) \pm SD was 16.4 ± 13.9 in patients with pneumonia compared to 12.1 ± 6.3 in patients without pneumonia while in the present study average duration of intubation in children with pneumonia was 7.66 days compared to 3.3 days in children without pneumonia.

The incidence of NP was 23% in colonized as against 3% in non-colonized patients. The study by Patra et al²¹ also showed Gram-negative microbes (acinetobacter) to be the commonest cause for NP.

Surgical Site Infections

All cases that developed SSI were developed between the 3rd and 5th day. Coagulase +ve and Coagulase-vestaphylococci accounted for the majority (5/6) of cases. One child had a pseudomonas infection.

This indicates that children who suffered from NI had a duration of stay in PICU lengthened leading to increased morbidity and the chances of acquiring nosocomial infection. A study done by Delagado et al⁸ and Singh, et al.²² had showed the mean duration of stay to be longer in patients with NI (9.8 vs. 1.8 days).

Mortality in patients in ICU strongly correlates with nosocomial infections. However, in the present study, out of 5 patients 3 patients had congenital anomalies. Thus 60% of the 5 patients who expired were critically ill most probably due to underlying illness (congenital anomaly) with shock, hemodynamic instability etc. In these cases, whether the underlying condition or NI was responsible for the death was difficult to ascertain. Tullu, et al²³ reported the mortality rate as 20% while CDC2 gave the mortality figure as 13%.

CONCLUSIONS

The risk of nosocomial infection was directly related to the duration of stay in the PICU and the duration of placement of indwelling catheters /tubes. Age and sex were the important independent risk factors for causing NIs as the incidence of NIs was more in the younger infants and BSI occurred more commonly in males while UTI in females. Other risk factors like malnutrition and immunocompromised status and underlying illness were also associated with NIs. The most common organism sent from various samples was *E-coli* (sensitive to amikacin) followed by klebsiella, maximum sensitivity to piperacillin-tazobactam.

Length of stay in PICU almost increased to twice in children with nosocomial UTI, VAP and SSI. There was no statistical difference between mortality in children due to NI and in those without NI.

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Conflict of Interest: None declared.

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