Brief Reports

Infections Related to Vascular Catheters in a Pediatric Intensive Care Unit

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We determined the rate and risk factors for colonization of 103 peripheral intravenous catheter and 32 central venous catheters. 52.5% peripheral catheters had colonization. Common organisms isolated were Pseudomonas (33.3%) and coagulase negative Staphylococci (29.6%). Colonization was higher in catheters inserted in the lower limb. Overall 62.5% of the central catheters were colonized, chiefly by coagulase negative Staphylococci, Pseudomonas and Candida. All central catheters in place for more than 11 days were colonized. Subclavian vein catheters had a higher rate (68.2%) of colonization in comparison to femoral vein insertions (40%). We conclude that upper limb placements are preferable to lower limbs when using peripheral lines. Changing peripheral intravenous catheters every 48 hours and central venous catheters every 10 days may decrease the rate of colonization.

Key words: *Bacteremia, Colonization, Intravenous catheters.*

INTRAVENOUS (IV) access in the ICU setting is now routine for the administration of fluids, blood products, drugs, parenteral nutrition and hemodynamic monitoring. Unfortunately this puts the child at risk for iatrogenic infections, especially blood stream infections originating from colonization of the device. Vascular catheter associated bacteremia or candidemia is associated with an increased mortality and longer hospital stay(1). The infections associated with catheters occur either due to microbial colonization of the intracutaneous or intravascular portion of the device or due to contamination of the catheter hub or infusate administered through the catheter(2,3). Percutaneously inserted IV catheters are associated with a low rate of local infections and blood stream infections (BSI) are rare(4). Literature search reveals many adult studies addressing colonization and infections of central lines. This study was undertaken to address some unanswered questions pertaining to IV catheter use in children.

Subjects and Methods

Of 800 patients admitted to the Pediatric Intensive Care Unit (PICU) at this hospital between January 2001 and July 2002, 103 patients required peripheral IV catheters and 32 had central lines. Patients between the ages of 1 month and 14 years who required IV catheters for more than 12 hours were included. Patients who required repeat insertion of a

catheter or those with sepsis at admission (documented on blood culture) were excluded.

The objectives of the study were: (*i*) To assess the rate of colonization of IV catheters (peripheral and central); (*ii*) To study the pattern of colonization; (*iii*) To determine the association between the duration of device use and rate of colonization; (*iv*) To correlate between culture positivity of blood and device related organism; and (*v*) To compare the rate of colonization of catheters inserted in control situations (PICU or OT) and those inserted in non-control situations (emergency or general ward).

All devices were inserted by residents or nursing staff as per protocol. When the device had to be changed or was no longer required the device was withdrawn under aseptic conditions and the tip sent for semi-quantitative culture and sensitivity. A blood sample was cultured simultaneously.

Protocol for catheter insertion and subsequent care

Before insertion of the catheters, local cleaning was done with povidone iodine and a contact time of 1 minute allowed. The site was then cleaned with surgical spirit. The catheters were fixed with transparent occlusive dressing; no antiseptic ointment was applied at the site of insertion. The dressing was changed twice a week. If a complication occurred or the IV line was no longer required, the appearance of the insertion site was recorded and the skin around the catheter cleaned with 70% alcohol. Care was taken not to touch the skin while removing the catheters.

After removal the terminal 1-2 cm of the catheter was cut with a sterile blade and the sample sent immediately to the laboratory. The catheters were cultured using the semi-quantitative technique of Brun-Buisson, *et al.* (5), which did not require direct handling(6) and ensured recovery of organisms present both at the tip and within the lumen. The catheter was dipped in 1 mL of sterile water in a tube and vortexed for one minute. The suspension (0.1 mL) was plated over culture media, and the catheter tip immersed in Trypticase-soy broth.

Simultaneous blood cultures were collected after skin disinfection; 2-4 mL of blood was collected in a blood culture bottle. The plates and broths were incubated at 37ºC, and the number of colonies counted. Microorganisms were identified by Gram stain, standard biochemical reactions and commercial identifications systems. Susceptibility patterns of bacterial isolates were determined using standard disk diffusion testing.

A proforma was used to record all data which included baseline information, site of insertion, number of attempts made, location of placement, duration of use of the intravascular device, treatment with antibiotics, culture and sensitivity results and clinical features suggestive of nosocomial infections.

Statistical Methods

Student's '*t*' test was used for continuous variables and Chi square test for discrete variables; $P< 0.05$ was considered significant.

Positive tip culture (colonization) was defined as growth of any organism from the tip cultured, irrespective of the number of colonies isolated.

Significant catheter colonization was defined as a quantitative culture of catheter tip showing $>10^3$ cfu/mL.

Catheter related bacteremia was considered in patients who showed growth of the same microorganism from both the catheter tip and simultaneous peripheral venous blood, with accompanying clinical symptoms of infection and no other obvious source of infection.

Results

A total of 135 catheter insertions were studied and peripheral and central venous catheters analyzed separately.

Peripheral intravenous catheters

Summary of the findings is given in *Tables I and II*. Positive tip culture was found in 54 (52.5%) samples. Commonest colonization was with *Pseudomonas* (33.3%) and coagulase negative *Staphylococci* (29.6%).

Positive tip culture was found in 21 (51.2%) catheters in place for 48-96 hours and 23 (60.5%) catheters in place for more than 96 hours. After 48 hours, the rate of positive tip cultures was uniform. Fourteen (50%) IV lines inserted outside the PICU had a positive tip culture compared to 40 (53.3%) of those inserted in PICU. Of the catheters with positive tip culture, 21 (38.8%) were inserted at the first attempt and 33 (61.1%) after two or more attempts; this difference was not significant (P = 0.3).

Catheter related sepsis

Of the 54 patients with positive tip cultures, 19 had corresponding blood cultures positive. Only 7 patients had similar organisms grown from both the tip culture and simultaneous blood culture; 2 had clinical features of sepsis with no other infective source identified. Antibiotics were changed on the basis of the culture report in the latter. The relationship of significant catheter colonization on semiquantitative culture to catheter related bacteremia was not statistically significant (odds ratio = 0.8; 95% CI 0.39-2.01)

TABLE I– *Microorganisms associated with catheter colonization*

Organism	Central (n = 20)	Peripheral (n = 54)
Pseudomonas	5 (25)	18 (33.3)
Coagulase negative *Staphylococci*	8 (40)	16 (29.6)
Enterobacter sp	–	7 (13)
Escherichia coli	2 (10)	2 (3)
Multiple organisms	1 (5)	2 (3)
Skin commensals	–	3 (5)
Candida	4 (20)	–

Figures in parenthesis indicate percentages.

Central Venous Catheters

Coagulase negative *Staphylococci* were the commonest (40%) organisms isolated, with *Pseudomonas* in 25% and Candida in 20% *(Table I)*. The rate of positive tip culture did not alter with the number of attempts made at insertion (P = 0.8). All 14 catheters in place for more than 11 days had a positive tip culture.

Catheter related bacteremia

Nine (45%) had significant catheter colonization, 4 of these 9 patients had a catheter related bacteremia with *S. aureus* (odds ratio = 4.8; 95% CI 0.44-22). The sensitivity of significant catheter colonization to detect catheter related bacteremia was 80% and specificity was 54%.

Discussion

The rate of colonization of peripheral IV catheters in this study was 52.5%. Rates described in literature range from 3.8-57% (7, 8). Search of literature from India showed limited information on similar parameters.

Positive tip culture in central venous catheters was 62.5% which is higher than that in a recent study from India where a rate of 46.7% was found(9). A prospective study by Martin, *et al.* quotes a rate of 17.9%(10). Possible reasons for these differences in rates could be (*i*) the use of central catheters only for very sick children, (*ii*) three way connector attachments

TABLE II– *Risk Factors for Catheter Colonization.*

	Peripheral catheter				Central catheter		
	Catheters inserted (n = 103)	Catheter colonization (n = 54)	Significance		Catheters inserted (n = 32)	Catheter colonization (n = 20)	Significance
Duration of use							
12-48 hr	24	10 (41.6)		< 10 days	18 (56.2)	6 (33.3)	P = 0.2
48-96 hr	41	21 (51.2)	P = 0.4	>11 days	14 (43.8)	14 (100)	
>96 hr	38	23 (60.5)					
Location of placement							
PICU	75	40 (53.3)	RR = 1.17	PICU	26 (81.3)	18 (69.2)	RR = 2.08
Outside PICU	28	15 (50)	P = 0.7	OT	8 (18.8)	2 (33.3)	P = 0.02
Number of attempts							
One	47	21 (38.8)	P = 0.3	One	22 (68.8)	14 (63.6)	P = 0.8
>One	56	33 (61.1)		>One	10 (31.2)	6 (60)	
Site of insertion							
Upper limb	81	37 (45.6)	P = 0.008	Subclavian	22 (66.7)	15 (68.2)	
Lower limb	22	17 (77.2)		Femoral	5 (15.6)	2 (40)	P = 0.6
				Brachial	3 (9.2)	2 (66.6)	
				Jugular	2 (6.25)	1 (50)	

Figures in parentheses indicate percentages.

Key Messages

- Peripheral venous catheters should be placed in the upper limbs compared to lower limbs for reducing the risk of colonization.
- Strict asepsis is required while inserting central venous catheters to reduce the risk of colonization.
- Peripheral IV catheters should be changed after 48 hours and central lines after 10 days.
- *Staphylococci, Pseudomonas and Candida spp.* are common organisms causing catheter related infections.
- Significant catheter colonization in central venous catheters should arouse suspicion of catheter related bacteremia.

to central lines for increasing the number of infusions, (*iii*) absence of dedicated IV catheter insertion teams, and (*iv*) lack of standardized protocol for replacement/ change of catheters(9).

The organisms isolated from both the peripheral and central venous catheters match the microbial profile of catheter colonization reported in the literature. The varying pattern of organisms isolated emphasizes the importance of studying the pattern of infection in every setting and underscores the impact of environmental contaminants in the pathogenesis of device related infections.

Garland, *et al*. found that the rate of positive cultures increased with the length of time the catheter was left in place (7). These observations have resulted in the widely accepted recommendation that plastic catheters be replaced after 48 hours. Reports cite that 66% of central venous catheters are colonized by 15 days. Strict asepsis during insertion has been found to decrease the risk of colonization(11).

Colonization was more commonly associated with peripheral IV lines that were inserted after two or more attempts. The difference though not statistically significant is clinically significant. We suggest that all peripheral IV catheters be discarded after a failed first attempt and a fresh one be used for the subsequent attempts.

In a study by Fuchs, *et al*. where 400 catheters were studied, one half of them were removed because of complications. Presence of phlebitis was found to be a risk factor for colonization, with the thrombus in the vein acting as a nidus for the growth of organisms(12).

Maki, *et al.* showed that a positive semiquantitative culture rather than overt septicemia can serve as the index for catheter related infection, distinguishing contamination from infection(13). Cleri, *et al.* also showed that the status of isolates with $<10^3$ colonies/ mL. was indeterminate, and that the so called contaminated catheters should not be disregarded. Some catheters having intermediate bacterial growth may cause silent infection which may lead to overt sepsis if left in place for a longer time(6). Brun-Buisson et al, who modified the quantitative method described by Cleri, *et al.* noted that though a semiquantitative culture of $>10^3$ colonies/mL was 97.5% sensitive and 88% specific, there is probably a continuum between contamination, colonization and eventual infection(5). In this study, colonized peripheral IV catheters did not correlate with catheter related bacteremia (sensitivity 20%). However, for central venous

catheters, significant catheter colonization (10^3 cfu/mL) had a sensitivity of 80% and specificity of 54% for diagnosis of catheter related bacteremia.

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