International Journal of Contemporary Pediatrics
Patel BG et al. Int J Contemp Pediatr. 2025 Feb;12(2):209-214
http://www.ijpediatrics.com
pISSN 2349-3283 | eISSN 2349-3291
DOI: https://dx.doi.org/10.18203/2349-3291.ijcp20250086

Original Research Article

A study on hospital acquired infections in paediatric patients admitted in paediatric intensive care unit of a tertiary care hospital of central Gujarat

Bhargav G. Patel*, Rinki H. Shah, Maitri Patel

Department of Pediatrics, Medical College and SSG Hospital, Baroda, Gujarat, India

Received: 23 December 2024
Revised: 14 January 2025
Accepted: 21 January 2025

***Correspondence:**
Dr. Bhargav G. Patel,
E-mail: bhargavpatel381@gmail.com

ABSTRACT

Background: Nosocomial infections (NIs) are a significant concern in healthcare settings, leading to increased mortality and costs. This study aimed to determine the prevalence of NIs in a paediatric intensive care units (ICU) in India.
Methods: A prospective, observational study was conducted over one year in a paediatric ICU. Routine investigations, including blood culture, urine examination, and chest X-ray, were performed.
Results: Nosocomial bloodstream infections (BSIs) and urinary tract infections (UTIs) were the most common NIs. *Pseudomonas* and *Klebsiella* were the predominant organisms isolated from blood and ET secretion cultures. Severe anemia and severe acute malnutrition were significant co-morbidities contributing to mortality.
Conclusions: The study highlights the need for effective infection control measures and antibiotic stewardship in paediatric ICUs. Administering sensitive antibiotics based on geographical bacteriological profiles can improve outcomes and prevent antibiotic resistance.

Keywords: Nosocomial infections, PICU, Pseudomonas

INTRODUCTION

Hospital acquired infections (HAIs) is an infection occurring in a patient in a hospital or other health care facility in whom the infection was not present or incubating at the time of admission. This also includes infections acquired in the hospital but appearing after discharge.[1] The most frequent NIs are infections of blood stream infections, surgical wounds, UTIs and lower respiratory tract infections.

The WHO study and others have also shown that the highest prevalence of NIs occurs in ICUs. Critical care patients are the sickest and subjected to the most invasive support and monitoring equipment and given more antibiotic therapy during their hospitalization. These factors increase the risk of acquiring HAI.[2]

The patients were suspected to have developed NIs after 48 hours of admission to PICU if they had following features: a) unexplained fever >38 degree Celsius, leucocytosis >10,000/cu. mm, b) new or persistent infiltrates on chest X-ray, c) Turbid urine, suprapubic tenderness, dysuria and/or, d) lab evidence of infection in the form of positive cultures from blood or catheter *in situ*.

According to national NIs surveillance (NNIS) updates, the rate of NI per 1,000 patient days has increased 36%, from 7.2 in 1975 to 9.8 in 1995. It is estimated that in 1995, NI contributed to more than 88,000 deaths-one death every 6 minutes.[3]

With this perspective in consideration, this study was conducted to identify the risk factors and common

microbial agents causing HAI and the sensitivity pattern of bacteria of HAI in admitted cases in tertiary care hospital in Vadodara.

METHODS

The present study was a prospective and observational study conducted over one year between March 2022 to December 2022 in the paediatric intensive care unit at Baroda medical college and SSG hospital Vadodara, Gujarat, India after taking approval from the institutional ethics committee on human research (IECHR), Baroda medical college, S. S. G. hospital, Vadodara (No. IECBHR/095-2022). A total of 300 critically ill patients were enrolled during the study period. Patients fulfilling the inclusion criteria were included.

Inclusion criteria were-all children aged 1 month to 12 years admitted in PICU. After the admission of a child, detailed history was taken from the parents. Anthropometric measurements were recorded in each case; which were then used to diagnose severe acute malnutrition and/or moderate acute malnutrition by using WHO criteria. A thorough clinical examination was done including the general condition of the patient at the time of admission, vital signs including axillary temperature, pulse rate, respiratory rate and blood pressure were noted. SpO_2 was taken in all patients with pulse oximeter without oxygen support to note hypoxia. A blood sample was drawn by venepuncture for routine investigations. Endotracheal swab for culture and sensitivity was collected in intubated patients who required mechanical ventilation.

Chest X-ray was done to examine the site, type, and associated complications. Blood culture was collected from a vein under strict aseptic measures using povidone-iodine, rectified spirit for skin sterilization in each patient. About 5 ml of blood was collected in BD BACTEC culture vial before administration of parenteral antibiotic.

Urine culture was also sent aseptically.

Exclusion criteria in current study were Children admitted with infections, pneumonia etc. Children admitted in ward without P.I.C.U. exposure. Children having P.I.C.U. stay for<48 hours. Children having same species infection even after 48 hours of P.I.C.U stay, newborn (less than 1 month of age).

Patients in ICU were examined by physicians on duty, and general data collection (in form of gender, age, referral place), clinical profile (like medical, surgical, trauma), and patients' status on admission (like presence of infection, antibiotics at the time of admission, history of surgical operation) were examined, and then risk factors during stay in a PICU, infection diagnosed during hospital stay, it's treatment and outcome (discharge or death) were recorded daily.

Statistical analysis

Data analysis and chart preparation were done using the software MedCalc 12.5 and Microsoft excel. Values for continuous data were presented as mean±SD. The results were analyzed using the chi square test. P value was calculated for risk factors. A statistical significance was considered at $p<0.05$.

RESULTS

Out of 300 patients 21.33% (64) were from less than 6 months of age, 59.67% (179) were from 6 months to 6 years of age and 19% (57) were from above 6 years of age group. Among them 178 (59%) were male and 122 (41%) were female. Majority of them coming from Rural background followed by urban and tribal constituting 67% (201), 25% (75) and 8% (24) respectively.

Association of nutritional status and hospital acquired infection among 6 months to 6 years shows maximum (43) infection were seen among severe acute malnutrition patients, followed by moderate acute malnutrition (25) and least among normal patients (15). Incidence of developing HAIs were more in malnourished as compared to healthy population ($p<0.05$) (Table 1).

Association of nutritional status and hospital acquired infection among 6 years and above shows maximum (66) infection were seen among Underweight patients, followed by normal (15). There was no overweight child mong HAIs. Development of various HAIs was more common in underweight children compared to well-nourished children ($p<0.05$) (Table 2).

Mean duration of hospital stay for patients with NIs compared to those without infections. Patients with infections (n=106) had a significantly longer average hospital stay (mean=18.69 days, SD=16.68) compared to non-infected patients (n=194), who had a mean stay of 13.03 days (SD=6.34). The difference in mean duration between the two groups is statistically significant, with a $p<0.0001$, indicating a strong association between NIs and prolonged hospital stay (Table 3).

Predominant isolates in BSI from peripherally inserted cannulas in our study were gram negative (57.69%); Pseudomonas being the commonest (26.92%) followed by *Klebsiella*. CONS was the most common gram-positive organism (31%) followed by *Enterococcus* (5.77%) (Figure 1). Gram negative bacteria were sensitive to Piptaz and polymyxin B like antibiotics whereas gram positive bacteria were sensitive to Vancomycin (Table 4).

In comparison to non-catheterized 4.8% (8 out of 165) patients, catheterized 14.8% (20 out of 135) patients developed UTI which was statistically significant ($p=0.005$). The average duration of stay in patients with UTI was 23.5 days whereas in patients without UTI was

13.77 days. Thus, in our research, it was found that UTI increases the average duration of hospital stay (p<0.0001) (Table 5).

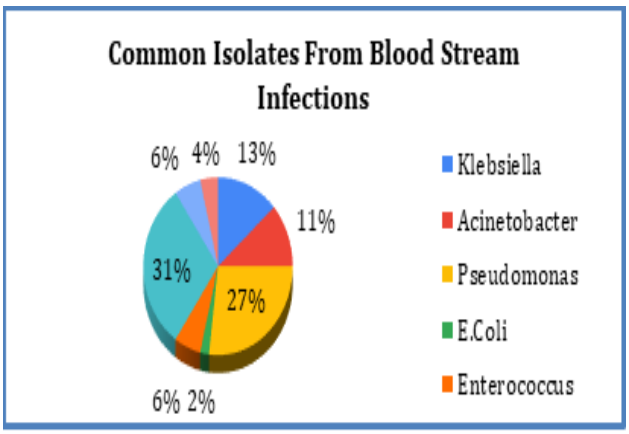

Figure 1: Common isolates from blood stream infections.

Urine culture and sensitivity report shows many first line antibiotics resistance (Table 6). Gram-negative *E. coli* (50%), *Klebsiella* (17.86%), *Pseudomonas* (7.14%), *Proteus* (7.14%), and *Acinetobacter* (3.57%) were the predominant isolates in our study. In gram-positive CONS and *Enterococcus* (3.57%) were the common isolates. fungal UTI was also seen in 2 patients (Figure 2).

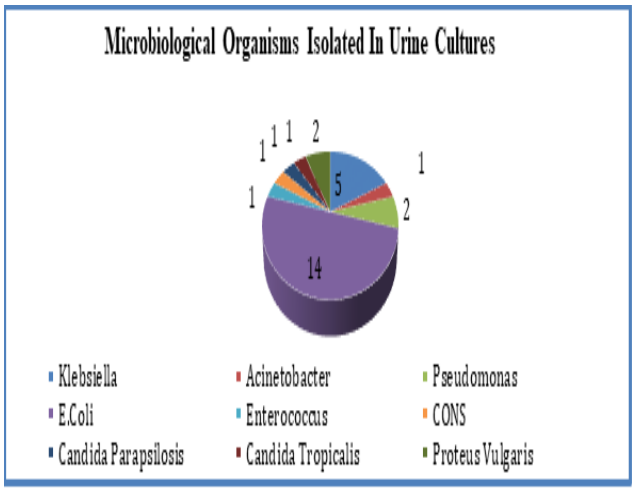

Figure 2: Common organisms isolated in urine culture.

Table 1: Nutritional assessment in patients and association with HAI among 6 months to 6 years age group.

Nutritional assessment	VAP	BSI	UTI	SSI
Normal	3 (1%)	10 (3.33%)	2 (0.67%)	0 (0%)
MAM	2 (0.67%)	17 (5.67%)	5 (1.67%)	1 (0.33%)
SAM	7 (2.33%)	24 (8%)	10 (3.33%)	2 (0.67%)
Total	12 (4%)	51 (17%)	17 (5.67%)	3 (1%)

Table 2: Nutritional assessment in patients and association with HAI among 6 years and above age group.

BMI (kg/m^2)	VAP	BSI	UTI	SSI
Normal	3 (1%)	10 (3.33%)	2 (0.67%)	0 (0%)
Underweight	8 (2.67%)	40 (13.33%)	15 (5%)	3 (1%)
Overweight	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Total	11 (3.67%)	50 (16.67%)	17 (5.67%)	3 (1%)

Table 3: Mean duration of hospital stays in patients with NIs versus non infection.

Variables	Total	Mean	SD	P value
Infection	106	18.69	16.68	<0.0001
Non-infection	194	13.03	6.34	

Table 4: Organisms isolated in blood cultures and their sensitivity patterns.

Organism	Most sensitive antibiotic	Resistance pattern
Pseudomonas	Polymyxin B> amikacin >piptaz>ceftazidime/clavulinic acid	Cefepime, gentamycin
Klebsiella	Piptaz=meropenem>amikacin=polymyxin B	Ampicillin, levofloxacin, ceftriaxone, ceftazidime
Acinetobacter	Polymyxin B>gentamycin=piptaz> meropenem	Levofloxacin, doxycycline
E. coli	Vancomycin>penicillin>doxycycline>ampicillin	Ceftriaxone, ceftazidime, ampicillin
Cons	Doxycyclin>vancomycin=linezolid vancomycin>ceftazidime/ clavulinic acid>gentamycin=imipenem	Penicillin G, erythromycin, co-trimoxazole
Enterococcus	Doxycyclin>vancomycin=linezolid	Levofloxacin, gentamycin

Continued.

Organism	Most sensitive antibiotic	Resistance pattern
Candida	Fluconazole>voriconazole	Nystatin
Burkholderia	Co-trimoxazole	Meropenem, ceftriaxone

Table 5: Association of catheterisation with urinary tract infection.

Catheterised	Total cases	UTI detected	Percentage (%)
Yes	135	20	14.8
No	165	8	4.8
Total	300	28	-
Patients		**Mean duration of stay**	
With UTI		23.50 days	
Without UTI		13.77 days	

Table 6: Organisms isolated from urine culture and their sensitivity patterns.

Organism	Most sensitive antibiotic	Resistance pattern
E. coli	Nitrofurantoin>fosfomycin=vancomycin=linezolid	Ceftriaxone, ceftazidime, ampicillin
Klebsiella	Co-trimoxazole>polymyxin B=piptaz=meropenem=ceftriaxone=levofloxacin=fosfomycin	Ampicillin, doxycycline
Pseudomonas	Amikacin>gentamycin=levofloxacin=imipenem=ceftazidime	Cefepime, amikacin
Acinetobacter	Ceftazidime	Levofloxacin, doxycycline
Proteus	Nitrofurantoin=fosfomycin	Ceftriaxone, meropenem
Enterococcus	Linezolid=vancomycin	Gentamycin, doxycycline
Cons	Linezolid=vancomycin	Penicillin G, erythromycin
Candida	Fluconazole>voriconazole	Clotrimzole, ketoconazole

DISCUSSION

HAIs remain a leading cause of morbidity and prolonged hospital stays among paediatric populations, despite advancements in infection control measures, improved nutritional interventions, and enhanced healthcare access. Malnutrition, invasive procedures such as catheterization, and other comorbidities have emerged as key contributors to the increased susceptibility to HAIs in children. The growing prevalence of antimicrobial-resistant pathogens further complicates the management of HAIs. Factors such as the inappropriate and excessive use of antibiotics, coupled with the lack of stringent antibiotic stewardship programs, have facilitated the emergence of resistant bacterial strains. Moreover, increased mobility through regional and international travel has contributed to the dissemination of resistant organisms across geographical boundaries.[4]

In our study, the incidence rate of HAIs was observed to be 35.3%, indicating a substantial burden of these infections in the paediatric population. Comparatively, a study conducted by Akash et al at TNMC, Mumbai, reported a slightly lower incidence rate of 27.3%.[5] This difference could reflect variations in study settings, healthcare practices, or patient profiles over time.

In our study 300 patients were enrolled, total 59% of children aged 6 to 60 months were found to be malnourished, with 16.82% categorized as moderately malnourished and 41.82% as severely malnourished. This age group represents a crucial period for transitioning to complementary feeding, where delays or inadequacies in the initiation or quality of complementary foods play a significant role in the high prevalence of malnutrition. Association was found to be significant ($p<0.05$). Similar findings were seen in study done in Croatia in 2014-15 found that on hospital admission overall 47 patients (12.8%) were malnourished; moderate malnutrition (BMI-2 to -3 SDS) was present in 8.7% patients, severe malnutrition (BMI<-2 SDS). Altogether 21 children (5.7%) experienced nosocomial infection. Malnourished patients acquired NIs significantly more often in comparison to well-nourished patients (11/47 (23.4%) vs. 11/318 (3.5%), respectively; $p<0.001$).[6]

BSIs were the most common nosocomial infection (27%), followed by UTIs (9.3%), ventilator-associated pneumonia (VAP) (5.6%), and surgical site infections (SSI) (2.6%). Similarly, a study by Michael et al conducted in six paediatric ICUs (PICUs) across U. S. hospitals also identified BSIs as the most frequent, followed by pneumonia and UTIs, highlighting consistent trends in HAIs.[7]

The average hospital stays for patients with HAIs in current study was 18.69 days (SD±16.68), notably longer than the 13.03 days (SD±6.34) observed in patients without HAIs. Comparatively, a study by Maria et al conducted in Lima, Peru, in 2010 reported an even higher mean hospital stay of 23 days for patients with NIs, emphasizing the consistent impact of such infections on prolonged hospitalization across settings.[8] Thus, our study shows that length of stay in patients with NIs is significantly higher than in patients without Nis ($p<0.0001$).

Microbiological profile of BSI shows predominant Gram-negative bacteria followed by Gram positive bacteria. Similar results were also found in study conducted by Lakshmi et al PGI, Chandigarh with microbiological profile showing PICU BSIs reported predominant isolates as Gram-negative (53.5%). *Klebsiella pneumonia* being the commonest.[9] In contrast to present findings Elward et al conducted a study at St. Louis children's hospital, USA, in 2000 reported Coagulase-negative *Staphylococcus* organisms as the leading cause (28 out of 57 patients) of BSI followed by *Enterobacter cloacae* (8 out of 57).[10]

Our result shows catheterization as one of possible associated factor for developing UTI among paediatric age group. Catheterisation as a risk factor has also been shown by Ahmed et al (Alexandria, 2005) and Nanda et al (AIIMS, India 2001).[11,12] Urine culture and sensitivity report shows fungal agent along with gram positive as well as Gram negative bacteria, which was not common finding. Singhi et al in a study of 69 patients in PICU reported Candida (52.1%) and *Enterococcus* (13%) as the commonest followed by *E. coli* (11.6%) and *Klebsiella* (10.1%).[13,14] According to Tullu et al showed in a study the commonest organisms isolated in UTI with catheter in situ in PICU patients over a period of 6 months at Seth GS hospital, KEM hospital, Mumbai, were *E.* coli (64.29%), *Pseudomonas* (14.29%), *Proteus* (7.14%), *Citrobacter* (7.14%) and *Klebsiella* (7.14%) with maximum sensitivity of *E. coli* to nitrofurantoin and maximum sensitivity of Pseudomonas to Amikacin which coincides with our study. Shalini et al in her study to determine the microbiological profile of PICUs showed *Klebsiella* pneumonia as the most common pathogen (38.41%), followed by *Staphylococcus aureus* (23.37%) with maximum sensitivity of *Klebsiella* to imipenem and amikacin.[15] Staph aureus isolates were mostly sensitivity to vancomycin and *Pseudomonas* had the maximum sensitivity to imipenem and ceftazidime.

Limitations

This study has several limitations. Being a single-center study, the findings may not be generalizable to other settings. Potential observer bias during daily assessments, the absence of data on socioeconomic status or comorbidities, and limited use of advanced diagnostics restrict a comprehensive understanding of risk factors. Additionally, seasonal variations in infection patterns were not considered, and the lack of post-discharge follow-up data may have missed late-onset HAIs or related complications.

CONCLUSION

The study highlights a significant burden of HAIs in the pediatric population. Malnourished children, particularly those with severe acute malnutrition, exhibited higher susceptibility to HAIs, emphasizing the role of nutritional status. BSIs were the most common, predominantly caused by gram-negative bacteria like *Pseudomonas* and *Klebsiella*. Catheterization increased the risk of UTIs, further prolonging hospital stays. The findings underscore the critical need for improved nutritional interventions, stringent infection control measures, and antibiotic stewardship programs to mitigate HAIs and reduce healthcare costs and morbidity.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Prevention of hospital acquired infections. A practical guide, 2nd edition, World Health Organization, Department of Communicable Disease, Surveillance and Response. Available at: whocdscsreph200212.pdf). Accessed on 12 December 2024.
2. Donowitz LG. High risk of nosocomial infection in the paediatric critical care patient. Crit Care Med. 1986;14(1):26-8.
3. Wattal C, Oberoi JK. Infections in Paediatric Intensive Care Units (PICU). Indian J Paediatr. 2012;79(5):647-9.
4. Laxminarayan R, Chaudhury RR. Antibiotic resistance in India: drivers and opportunities for action. PLoS Med. 2016;13:e1001974.
5. Deep A, Ghildiyal R, Kandian S, Shinkre N. Clinical and microbiological profile of nosocomial infections in the paediatric intensive care unit (PICU). Indian Pediatr. 2004;41(12):1238-46.
6. Niseteo T, Hojsak I, Kolaček S. Malnourished children acquire nosocomial infections more often and have significantly increased length of hospital stay. Clin Nutrit. 2020;39(5):1560-3.
7. Richards MJ, Edwards JR, Culver DH, Gaynes RP. Nosocomial Infections in Paediatric Intensive Care Units in the United States. Paediatrics. 1999;103(4):e39-9.
8. Mello MJG, De Albuquerque MFPM, Lacerda HR, De Souza WV, Correia JB, De Britto MCA. Risk factors for healthcare-associated infection in paediatric intensive care units: a systematic review. Cad Saude Publica. 2009;25(3):S373-91.

9. Lakshmi KS, Jayashree M, Singhi S, Ray P. Study of Nosocomial Primary Bloodstream Infections in a Pediatric Intensive Care Unit. J Trop Pediatr. 2006;53(2):87-92.
10. Yogaraj JS, Elward AM, Fraser VJ. Rate, risk factors, and outcomes of nosocomial primary bloodstream infection in pediatric intensive care unit patients. Pediatrics. 2002;110(3):481-5.
11. El-Nawawy AA, Abd El-Fattah MM, Abd El-Raouf Metwally H, El Din Barakat SS, Abdel Rehim Hassan, I. One Year Study of Bacterial and Fungal Nosocomial Infections among Patients in Pediatric Intensive Care Unit (PICU) in Alexandria. J Trop Pediatr. 2006;52(3):185-91.
12. Lodha R, Natchu UC, Nanda M, Kabra SK. Nosocomial infections in pediatric intensive care units. Indian J Pediatr. 2001;68(11):1063-70.
13. Brindha SM, Jayashree M, Singhi S, Taneja N. Study of nosocomial urinary tract infections in a pediatric intensive care unit. J Trop Pediatr. 2011;57(5):357-62.
14. Tullu MS, Deshmukh CT, Baveja SM. Urinary catheter related nosocomial infections in paediatric intensive care unit. J Postgrad Med. 1998;44(2):35-9.
15. Shalini S, Kranthi K, Bhat KG. The microbiological profile of nosocomial infections in the intensive care unit. J Clin Diagnostic Res. 2010;4(5):3109-12.

Cite this article as: Patel BG, Shah RH, Patel M. A study on hospital acquired infections in paediatric patients admitted in paediatric intensive care unit of S. S. G. hospital, a tertiary care hospital of central Gujarat. Int J Contemp Pediatr 2025;12:209-14.