# Catheter related blood stream infections in the paediatric intensive care unit: A descriptive study

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**Abstract**

**Context:** Catheter related blood stream infections (CRBSI) contributes significantly to morbidity, mortality and costs in intensive care unit (ICU). The patient profile, infrastructure and resources in ICU are different in the developing world as compared to western countries. Studies regarding CRBSI from pediatric intensive care unit (PICU) are scanty in the Indian literature. **Aims:** To determine the frequency and risk factors of CRBSI in children admitted to PICU. **Settings and Design:** Descriptive study done in the PICU of a tertiary care teaching hospital over a period of four months. **Materials and Methods:** Study children were followed up from the time of catheterization till discharge. Their clinical and treatment details were recorded and blood culture was done every 72 h, starting at 48 h after catheterization. The adherence of doctors to Centre for Disease Control (CDC) guidelines for catheter insertion was assessed using a checklist. **Statistical Analysis:** Clinical parameters were compared between colonized and non-colonized subjects and between patients with and without CRBSI. Unpaired $t$-test and Chi-square test were used to test the significance of observed differences. **Results:** Out of the 41 children, 21 developed colonization of their central venous catheter (66.24/1000 catheter days), and two developed CRBSI (6.3/1000 catheter days). Infants had a higher risk for developing colonization ($P = 0.01$). There was 85% adherence to CDC guidelines for catheter insertion. **Conclusions:** The incidence of CRBSI and catheter colonization is high in our in spite of good catheter insertion practices. Hence further studies to establish the role of adherence to catheter maintenance practices in reducing risk of CRBSI is required. The role of a composite package of interventions including insertion and maintenance bundles specifically targeting infants needs to be studied to bring down the catheter colonization as well as CRBSI rates..

**Keywords:** Catheter related blood stream infections, nosocomial infections, pediatric intensive care unit

## Introduction

Catheter related blood stream infections (CRBSI) contributes significantly to increased morbidity, mortality and medical costs to hospitalized patients.[1,2] The incidence of CRBSI, in pediatric intensive care units (PICUs) ranges between 5.3 and and 8.64 episodes/1000 catheter days.[3-5] Along with the illness and immune status of the patient, catheter insertion and maintenance practices followed by the health care providers also contribute to the causation of CRBSI. Studies regarding the incidence and risk factors of CRBSI are scanty in the Indian literature, especially in the PICU setting. We, therefore, did a prospective study on CRBSI in our PICU, studying the frequency and risk factors associated with it and assessing the adherence of health care providers to Centre for Disease Control (CDC) guidelines for catheter insertion.

## Materials and Methods

This prospective observational study was done in the

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PICU of a tertiary care teaching hospital in Pondicherry over a period of 2 months, May-June 2012, after approval by the institute ethics committee. All children aged 1 month to 12 years admitted in PICU in whom a central venous or arterial catheter was inserted were included in the study. Patients in whom intravascular catheter was removed within 48 h and patients who expired or were transferred out from PICU within 48 h of insertion of catheter were excluded. Informed consent was obtained from parents or legal guardians of included subjects. A study proforma was made in which demographic details, clinical details and relevant parameters of included children were recorded. In such children, 48 h after catheter insertion and subsequently every 72 h, blood samples (amounting to 1 ml each) were collected from the catheters and sent for bacterial culture.

In the presence of a positive blood culture from the catheter sample and/or clinical signs of infection such as fever, leukocytosis, hypotension or chills, two samples were taken simultaneously from the catheter and peripheral vein and sent for microbiologic culture. Based on the culture results, a diagnosis of catheter colonization or CRBSI was made. When the catheter sample and the peripheral blood sample grew the same organism, with clinical signs of infection in the patient and in the absence of another known focus of infection, CRBSI was established. If only the catheter sample grew an organism, it was considered as a catheter colonization. A questionnaire was used to assess the adherence of health-care providers, specifically resident doctors to the standard guidelines for prevention of catheter related infections as set down by the CDC and Healthcare Infection Control Practices Advisory Committee.[6] During the study period, the doctors who inserted catheters in patients were asked to fill up the questionnaire. A doctor who had performed independently more than 10 similar central venous catheter (CVC) insertions in the past was defined as an "experienced doctor." Clinical parameters were compared between colonized and non-colonized subjects and between patients with CRBSI and colonizers without CRBSI.

All statistical tests were carried out using GraphPad Prism6 (GraphPad Inc., San diego, California, USA) software. Unpaired $t$-test (continuous variables) and Chi-square test (discrete variables) were used to test the significance of observed differences. $P$ value of less than 0.05 was considered significant.

## Results

Among 57 children admitted in the PICU during the study period, 41 children with a central vascular catheter were included in the study. Twenty three children (56.1%) were less than 1 year of age. Children in the age groups 1-3 years, 4-6 years and 6-12 years constituted 19.5%, 4.9% and 19.5% of the study population respectively. Among the study children, 76% were boys and 24% girls. Out of them 24 children (58.5%) were admitted with an infectious illness. None of the patients had any underlying condition causing immunosuppression at the time of admission [Table 1].

Twenty one children developed colonization and two out of them developed CRBSI, leading to a colonization rate of 66.24/1000 catheter days and a CRBSI rate of 6.3/1000 catheter days. The overall mortality rate in the study patients was 19.5%. Infants less than 12 months of age formed 76.2% of the children who developed colonization. Compared to older children, infants showed a significantly higher rate of catheter colonization ($P = 0.01$).

In the colonized group, 19 children (90.5%) had undergone catheterization in the femoral vein and two children (9.5%) in the subclavian vein (Table: 2). In the non-colonized group, 16 children (80%) had femoral vein catheterization against 4 (20%) with a non-femoral catheter. All the patients in the non-colonized group received broad spectrum antibiotics for their primary clinical illness before or during the days after catheter insertion. All, but one patient received antibiotics in the colonized group and this patient went on to develop CRBSI. Overall, 97.5% of the patients received broad spectrum antibiotics as part of the medical treatment for their primary illness. While all the children in the non-colonized group received antibiotics for the mean duration of 170 h, 95% among the colonized group had received drugs for a mean 141 h. In both groups, 3rd generation cephalosporins were used more often, 11 children (52.3%) in colonized and 14 (70%) in non-colonized, followed by ciprofloxacin (23.8%), meropenem (14.3%) and doxycycline (4.7%). In the CRBSI patients ($n = 2$), only one had received broad spectrum antibiotics while all the children in the non-CRBSI group had concurrent antibiotic therapy.

### Table 1: Primary diagnoses among the study children

| Diagnostic categories | No. of cases (%) |
| --- | --- |
| Septic shock | 10 (24.3) |
| Intracranial infection | 7 (17.1) |
| Respiratory failure | 7 (17.1) |
| Cardiogenic shock/CCF | 5 (12.2) |
| Hemolytic uremic syndrome | 3 (7.3) |
| Intracranial bleed | 3 (7.3) |
| Others | 6 (14.6) |
| Total | 41 (100) |

CCF: Congestive cardiac failure

**Table 2: Comparison of factors contributing to CVC colonisation**

| Contributing factors | Colonised (N=21) | | Non colonized (N=20) | | P value |
|---|---|---|---|---|---|
| | Number | Percentage | Number | Percentage | |
| Malnutrition* | 12 | 57.1 | 16 | 80 | 0.2 |
| Primary clinical illness | | | | | |
|   Infectious | 15 | 71.4 | 9 | 45 | 0.16 |
|   Non-infectious | 6 | 28.6 | 11 | 55 | 0.16 |
| Site of catheterisation | | | | | |
|   Femoral vein | 19 | 90.5 | 16 | 80 | 0.6 |
|   Subclavian vein | 2 | 9.5 | 3 | 15 | 0.9 |
|   Others | - | - | 1 | 5 | 0.98 |
| Triple lumen catheters | 17 | 81 | 13 | 65 | 0.4 |
| Non-triple lumen catheters | 4 | 19 | 7 | 35 | 0.4 |
| Indication for catheterisation | | | | | |
|   In view of long PICU stay | 8 | 39 | 8 | 40 | 0.9 |
|   As infusion/drug delivery port | 11 | 52.4 | 10 | 50 | 0.87 |
|   CVP monitoring | 1 | 4.8 | 1 | 5 | 0.97 |
|   Repeated sampling | 1 | 4.8 | 1 | 5 | 0.97 |
| Concurrent antibiotic therapy | 20 | 95.2 | 20 | 100 | 0.3 |
| Blood transfusion | | | | | |
|   Fresh frozen plasma | 0 | - | 1 | 5 | 0.98 |
|   Packed cells | 4 | 19 | 1 | 5 | 0.4 |
|   Catheter days-median (range) | 7 (4-15) | | 5.5 (2-28) | | |

CVC: Central venous catheter; PICU: Pediatric intensive care unit; CVP: Central venous pressure; *:Defined as weight for age less than 3rd centile, P value not significant for any of the parameters tested

In the colonized group, 19.04% of patients received a transfusion of packed red cells via their central vascular catheter (Table: 2). In the non-colonized group, one patient each (10%) received a transfusion of fresh frozen plasma and packed red blood cells. However, there was no statistically significant association between transfusion of blood products and catheter colonization. 21% patients in the non-CRBSI group received a transfusion of packed red cells via their catheters while the CRBSI patients did not receive any.

The median number of days of admission in PICU with the central vascular catheter intact, i.e., catheter days varied between the two groups (Table: 2). While it was higher (7 days; range [4-15]) among the colonized group versus the non-colonized (5.5 days; range [2-28]), the observed difference did not achieve statistical significance. Only 31.7% of CVC insertions were done by experienced health care providers. In the colonized group, 38% of patients were catheterized by experienced health care providers while in the non-colonized group, it was only 25%; however, again the difference was not statistically significant. None of the catheter insertions were performed with ultrasound guidance. More than three unsuccessful punctures were done prior to successful catheterization in 47.6% of patients in the colonized group, 25% of the non-colonized patients. However, this could not be identified as a risk factor for colonization by statistical analysis. Adherence to CDC guidelines was 83% among the health care providers who performed the catheter insertion procedure.

Among the 21 children with colonized catheters, two developed CRBSI (6.3/1000 catheter days). Both of them were less than one year of age. They were malnourished (52.6% in the non-CRBSI group), both of them presented with an infectious illness while only 68.4% in non-CRBSI had a primary infectious illness. The CRBSI patients underwent catheterization at the femoral site (89.5% in non-CRBSI group) and had triple lumen catheters (79% in the non-CRBSI group).

A significant proportion of the CVC colonization (39.02%) occurred in the first 120 h (5 days) of catheterization, with 21.9% in first 48 h and another 18% in the subsequent 72 h [Figure1]. Most common organisms isolated were *Klebsiella pneumoniae* (19%) and coagulase negative *Staphylococci* (CONS) (19%), followed by *Pseudomonas spp* (14.3%), *Burkholderia cepacia* (14.3%) and *Acinetobacter baumannii* (14.3%). Of the two children who developed CRBSI, one was found to be due to *K. pneumoniae* and the other by *B. cepacia*.

## Discussion

Among the 57 children admitted in the paediatric ICU during the study period, forty one children with a central vascular catheter were studied. Among them, the rate of colonization was observed to be 66.24/1000 catheter days and CRBSI rate was 6.3/1000 catheter days. This was less than the rate of 8.6 CRBSIs per 1000 catheter days reported from Mumbai.[3] Our observation is also

comparable to reports from the USA showing a rate of 5.4 CRBSIs per 1000 catheter days.[7,8]

We observed that, among the colonized children, 76% were infants less than 12 months of age; while in the non-colonized group, only 35% were infants. This difference was found to be statistically significant (*P* = 0.01) showing that infants were at a higher risk of catheter colonisation. In an Indian study, neonates were shown to be more prone to CRBSI.[3] The immature immune system of infants and the technical difficulties in securing and maintaining catheters in them could be possible reasons for their increased propensity to CRBSI. It was also observed that infants were admitted most commonly with a primary infectious illness. This could also have a possible role in the increased rate of colonization observed in infants.

Among the children studied, more than two third (68.3%) were malnourished, i.e., weight for age less than third centile, both in the colonized as well as the non-colonized groups. According to National Family Health Survey-3, 40% of Indian children under the age of three are underweight, 45% are stunted and 23% are wasted.[9] Malnourished children are more likely to develop serious infections and require PICU care. In our study, both colonized and non-colonized groups showed a high rate of malnutrition, 57% and 80% respectively. But the difference observed was not statistically significant.

The most common site of catheter placement in our study children was the femoral vein (85.6%). Catheterization at the subclavian and jugular sites is less preferred in infants and children due to technical difficulties and higher incidence of complications.[10] Venkataraman *et al*. demonstrated that femoral catheters have a low incidence of mechanical complications and might have an equivalent infection rate to that of non-femoral catheters.[11] Similarly in our study population we did not observe any association between site of catheterization and colonization.

Among the 41 children studied, only 6 (14.6%) received transfusions of blood products via their central vascular catheters. Though a study in the United States[12] has associated a higher risk of microbial proliferation with transfusion of blood products, no such association was observed by us. This could be due to the fact that the number of transfusions in our study population was few.

In the study population, 40 (97.6%) children received broad spectrum antibiotics before or during the catheter
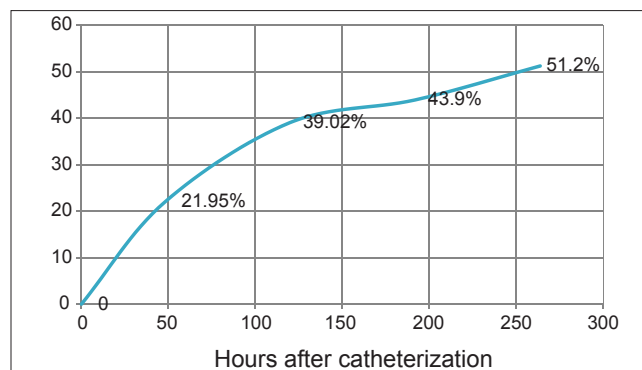


**Figure 1:** Cumulative frequency curve showing colonisation of catheters with time

days. Only one child did not receive antibiotics who went on to develop CRBSI. This data is insufficient to draw any conclusion about the role of broad spectrum antibiotics and CRBSI. Since broad spectrum antibiotic use in the ICUs has been associated with increased development of resistant organisms, the use of antibiotics for CRBSI prophylaxis is controversial.

We observed that the most common organisms isolated from the catheter colonized patients were *K. pneumoniae* (19%) and CONS (19%). Other common bacteria isolated were *Pseudomonas* spp (including *B. cepacia*) and *A. baumannii* and one sample grew *Candida Albicans*. Studies in the USA on adults have shown that CONS, followed by enterococci, were the most frequently isolated causes of CRBSI accounting for 37% and 12.6% respectively[13] An increasing percentage of *Enterobacteriaceae* particularly *K. pneumoniae* was also isolated.[14] Our observations are also similar.

We also observed that in our study children, out of the 21 children (51.2%) who got colonized, nine children (43%) were colonized within just 48 h of catheterization. The mean duration of catheterization in our study was 7.7 days. This points to the need for removal of catheters as early as possible once they are no longer required.

Among the health care providers at our PICU who performed CVC insertions, adherence to CDC guidelines for prevention of intravascular catheter related infections was found to be around 85%. Studies have shown that adherence to these guidelines can substantially reduce the incidence of CRBSI.[15] Since there was no significant difference in adherence between the colonized and non-colonized groups in our PICU, insertion practices were unlikely to be a risk factor for colonization in our study population.

Studies in the United Kingdom and United States have shown that utilization of maintenance care bundles and education of health care providers regarding the same can significantly reduce catheter colonization and CRBSIs.[16] The adherence to maintenance guidelines among the health care providers was not assessed in our study. Since the adherence to CDC guidelines for catheter insertion was observed to be high, the relatively high colonization rates that resulted could be due to poor adherence to maintenance practices. As this aspect was not studied, conclusive inference cannot be made.

## Conclusions

The incidence of CRBSI and catheter colonization is high in our setting in spite of good catheter insertion practices. Further research needs to be done to establish the role of adherence to maintenance practices in reducing risk of CRBSI in our population. In addition, the role of a composite package of interventions including insertion and maintenance bundles specifically targeting infants needs to be studied to bring down the catheter colonization as well as CRBSI rates significantly.

## Acknowledgments

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