

## FREQUENCY OF HEMODIALYSIS CATHETER RELATED INFECTIOUS COMPLICATIONS IN PATIENTS WITH END STAGE RENAL DISEASE

Uzma Shehzadi, Naureen Akhtar, Muhammad Aamir Usman, Adeela Chaudhry, Faiza Noor, Nazia Rafique\*

The Children's Hospital and the Institute of Child Health, Lahore Pakistan, \*Services Hospital Lahore Pakistan

### ABSTRACT

**Objective:** To determine frequency of various types of infectious complications occurring in patients undergoing hemodialysis using temporary non-cuffed hemodialysis catheters.

**Study Design:** Cross-sectional study.

**Place and Duration of Study:** The Children's Hospital and the Institute of Child Health, Lahore, from Oct 2016 to Sep 2017.

**Material and Methods:** The study was conducted on 104 patients aged 5-15 years with end stage renal disease. Demographic information like age, gender, duration of end stage renal disease (ESRD), and details about etiology of ESRD, number of days catheter remained in situ, difficult catheter insertion and infectious complications related to catheter were recorded. Exit site, tunnel and blood stream infections and their causative organisms were detected using blood and catheter tip cultures.

**Results:** The mean age of the patients was  $11.1 \pm 2.7$  (range: 5-15) years and female to male ratio 1.48. Internal jugular, femoral and subclavian veins were used in 85.6%, 7.7% and 6.7% of the cases respectively. The frequency of catheter related exit site infection, tunnel infection, blood stream infection and infective endocarditis was found to be 16.3%, 7.7%, 52.9% and 34.6% respectively. Staphylococcus aureus, Escherichia coli and Klebsiella pneumonia were the commonest etiological pathogens in blood cultures whereas Staphylococcus aureus, Pseudomonas aeruginosa and Escherichia coli were the commonest organisms found in the catheter tip cultures.

**Conclusion:** Hemodialysis poses a very heavy burden of blood stream infections which should alert clinicians of their timely management to prevent life threatening complications later.

**Keywords:** Blood stream infections, Complications, End stage renal disease, Frequency, Hemodialysis.

---

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

---

### INTRODUCTION

Hemodialysis is associated with considerable morbidity and mortality. Infections are major cause of death in these patients. The requirement of renal replacement therapy (RRT) in the form of hemodialysis has increased in the last decade and it is expected that it will continue to do so over the next 10 years. Hemodialysis is the mainstay of therapy in end stage renal disease (ESRD) and it needs effective and long term vascular access. Arteriovenous (AV) fistula is the access of choice<sup>1</sup>. Despite the efforts to secure early permanent vascular access, catheters remain an essential access in large number of ESRD

patients. About 20%-60% of patients treated with hemodialysis worldwide use grafts or catheters at least in part because their vessels are not suitable for fistula creation<sup>2,3</sup>. The hemodialysis catheters can be used in virtually any patient as they are easily inserted and are suitable for immediate use following insertion. The catheter access is even more economical as compared to AV fistula by about five folds<sup>4,5</sup>.

Though the catheter access some benefits, the rate of complications associated with it make it a less preferred choice. One of the major complications associated with catheter access is infection in the form of rampant bacteremia. According to a recent study the incidence of tunneled catheter related bacteremia is as high as one episode per 252 catheter days<sup>6,7</sup>. Similarly, many studies have also reported development of infective endocarditis in these patients<sup>8,9</sup>.

---

**Correspondence:** Dr Uzma Shehzadi, Paediatric Nephrology, The Children's Hospital and the Institute of Child Health, Lahore Pakistan (Email: [dr.uzma.amir@hotmail.com](mailto:dr.uzma.amir@hotmail.com))

Received: 10 Jan 2018; revised received: 08 Jun 2018; accepted: 12 Jun 2018

The study was conducted with the rationale to determine frequency of various types of catheter related infections in tertiary care centers from our country. The results of the study are expected to create awareness among clinicians to prevent and treat these complications at an early stage to increase mean survival of the patients in whom the catheter use is inevitable.

### PATIENTS AND METHODS

This was a cross-sectional study conducted from October 2016 to September 2017. The study was conducted at the Department of Nephrology of the Children's Hospital and Institute of Child Health, Lahore after approval of its synopsis from the Ethical Review Board of the same institution. The sample size was calculated using WHO Sample size calculator. Taking a previous reported frequency of catheter related infections to be 7.3%, a sample size of 104 patients was calculated with 95% confidence interval and 7% margin of error<sup>11</sup>.

The patients were recruited following non-probability, consecutive sampling. Patients aged 5-15 years, belonging to either gender diagnosed with end stage renal disease and on hemodialysis via temporary non-cuffed catheters were included in the study. Patients with end stage renal disease undergoing dialysis using arteriovenous fistula were excluded.

One hundred and four patients fulfilling the criteria were included in the study. Demographic information like age, gender, duration of ESRD, and details about etiology of ESRD, number of days catheter remained in situ, difficult catheter insertion and infectious complications related to catheter were recorded in a predesigned proforma. We used Duke's criteria for diagnosis of infective endocarditis.

All the collected data was analyzed using SPSS software version 20.0. Age, number of days catheter remained in situ were presented as mean and SD. Complications were presented as frequency and percentages. Post stratification, chi-square test was applied with  $p$ -value  $\leq 0.05$  considered as statistically significant.

### RESULTS

There were 104 patients in the study with mean age  $11.1 \pm 2.7$  (range: 5 - 15) years. The female to male ratio was 1.48 with 62 males (59.6%) and 42 females (40.4%). The internal jugular was the commonest site of central venous catheter (CVC) insertion with 89 (85.6%) of the patients undergoing venous catheterization through this route. Difficult catheter insertion was experienced by 67 (64.4%) of the patients and the mean number of days patients had venous catheter in place was  $74.9 \pm 26.1$  days (table-I). All

**Table-I: Demographic and clinical profile of the study population.**

Variable	Mean	S.D
Age (years)	11.1	2.7
Female to Male Ratio	1 : 1.48	
Duration of CVC (days)	74.9	26.1
TLC (x106/uL)	16.90	6.442
Difficult catheterization n(%)	67 (64.4)	
<b>Catheterization (%)</b>		
Internal jugular vein	85.6	
Femoral	7.7	

patients presented with fever  $>38^{\circ}\text{C}$  and no source of infection could be found except for an infected central venous catheter.

The frequency of catheter related exit site infection, tunnel infection, blood stream infection was found to be 16.3%, 7.7% and 52.9% respectively. The frequency of infective endocarditis complicating the course of the disease was found to be 34.6%. All of them had vegetations on echocardiography except one. with 34.0% developing subsequent echo vegetations (table-II). The mean total leukocyte count was found to be  $16.9 \pm 6.4 \times 10^3/\text{uL}$ . Analysis of the culture reports showed that *Staphylococcus aureus*, *Escherichia coli* and *Klebsiellapneumoniae* were the commonest etiological pathogens in blood culture with their presence observed in 33 (31.7%), 17 (16.3%) and 14 (13.5%) of the cases respectively. Whereas, *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Escherichia coli* were the commonest organisms found in the catheter tip cultures (table-III).

We analyzed the effect of gender, site of catheter insertion and etiology of end stage renal

disease on exit site, tunnel and blood stream infections. The results showed that the differences in the male and female population were statistically significant for exit site infections ( $p$ -value: 0.025) (table-IV). Similarly, etiology of ESRD significantly affected exit site and tunnel infections ( $p$ -value: 0.040 and 0.004 respectively)

significantly related to infective endocarditis ( $p$ -value: 0.015).

## DISCUSSION

The primary objective of the study to find the frequency of hemodialysis related blood infections was successfully achieved. There are multiple complications seen with the venous

**Table-II: Various types of hemodialysis related blood infections in the study population.**

Infection	Present (n, %)	Absent (n, %)	Total
Exit site infection	17, 16.3	87, 83.7	104, 100.0
Tunnel infection	8, 7.7	96, 92.3	104, 100.0
Blood stream infection	54, 52.9	48, 47.1	102, 98.1a
Infective endocarditis	36, 34.6	68, 65.4	104, 100.0
Echo vegetations	35, 34.0	68, 66.0	103, 99.0a

A data for 2 patients was missing for these parameters.

**Table-III: Organisms found in blood and catheter tip cultures of hemodialysis patients.**

Organism	Blood Culture		Catheter Tip Culture	
	n	%	n	%
Escherichia coli	17	16.3	19	18.3
Enterobacter species	11	10.6	6	5.8
Klebsiella pneumonia	14	13.5	14	13.5
Pseudomonas aeruginosa	9	8.7	20	19.2
Staphylococcus aureus	33	31.7	25	24.0
Staphylococcus epidermidis	2	1.9	4	3.8
Others	2	1.9	2	1.9
Culture negative	16	15.4	14	13.5
Total	104	100.0	104	100.0

**Table-IV: Effect of gender on various blood infections in hemodialysis patients.**

Type of Infection			Gender		Total	$p$ -value
			Male (%)	Female (%)		
Exit site infection	Yes	n (%)	6 (5.8)	11 (10.6)	17 (16.3)	0.025
	No	n (%)	56 (53.8)	31 (29.8)	87 (83.7)	
Total		n (%)	62 (59.6)	42 (40.4)	104 (100)	
Tunnel Infection	Yes	n (%)	6 (5.8)	2 (1.9)	8 (7.7)	0.356
	No	n (%)	56 (53.8)	40 (38.5)	96 (92.3)	
Total		n (%)	62 (59.6)	42 (40.4)	104 (100)	
Blood Stream Infections	Yes	n (%)	36 (35.3)	18 (17.6)	54 (52.9)	0.197
	No	n (%)	26 (25.5)	22 (21.6)	48 (47.1)	
Total		N (%)	62 (60.8)	40 (39.2)	102 (100)	
Infective Endocarditis	Yes	n (%)	20 (19.6)	16 (15.4)	36 (34.6)	0.539
	No	n (%)	42 (40.4)	26 (25)	68 (65.4)	
Total		n (%)	62 (59.6)	42 (40.4)	104 (100)	

with most prevalence seen in cases of nephrolithiasis (26.9%) and glomerulopathies (21.2%) (table-V). The site of CVC insertion significantly affected blood stream infections ( $p$ -value: 0.019). Catheterization in the internal jugular vein was

catheterization in hemodialysis patients which can be broadly categorized into anatomic, thrombotic and infective. During placement of a catheter patient may develop bleeding, hematoma formation, arterial puncture, atrial puncture,

thromboembolic event, pneumothorax, hemothorax etc. But the most common and distressing complications associated with catheter are blood infections.

In a study by Napalkov *et al*, incidence rate of complications/1000 in patients with hemodialysis catheters were described. They reported an incidence of thrombosis: 0.8; mechanical

A study conducted by investigators in Sudan reported that the rate of catheter related sepsis was 69.2% and 30.8% in jugular and femoral catheters. They also reported that exit site infections were co-existent with sepsis in majority (85.3%) of the cases<sup>12</sup>. Another group researchers showed that catheter related tunnel infections were seen in three out of nine hemodialysis patients<sup>13</sup>. Our results showed that catheter rela-

**Table-V: Effect of etiology of end stage renal disease on various types of blood infections in hemodialysis patients.**

			Etiology of ESRD							p-value	
			Nephro-lithiasis	Posterior Urethral Valves	Reflux Nephropathy	Neurogenic Bladder	Nephrono-phthisis	Glomerulo-pathies	Congenital hypoplastic kidneys		Total
Exit Site Infection	Yes	n, %	6, 5.8%	0, 0.0%	0, 0.0%	4, 3.8%	0, 0.0%	7, 6.7%	0, 0.0%	17, 16.3%	0.040
	No	n, %	22, 21.2%	15, 14.4%	16, 15.4%	11, 10.6%	6, 5.8%	15, 14.4%	2, 1.9%	87, 83.7%	
Total		N	28, 26.9%	15, 14.4%	16, 15.4%	15, 14.4%	6, 5.8%	22, 21.2%	2, 1.9%	104, 100%	
Tunnel Infection	Yes	n, %	0, 0.0%	4, 3.8%	2, 1.9%	0, 0.0%	2, 1.9%	0, 0.0%	0, 0.0%	8, 7.7%	0.004
	No	n, %	28, 26.9%	11, 10.6%	14, 13.5%	15, 14.4%	4, 3.8%	22, 21.2%	2, 1.9%	96, 92.3%	
Total		N	28, 26.9%	15, 14.4%	16, 15.4%	15, 14.4%	6, 5.8%	22, 21.2%	2, 1.9%	104, 100%	
CRBSI	Yes	n, %	13, 12.7%	11, 10.8%	8, 7.8%	7, 6.9%	2, 2.0%	11, 10.8%	2, 2.0%	54, 52.9%	0.412
	No	n, %	15, 14.7%	4, 3.9%	6, 5.9%	8, 7.8%	4, 3.9%	11, 10.8%	0, 0.0%	48, 47.1%	
Total		N	28, 27.5%	15, 14.7%	14, 13.7%	15, 14.7%	6, 5.9%	22, 21.6%	2, 2.0%	102, 100%	
Infective Endocarditis	Yes	n, %	13, 12.5%	2, 1.9%	4, 3.8%	6, 5.8%	2, 1.9%	9, 8.7%	0, 0.0%	36, 34.6%	0.319
	No	n, %	15, 14.4%	13, 12.5%	12, 11.5%	9, 8.7%	4, 3.8%	13, 12.5%	2, 1.9%	68, 65.4%	
Total		N	28, 26.9%	15, 14.4%	16, 15.4%	15, 14.4%	6, 5.8%	22, 21.2%	2, 1.9%	104, 100%	

catheter-related complications (MCRCs): 0.7; embolism: 0.5; major bleed: 0.3; and intracranial hemorrhage (ICH), 0.1 complications<sup>10</sup>. In another study by Wang *et al*, done at a single center in China, on Cuffed-tunneled hemodialysis catheter survival and complications in pediatric patients, the overall rate of catheter-related infections, thrombosis and malposition was 7.3, 23.4 and 3.4 episodes/1000 catheter days, respectively<sup>11</sup>.

ted blood stream infections were the commonest form of hemodialysis related infections seen in 52.9% of the patients with exit site and tunnel infections seen in 16.3% and 7.7% of the patients respectively. In the current study, we also presented the organisms found on blood and catheter tip cultures which were not reported by the afore mentioned study. The commonest organism was found to be Staphylococcus aureus

that was obtained both in blood and catheter tip cultures most frequently.

There is a significant increase in metastatic infection in patients with dialysis catheters versus AV grafts<sup>8</sup>. Furthermore the incidence of infective endocarditis is much higher in patients with catheters as opposed to patients with AV access<sup>9</sup>. Investigators have noted four episodes of endocarditis in patients with cuffed tunneled catheters followed for 16,000 catheter days<sup>14,15</sup>. We found a prevalence of 34.6% of infective endocarditis in our patients with 34.0% developing detectable echo vegetations.

Our patients had internal jugular catheterization in 85.6% of the cases which is in agreement with an earlier study that showed similar catheterization in 83% of the cases<sup>12</sup>. In our study, the femoral route was used in 7.7% of the cases which is relatively less than an earlier report of 17% (12) but slightly higher than an earlier published report of 2%<sup>16</sup>. Our study showed that catheterization in internal jugular vein was significantly associated with bacteremia which is in disagreement with some earlier reports that showed that anatomic site did not affect bacterial infections<sup>17</sup>. However, there have been certain randomized trials that proved that jugular venous catheterization did not reduce the incidence of bacteremia as compared to femoral access<sup>18</sup>.

To the best of our knowledge, this is the first study from Pakistan to report various infectious complications related to hemodialysis catheters in children with end stage renal disease. The highest frequency was of catheter related blood stream infections followed by exit site and catheter tunnel infections. It is recommended to adopt absolute aseptic techniques while passing hemodialysis catheters and especially every time the medical staff handles the catheters during dialysis. Besides, local disinfectant should be applied when handling during session and antibiotic lock with heparin may be of great help to decrease rate of infection<sup>19</sup>. If need arises, then local antibiotics like mupirocin ointment have also shown to be effective in controlling localized

infections. For more disseminated infections systemic antibiotics are recommended<sup>20,21</sup>.

Our study is limited by the fact that it was a single center study and the sample size was small. Larger sample size would be required to establish stronger association between hemodialysis and associated blood stream infections. Secondly, we could not keep a long term follow up of our patients to see any life threatening complications later in life emerging from these blood stream infections.

## CONCLUSION

Hemodialysis catheter use is inevitable in patients who await establishment of permanent vascular access for hemodialysis. This central venous catheterization puts patients at risk of developing various infections that range from exit site and tunnel infections to sepsis and infective endocarditis. The commonest organisms involved include *S. aureus*, *E. coli*, *K. pneumoniae* and *P. aeruginosa*. Selection of internal jugular vein does not prove to offer any additional benefit in reducing the risk of such complications. However, proper catheter insertion technique and disinfection can help reduce burden of such complications. Besides, timely management, once these infections have set in, can lead to prevention of life threatening complications. The clinicians should be well equipped with managing such complications to reduce the burden of morbidity and mortality in hemodialysis patients.

## CONFLICT OF INTEREST

This study has no conflict of interest to be declared by any author.

## REFERENCES

1. Drew DA, Lok CE, Cohen JT, Wagner M, Tangri N, Weiner DE. Vascular access choice in incident hemodialysis patients: A decision analysis. *J Am Society Nephrology* 2015; 26(1): 183-91.
2. Ravani P, Palmer SC, Oliver MJ, Quinn RR, MacRae JM, Tai DJ, et al. Associations between hemodialysis access type and clinical outcomes: A systematic review. *J Am Society Nephrology* 2013; 24(3): 465-73.
3. Xue H, Ix JH, Wang W, Brunelli SM, Lazarus M, Hakim R, et al. Hemodialysis access usage patterns in the incident dialysis year and associated catheter-related complications. *Am J Kidney Diseases* 2013; 61(1): 123-30.

4. Santoro D, Benedetto F, Mondello P, Pipitò N, Barillà D, Spinelli F, et al. Vascular access for hemodialysis: current perspectives. *Int J Nephrol Renovasc Dis* 2014; 7: 281.
5. Feldman ZM, Liu LB, Abramowitz SD, Faries PL, Marin ML, Schanzer HR et al. Hemodialysis Vascular Access: Rising Costs as a Surrogate Marker for Patency and Function of Arteriovenous Fistulas. *Ann vascular surgery* 2017; 38: 136-43.
6. Kreuziger LB, Jaffray J, Carrier M. Epidemiology, diagnosis, prevention and treatment of catheter-related thrombosis in children and adults. *Thrombosis Research* 2017; 157: 64-71.
7. Jamal S, Ali MH, Ayub MH, Butt NH. Frequency and Grading of Diabetic Retinopathy in Diabetic End Stage Renal Disease Patients. *Pak J Ophthalmol* 2016; 32(2): 64-69.
8. Chaudry MS, Carlson N, Gislason GH, Kamper AL, Rix M, Fowler VG, et al. Risk of infective endocarditis in patients with end stage kidney disease. *Clini J American Society Nephrology* 2017; CJN. 02320317.
9. Hsiao CC, Weng CH, Li YJ, Wu HH, Chen YC. Comparison of the clinical features and outcomes of infective endocarditis between hemodialysis and non-hemodialysis patients. *Therapeutics Clinical Risk Management* 2017; 13: 663-68.
10. Napalkov P, Felici DM, Chu LK, Jacobs JR, Begelman SM. Incidence of catheter-related complications in patients with central venous or hemodialysis catheters: a health care claims database analysis. *BMC Cardiovascular disorders* 2013; 13(1): 86.
11. Wang K, Wang P, Liang XH, Yuan FF, Liu ZS. Cuffed-tunneled hemodialysis catheter survival and complications in pediatric patients: A single-center data analysis in China. *Intl J Clini Experimental Med* 2015; 8(6): 9765.
12. Abdalrahman IB, Kheir AE, KhairAllah M, Khair MM. Hemodialysis catheter-related complications in Khartoum Teaching Hospital Dialysis Centre.
13. Gominet M, Compain F, Beloin C, Lebeaux D. Central venous catheters and biofilms: where do we stand in 2017? *APMIS* 2017; 125(4): 365-75.
14. Morris AM. Catheter-Related Bloodstream Infection. *Encyclopedia of Intensive Care Medicine* 2012; 506-8.
15. Sandroni S. Venous needle dislodgement during hemodialysis: an unresolved risk of catastrophic hemorrhage. *Hemodialysis Intl* 2005; 9(1): 102-3.
16. Maya ID, Allon M. Outcomes of tunneled femoral hemodialysis catheters: comparison with internal jugular vein catheters. *Kidney Intl* 2005; 68(6): 2886-9.
17. Ștefan G, Stancu S, Căpușă C, Ailioaie OR, Mircescu G. Catheter-related infections in chronic hemodialysis: A clinical and economic perspective. *Intl Urology Nephrology* 2013; 45(3): 817-23.
18. Parienti JJ, Thirion M, Mégarbane B, Souweine B, Ouchikhe A, Polito A, et al. Femoral vs jugular venous catheterization and risk of nosocomial events in adults requiring acute renal replacement therapy: a randomized controlled trial. *JAMA* 2008; 299(20): 2413-22.
19. Patel PR, Brinsley-Rainisch K. The making dialysis safer for patients coalition: A new partnership to prevent hemodialysis-related infections. *Clinical J American Society Nephrol* 2017; CJN. 02730317.
20. Allon M, Brouwer-Maier DJ, Abreo K, Baskin KM, Bregel K, Chand DH, et al. Recommended clinical trial end points for dialysis catheters. *Clini J American Society Nephrol* 2017; CJN. 12011116.
21. Hoekstra BP, de Vries Hoogsteen A, Winkels B, Zevenbergen-Osinga H, Thijssen Broers I. Exit site care in the Netherlands: the use of guidelines in practice. *J Renal Care* 2017; 43(3): 156-62.