RESEARCH ARTICLE

Tunneled dialysis catheter utilization and patency: A retrospective-prospective study from a tertiary care hospital in Karachi Pakistan

Misbah Tahir[1], Muhammad Ali[2], Danial Khalid Siddiqui[3], Noureen Durrani[4], Jawaid Iqbal[5], Khalid Mustafa[6]

Abstract

Objective: To assess the patency of tunnel dialysis catheters and their results in patients in a tertiary care setting.

Method: The retrospective-prospective, observational study was conducted at the Department of Interventional Radiology, Liaquat National Hospital, Karachi, from September 2021 to February 2022, and comprised records of patients who underwent tunnel dialysis catheters placement from July 2019 to December 2020. Data regarding age, gender, residence, comorbidity, catheter placement site, use of antibiotics before catheter insertion, reasons for catheter removal, and total catheter days was retrieved from the medical record. Data was analysed using STATA 14.

Results: Of the 134 patients, 74(56.9%) were males and 56(43.1) were females. The overall median age was 65 years (interquartile range: 56.75-70.25 years). Catheters were electively removed in 97(72.4%) patients, while in 19(14.2%), 16(11.9%) and 2(1.5%) cases, catheters were removed due to infections, blockage and physical damage, respectively. Mortality due to catheter-related complications was not found. Incidence per 10,000 catheter days of overall infection, bacteraemia and other infections during one year was 8.4, 5.3 and 3.1, respectively. Overall infection-free survival rate was seen for 19 patients (survival rate=67.6%). Survival rate from catheter removal was seen in 36 patients (survival rate=53.2%).

Conclusion: When all precautions were followed to circumvent catheter-related issues, tunnel dialysis catheters were found to be a viable option for haemodialysis until permanent access for dialysis is gained or a kidney transplant is performed.

Keywords: Tunnel dialysis catheter, End-stage kidney disease, Chronic kidney disease, Interventional radiology.

(JPMA 73: 48; 2023) **DOI: https://doi.org/10.47391/JPMA.8006**

Introduction

Worldwide, the burden of chronic kidney disease (CKD) is increasing, affecting roughly 10-15% of the world's population, with emerging nations bearing a heavier burden having an approximate prevalence among adults of 21.2%.[1] End stage kidney disease (ESKD) is the final result of CKD, and predictions are not positive for the next few decades.[2] With the current global burden of CKD, more and more countries are dealing with ESKD epidemic silently.[3] Haemodialysis (HD) is the primary form of renal replacement therapy in 70-90% of cases worldwide, and all these cases necessitate vascular access to carry out the process.[4]

For ESKD patients to receive dialysis, arteriovenous grafts (AVGs), arteriovenous fistulas (AVFs), or catheters are employed.[5] In patients who are unable to attain AVG or AVF due to a variety of factors, including advanced age, the sole choice for dialysis is tunnel dialysis catheter (TDC). Tunnelled cuffed catheters are a suitable backup to offer a reliable vascular access for HD, while fistulae take a little longer to mature, taking anywhere from 4 to 8 weeks.[6]

Unluckily, these catheters may result in obstacles that raise the burden of morbidity and mortality owing to infectious or non-infectious causes.[7] These issues could arise immediately after catheter insertion or at a later period. There are a variety of minor to severe TDC-related complications, including, catheter-related infections, sepsis, central venous stenosis, thrombosis, dislodgments and occlusions. TDC-related problems are not only associated with increased morbidity, but also with more frequent hospitalisations and higher medical expenses.[8]

If either problem is not promptly recognised and treated, catheter malfunction and infections are the most common consequences that lead to catheter removal. Catheter-related infections (CRIs) are the most common arising problem in TDC that result in hospital visits and admission after TDC implantation.[9]

The perennial usage of TDC without preparing for the construction of stable access was forbidden by the National Kidney Foundation Kidney Disease Outcomes Quality Initiative (NKF-KDOQI), which has recently advocated for additional modifications to make it patient-centred. These recommendations enable sensible TDC usage in the event of multiple access failures, even in the presence of limited arteriovenous (AV) access and/or life expectation, as well as the absence of further dialysis access options.[10]

[1-3,5,6]Department of Interventional Radiology, Liaquat National Hospital, Karachi, Pakistan; [4]Publication Department, Liaquat National Hospital, Karachi, Pakistan.

Correspondence: Danial Khalid Siddiqui. e-mail: daniyal106@gmail.com

Submission complete: 24-09-2022 **Review began:** 01-11-2022
Acceptance: 27-09-2023 **Review end:** 09-08-2023

Published material on the prevalence of TDC is scarce from Pakistan. The current study was planned to fill the gap by assessing the patency of TDCs and their results in patients in a tertiary care setting.

Materials and Methods

The retrospective-prospective, observational study was conducted at the Department of Interventional Radiology, Liaquat National Hospital, Karachi, from September 2021 to February 2022, and comprised records of patients who underwent TDC placement from July 2019 to December 2020. Data of patients who failed to show up at the department despite multiple messages on their provided network contact numbers were excluded. The study was initiated following receiving formal ethical letter bearing letter number "Ref:App#0671-2021-LNH-ERC".

Patients were monitored from the time of TDC placement until the catheter was removed for any reason. Demographic and clinical data was retrieved from the patient's medical record files, including comorbidities, site of catheter insertion, prophylactic use of antibiotics, causes of catheter removal, and time to catheter usage in days.

Before placing a TDC, the patient and attendant provided a signed informed consent. All catheters were placed by interventional radiologists with at least 5 years of experience. It was done under local anaesthesia in an angiography suite with real-time ultrasonography and fluoroscopic guidance. Pre-procedure, intravenous (IV) injection co-amoxicillin 1.2gm was administered. A suitable vein was chosen for TDCs. Doppler ultrasonography (DUS) was used to confirm the vein's patency. A TDC of 14.5 French [Medcomp (USA), Bard (Switzerland) and Covadian plandrome (UK)] was inserted with lengths 19cm, 23cm and 28cm for right subclavian and internal jugular, left internal jugular and right femoral vein, respectively. Seldinger method was used to puncture the vein.[11] In order to validate the catheter tip, fluoroscopy was performed. For bilateral internal jugular and subcalvian catheters, the tip of catheter was positioned at the junction of superior vena cava and right atrium. The tip of catheter was positioned in the proximal inferior vena cava for femoral vein catheters. For jugular veins, the tunnel was approximately 7-10cm long in the supraclavicular region, and for femoral veins, it was on the anterolateral side of the thigh, while for subclavian vein catheters, it was on the anterior chest wall. Three weeks after the procedure, the stitches were removed, and the catheter was flushed with heparinised saline. The catheter was used immediately, otherwise it was used as per the need of the patient.

Erythema and purulent discharge >2cm away from the exit point of catheter with negative blood cultures were considered tunnel infections. Catheter-related bloodstream infection (CRBSI) was characterised as the presence of systemic infection, such as chills or fever, together with positive blood cultures. When a catheter was rendered inoperable by a tear or puncture, physical damage was taken into account. The catheter was marked as obstructed when flow rate was <350ml/min even after flushing of the catheter with heparinised saline, secondary to a thrombus and/or fibrin sheath at the tip of the catheter. The time between the TDC being placed and being removed because the catheter had to be changed because of an infection, blockage, or physical damage was known as catheter patency, which is also known as catheter survival. Functional catheters were the ones that had been removed because the patient had passed away, a fistula had formed, or there was no longer a necessity for dialysis.

Data was analysed using STATA 14. Frequencies with percentages were computed for summarising categorical variables. After assessing the normality assumption of numerical variables, they were expressed as mean ± standard deviation or as median with interquartile range (IQR). To compute the incidence rate, the total number of occurrences were divided by the total number of catheter days. The survival rates were calculated using Kaplan-Meier curves and compared between several subgroups using the Log-rank test Two-tailed $p<0.05$ was considered statistically significant.

Results

Of the 174 patients who had received a TDC, 40(23%) were

Table-1: Descriptive data.

Variables	n (%)
Age (years)#	65 (56.75-70.25)
Gender	
Male	74 (56.9)
Female	56 (43.1)
Comorbidities	
Hypertension	89 (68.5)
Diabetes	70 (53.8)
Ischaemic heart disease	18 (13.8)
Hypothyroidism	3 (2.3)
Insertion site	
Right internal jugular vein	118 (88.1)
Left internal jugular vein	14 (10.4)
Right femoral vein	1(0.7)
Right subclavian vein	1(0.7)
Catheter status	
Functional catheter at the time of removal	97 (72.4)
Non-functional at the time of removal	37 (27.6)
Causes of malfunctioning catheters	
Catheter-related infections	19 (14.2)
Blockage	16 (11.9)
Physical damage	2 (1.5)

Expressed as median (1st-3rd quartile)

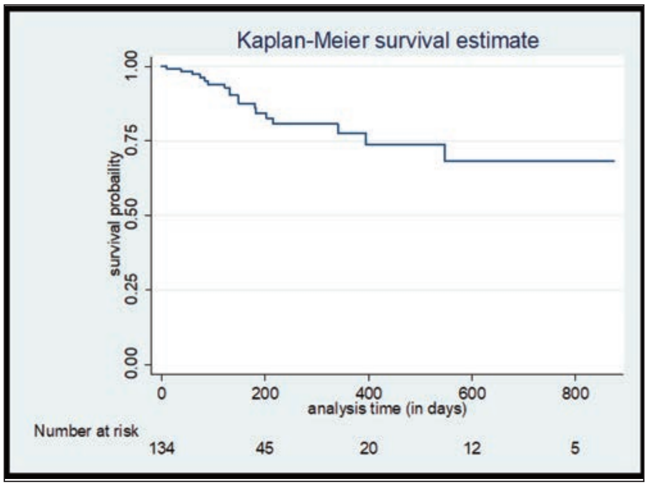

Figure-1: Infection-free survival during the study period.

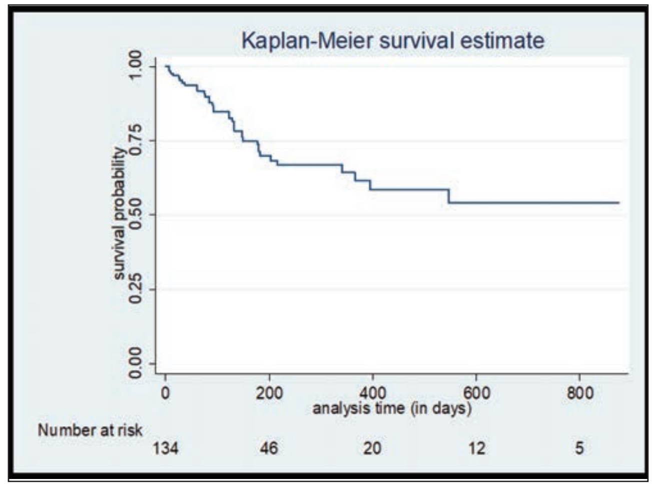

Figure-2: Catheter survival during the study period.

Table-2: Infection-free survival and catheter survival from malfunctioning at 6 months and 1 year.

Variables	**Infection-free survival**		**Catheter survival**	
	6 months Cumulative events (survival probability in %)	**1 year** Cumulative events (survival probability in %)	**6 months** Cumulative events (survival probability in %)	**1 year** Cumulative events (survival probability in %)
Overall survival	13 (83.6)	16 (76.9)	32 (66.2)	34 (60.5)
Age (years)				
≤50	2 (81.8)	4 (45.5)	5 (59.1)	6 (38.3)
>50	11 (83.9)	12 (8.3)	27 (67.3)	28 (63.9)
p-value	0.942	0.294	0.973	0.677
Gender				
Male	6 (88.5)	7 (83.3)	14 (76.6)	16 (67.3)
Female	7 (76.3)	9 (67.8)	18 (52.1)	18 (51.7)
p-value	0.173	0.093	0.032	0.069
Residence				
Rural	0 (100)	0 (100)	2 (89.1)	2 (89.1)
Urban	13 (80.4)	16 (72.7)	30 (62.3)	32 (55.8)
p-value	0.084	0.058	0.089	0.073
Comorbidity				
Yes	2 (80.8)	13 (75.9)	27 (61.5)	6 (57.3)
No	11 (92.6)	3 (82.3)	5 (82)	28 (72.9)
p-value	0.337	0.414	0.169	0.232
Received antibiotics				
Yes	9 (85.2)	11 (79.2)	25 (67.6)	27 (60.8)
No	4 (78.1)	5 (66.9)	7 (61.2)	7 (59.9)
p-value	0.247	0.153	0.531	0.640
Placement site				
Right internal jugular vein	11 (84.2)	13 (78.3)	27 (67.6)	29 (60.8)
Others	2 (77.9)	3 (64.9)	5 (55.8)	5 (55.8)
p-value	0.718	0.467	0.509	0.676

lost to follow-up. As such, the sample comprised 134(77%) patients. Of the 134 patients, 74(56.9) were males and 56(43.1) were females. The overall median age was 65 years (interquartile range: 56.75-70.25 years), with 114(85.1%) patients aged >50 years. Catheters were electively removed in 97(72.4%) patients, while in 19(14.2%), 16(11.9%) and 2(1.5%) cases, catheters were removed due to infections, blockage and physical damage, respectively. Mortality due to catheter-related complications was not found. Out of 97(72.4%) cases with electively removed catheters, 58(59.8%) were alive and 39(40.2%) were dead. Overall catheter removal reasons were fistula formation 47(35.1%), death 39(29.1%), blockage 16(11.9%), infection 19(14.2%), no requirement of dialysis 1(8.2%) and physical injury 2(1,5%). Hypertension was the most common comorbidity 89(68.5%) and right internal jugular vein (RIJV) was the most common insertion site 118(88.1%) (Table 1).

Out of the total sample, overall infection-free survival rate was seen for 19 patients (survival rate=67.6%) (Figure 1). Bacteraemia and other tunnel infections were seen among 12(8.9%) and 7(5.2%) respectively. In one year, the incidence of total infection was 8.4/10,000 catheter days, that of bacteraemia was 5.3/10,000 catheter days, and that of other infections was 3.1/10,000 catheter days. Patients aged 50 years or less and those aged >50 years had no significantly different survival rates (p=0.314). Survival rate differed on the basis of male and female gender (p=0.028). Comparisons were done for infection-free survival over 6 months and a year (Table 2).

Survival rate from catheter removal was seen in 36 patients (survival rate=53.2%) (Figure 2). The mean time of catheter patency was 557±42.4 (95% confidence interval [CI]: 475.3-640.1) days. Patients aged ≤50 years and >50 years had no difference in survival rate (p=0.696). Females and males had a significantly different cumulative catheter survival rate (p=0.027). Patients with and without comorbidity had no significantly different catheter survival rate (p=0.180), and patients with catheter placement in RIJV and other sites had a no different cumulative catheter survival statistically (p=0.818). Catheter patency was not significantly different for patients receiving and not receiving antibiotics at baseline (p=0.771).

Discussion

Dialysis catheters are crucial for ESKD patients who need long-term dialysis. Depending on the patients' needs, many dialysis catheter types are utilised. Depending on the use and duration, it might be either temporary or permanent (tunnelled). In contrast to a double lumen (D/L) catheter directly penetrating into the vein, a tunnelled dialysis catheter travels 6-10cm under the skin in subcutaneous tissues before accessing the targeted vein, and lowers the likelihood of infection. Surgeons have historically positioned TDCs by palpating and using anatomical landmarks. Due to their enhanced experience and capacity for managing problems, interventional radiologists have seen a growth in the trend of placing TDC during the past several years.[12]

Clinical outcomes for patients are significantly influenced by the place of vascular access. Depending on the vein's patency, other veins may be suggested for TDC insertion, but with each catheter transit, the vein becomes stenosed and thrombosed.[13] A single turn and a straight path make RIJV the optimal vascular access point, according to NKF-KDOQI. In order of preference, further access options include the femoral veins, the external jugular veins, the subclavian veins and LIJV.[10] Jugular vein anatomical variances occur in 5-18% patients, and, as a result, ultrasound-guided puncture and fluoroscopy-guided placement result in significantly fewer ineffective attempts, haematoma formations, and arterial punctures.[14] In the current study, most catheters were placed via RIJV.

TDCs may be more appropriate for average to long-term use when a kidney transplant or the development of an AVF is anticipated to last many weeks or months. The mean time to catheter removal owing to malfunction in the current study was 557 days. The average time spent using a catheter varies substantially between researches. The median catheter stay was reported to be 62.5 (IQR: 46-89.5) days in a study from Pakistan.[15] A median catheter usage of 213 days was observed by Sampathkumar et al.[16] Yalvac et al. report a catheter use mean duration of 729.65 days.[17] A study in Egypt found that the average catheter lasted 122 days.[17] According to the current study, average catheter time for the elderly was 137.4 days, and it was 139.7 days for the relatively younger patients. The rate of infection, various patient care methods, and patient handling are only a few of the numerous potential causes of variance in catheter usage time.

In comparison to the usage of AVG or AVF, the increasingly necessary TDC role for delivering HD in resource-poor settings is of great concern and may contribute to the lesser quality of life and unfavourable patient consequences. Common source of infections among HD patients is catheter usage, whereas CRBSIs are the second leading reason of mortality, catheter elimination and metastatic infection.[18] In the current study, 8.9% patients experienced CRBSIs during the course of a year, translating to an incidence rate of 5.3/10,000 catheter days. Another similar investigation from Pakistan found that during the observation period, 19.8% patients experienced CRBSIs, and 63.6% of these patients required catheter removal.[15] During one-year follow-up, bacteraemia risk was reported to be 9% at one year and any central venous catheter (CVC)-related complication risk to be 30%.[19] In contrast to current findings, an upsetting infection rate was reported by an Indian study, showing that during a six-month follow-up period following the installation of the TDC, 30.4% patients had positive blood cultures.[20] According to a Saudi study, the CRBSI rate was 23.6% annually.[21] Likewise, Egypt reported 6 per 1,000 catheter days incidence rate for CRBSIs.[22] Numerous factors, including differing healthcare environments and patient attitudes, could contribute to the variation in infection rates in literature. Individuals with diabetes, a longer catheter and a left internal jugular catheter placement had a considerably increased chance of developing CRBSI.[23,24] However, no meaningful correlation between any component and CRI was found in the current study.

The current study analysed that nearly three-fourth of the catheters (72.4%) were removed voluntarily because the patients were dead, had gained stable access via the development of a fistula, or no longer required dialysis. The remaining catheters were removed because of problems, including physician damage, blockage and infection. Contrary to what the current study discovered, a Turkish study revealed that TDCs were voluntarily detached in 31.1%.[17] Another study demonstrated that around quarter of the catheters (28%) were withdrawn voluntarily because of a working arteriovenous (AV) access, a kidney transplant, or the restoration of acceptable kidney function.[25] According to another comparable study, 45% catheters were removed voluntarily over a three-year period[16] due to the majority of deaths involving functional catheters, the conversion to AVF, and kidney transplants. The current findings did not support any correlation between getting older and having diabetes, which have both been reported as independent factors that negatively affect catheter patency.[17,26]

The current study has limitations as it was done at a single institution, and the sample size was limited as no sample size calculation was performed which could have affected the power of the study. Due to the varying placement techniques, catheter types, and patient characteristics used by different institutions, comparisons between them might be challenging. However, with a highly skilled multidisciplinary team, these risks can be minimised.

Conclusion

When all precautions being followed to circumvent catheter-related problems, TDCs were found to be a viable option for HD until permanent access for dialysis is gained or a kidney transplant is performed.

Disclaimer: None.

Conflict of Interest: None.

Source of Funding: None.

References

1. Webster AC, Nagler EV, Morton RL, Masson P. Chronic Kidney Disease. Lancet 2017;389:1238-52. doi: 10.1016/S0140-6736(16)32064-5.
2. Hashmi MF, Benjamin O, Lappin SL. End-Stage Renal Disease. Treasure Island, FL: StatPearls Publishing; 2023.
3. George C, Mogueo A, Okpechi I, Echouffo-Tcheugui JB, Kengne AP. Chronic kidney disease in low-income to middle-income countries: the case for increased screening. BMJ Glob Health 2017;2:e000256. doi: 10.1136/bmjgh-2016-000256.
4. Agarwal AK, Haddad NJ, Vachharajani TJ, Asif A. Innovations in vascular access for hemodialysis. Kidney Int 2019;95:1053-63. doi: 10.1016/j.kint.2018.11.046.
5. Allon M. Vascular Access for Hemodialysis Patients: New Data Should Guide Decision Making. Clin J Am Soc Nephrol 2019;14:954-61. doi: 10.2215/CJN.00490119.
6. Agarwal AK, Haddad N, Boubes K. Avoiding problems in tunneled dialysis catheter placement. Semin Dial 2019;32:535-40. doi: 10.1111/sdi.12845.
7. Raji YR, Ajayi SO, Aminu O, Abiola B, Efuntoye O, Salako BL, et al. Outcomes of tunneled internal jugular venous catheters for chronic haemodialysis at the University College Hospital, Ibadan, Nigeria. Pan Afr Med J 2018;31:e218. doi: 10.11604/pamj.2018.31.218.17525.
8. Hyder SMS, Iqbal J, Lutfi IA, Shazlee MK, Hamid K, Rashid S. Complications Associated with Permanent Internal Jugular Hemodialysis Catheter: A Retrospective Study. Cureus 2019;11: e4521. doi: 10.7759/cureus.4521.
9. Castro V, Farber A, Zhang Y, Dicken Q, Mendez L, Levin SR, et al. Reasons for long-term tunneled dialysis catheter use and associated morbidity. J Vasc Surg 2021;73:588-92. doi: 10.1016/j.jvs.2020.06.121.
10. Beigi AA, Sharifi A, Gaheri H, Abdollahi S, Esfahani MA. Placement of long-term hemodialysis catheter (permcath) in patients with end-stage renal disease through external jugular vein. Adv Biomed Res 2014;3:252. doi: 10.4103/2277-9175.146381.
11. Zappacosta AR, Perras ST, Closkey GM. Seldinger technique for Tenckhoff catheter placement. ASAIO Trans 1991;37:13-5. doi: 10.1097/00002480-199101000-00005.
12. Trerotola SO. Hemodialysis catheter placement and management. Radiology 2000;215:651-8. doi: 10.1148/radiology.215.3.r00jn23651.
13. Allon M. Dialysis catheter-related bacteremia: treatment and prophylaxis. Am J Kidney Dis 2004;44:779-91.
14. Reeves AR, Seshadri R, Trerotola SO. Recent trends in central venous catheter placement: a comparison of interventional radiology with other specialties. J Vasc Interv Radiol 2001;12:1211-4. doi: 10.1016/s1051-0443(07)61681-9.
15. Yaqub S, Abdul Razzaque MR, Aftab A, Siddiqui NA. Outcomes of tunneled cuffed hemodialysis catheters: An experience from a tertiary care center in Karachi, Pakistan. J Vasc Access 2022;23:275-9. doi: 10.1177/1129729821989904.
16. Sampathkumar K, Ramakrishnan M, Sah AK, Sooraj Y, Mahaldhar A, Ajeshkumar R. Tunneled central venous catheters: Experience from a single center. Indian J Nephrol 2011;21:107-11. doi: 10.4103/0971-4065.82133.
17. Denli Yalvaç EŞ, Bademci MŞ, Kocaaslan C, Öztekin A, Aldağ M, Yılmaz Karadağ F, et al. Patency and complications of patients with tunneled dialysis catheters: A long-term follow-up study. Turk J Vasc Surg 2019;28:138-43. DOI: 10.9739/tjvs.2019.358.
18. Abo Shousha H, Gouda Z, Foula H, Hemida W, Zaghloul S. SAT-214 Outcomes of tunneled hd catheters inserted by nephrologists in Egypt: a single center, retrospective analysis. Kidney Int Rep 2020;5(Suppl 1):s92. Doi: 10.1016/j.ekir.2020.02.229
19. Poinen K, Quinn RR, Clarke A, Ravani P, Hiremath S, Miller LM, et al. Complications From Tunneled Hemodialysis Catheters: A Canadian Observational Cohort Study. Am J Kidney Dis 2019;73:467-75. doi: 10.1053/j.ajkd.2018.10.014.
20. Pattanashetti N, Ramachandran R, Kohli HS, Gupta KL. Hemodialysis tunneled catheter-related infection in a tertiary care center: A changing trend. Saudi J Kidney Dis Transpl 2019;30:1187-9. doi: 10.4103/1319-2442.270280.
21. Masoodi I, Alharth FR, Irshad S, Mastan AR, Alzaidi A, Balbaid KA, et al. Hemodialysis catheter-related infections: Results of a tertiary care center study in Saudi Arabia. Int J Med Sci Public Health 2019;8:319-25.
22. Malek AM, Abouseif HA, Abd Elaziz KM, Allam MF, Fahim HI. Incidence Of Central Line-associated Bloodstream Infections In Intensive Care Units In A Private Hospital (Cairo, Egypt). Open Public Health J 2018;11:562-71. DOI: 10.2174/1874944501811010562.
23. Martin K, Lorenzo YSP, Leung PYM, Chung S, O'flaherty E, Barker N, et al. Clinical Outcomes and Risk Factors for Tunneled Hemodialysis Catheter-Related Bloodstream Infections. Open Forum Infect Dis 2020;7:ofaa117. doi: 10.1093/ofid/ofaa117.
24. Demirci R, Sahtiyancı B, Bakan A, Akyuz O. The predictors of catheter-related bloodstream infections in patients undergoing hemodialysis: A single center experience. J Vasc Access 2023;24:76-81. doi: 10.1177/1129729821998836.
25. Forauer AR, McNulty NJ, Kaneko TM. Tunneled hemodialysis catheter outcomes in elderly patients. J Vasc Interv Radiol 2009;20:467-71. doi: 10.1016/j.jvir.2009.01.013.
26. Dittmer ID, Sharp D, McNulty CA, Williams AJ, Banks RA. A prospective study of central venous hemodialysis catheter colonization and peripheral bacteremia. Clin Nephrol 1999;51:34-9.

Author Contribution:
MT: Concept
MT, DK: Study design and protocol
MA, KM: Questionnaire design, supervision, data. collection and entry.
ND: Data analysis, interpretation and results writing.
JI, MA: Initial draft of the work.
MT, DK: Initial critical revision.