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Short Communication

# A Retrospective Study of Catheter-Related Bloodstream Infection Risk after Exchanging Tunneled Dialysis Catheters in Patients with End-Stage Renal Disease

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**Abstract**

**Background:** Tunneled dialysis catheters (TDC) are used for hemodialysis in patients with acute kidney injury or end-stage renal disease who do not have functioning arteriovenous fistulas or grafts. Sometimes, TDCs must be exchanged because of mechanical flow limitations, infection, or catheter cuff exposure. TDC can either be removed with delayed reinsertion or exchanged over a guidewire. Currently, the risk of downstream infection associated with TDC exchange with a guidewire is unclear.

**Methods:** This single-center, retrospective study assessed patients with end-stage renal disease who had a hemodialysis TDC replacement between January 2015 and December 2019. We analyzed the association of the type of inciting event for TDC replacement (infection, exposed cuff, and flow dysfunction) and mode of TDC replacement (removal with delayed reinsertion versus guidewire exchange) with bloodstream infection at 30 and 90 days after exchange.

**Results:** Of 537 patients who had a TDC replacement, 435 underwent guidewire exchange: 305 (57%) for flow dysfunction and 130 (24%) for exposed cuff. One hundred two (19%) patients underwent catheter removal with delayed reinsertion for presence of infection. TDC exchange with removal and delayed insertion performed because of existing infection was associated with higher risk of subsequent infection than guidewire exchanges performed due to flow dysfunction (hazard ratio 2.36; 95% CI, 1.03-5.37; P = 0.042). No significant differences in infection at 30 and 90 days were seen in patients who underwent guidewire exchange for exposed cuff or mechanical dysfunction.

**Conclusions:** Exchanging TDCs because of exposed cuff or flow dysfunction via a guidewire may not increase the risk of bloodstream infection. However, patients with bloodstream infections who have TDCs removed and reinserted at a different site after infection clearance may still be at increased risk of subsequent catheter-related infection

## INTRODUCTION

Tunneled dialysis catheters (TDCs) are commonly used for patients with end-stage renal disease who do not have functioning arteriovenous fistulas or grafts. TDCs are preferentially placed as the initial access in patients who have acute kidney injury. As of 2021, over 800,000 people in the United States were living with end-stage renal disease, and approximately 82% of patients with renal failure in 2019 required initiation of hemodialysis with a TDC (with or without a maturing fistula or graft) [1]. Among patients who initiated hemodialysis in 2018 and remained on hemodialysis, 70% were still receiving care with a catheter 3 months after hemodialysis had been initiated [1]. Thus, the prevalence of TDCs in patients on hemodialysis is high. However, TDCs are prone to malfunctions like flow limitations, fibrin sheath formation, and catheter cuff exposure, and these malfunctions can lead to significant morbidities such as thrombosis, infections, and central venous stenosis [2,3].

Current TDCs include a Dacron or polyester cuff in the subcutaneous tract. The purpose of the cuff is to fix the catheter in position and to provide a physical barrier against infection once fibrous tissue is incorporated into the cuff [4]. However, catheter cuff exposures can occur because of mechanical traction or loss of cuff adhesions due to the presence of infection or inflammation. Therefore, TDCs often need to be removed with delayed reinsertion in patients who have severe sepsis, suppurative thrombophlebitis, endocarditis, bloodstream infections lasting longer than 72 hours, and infections with certain organisms. Consequently, catheter replacement at a different venous site can lead to loss of future access sites [3,5]. Current Infectious Diseases Society of America guidelines recommend administering systemic antibiotics without TDC removal for patients who have TDCs and an uncomplicated catheter-related bloodstream infection (CRBSI) due to pathogens other than Staphylococcus aureus, Pseudomonas aeruginosa, Bacillus species, Micrococcus species, Propionibacteria, fungi, or mycobacteria [5].

Sometimes TDCs must be replaced for non-infectious reasons, and catheter exchanges over guidewires are performed for TDCs with mechanical dysfunction, such as poor catheter blood flow, catheter thrombosis, extrusion of the catheter cuff, and broken clamps [6-8]. Currently, whether cuff exposures or other mechanical catheter-related problems increase the risk of subsequent CRBSI is unclear. Thus, understanding the impact of modality of catheter replacement on infection risk in patients on hemodialysis is critical for improving patient care. Our aim was to explore whether TDC replacement initiated for an exposed cuff, mechanical dysfunction, or CRBSI would be associated with downstream infection or other complications in patients who are on hemodialysis. Additionally, we asked whether the method of catheter exchange over a guidewire would be associated with increased infection rates in comparison to catheter removal with delayed reinsertion.

## METHODS

This was a retrospective analysis of patients who underwent TDC replacement at a single center between January 2015 and December 2019 due to an exposed cuff, flow dysfunction, or catheter- related infection. The study was approved by the Henry Ford Health System Institutional Review Board. The Institutional Review Board granted waiver of the requirements to obtain informed consent and, acting as a Privacy Board, also granted a waiver of authorization to use or disclose protected health information pursuant to Federal regulations. Institutional Review Board Approval number 13216.

The study included patients 18 years or older, receiving maintenance hemodialysis, and a cuffed TDC for at least 2 weeks. Patients no longer on maintenance dialysis, patients with end-stage liver disease, patients with acute kidney injury on dialysis less than 14 days (about 2 weeks), and pregnant patients were excluded from the study.

Data were collected retrospectively from the hospital electronic medical record. Patient age, sex, and diagnosis of diabetes mellitus, immunocompromised status, or peripheral artery disease were recorded. Immunocompromised status was defined as patients with long-term steroid use of prednisone 20 mg per day or more, HIV (Human Immunodeficiency Virus) infection, chronic hepatitis B infection, chronic hepatitis C infection, and use of immunosuppressive medications for autoimmune disease or antirejection medication. Dialysis-related data regarding number of years on dialysis, indication for dialysis, prior CRBSI, and cuffed TDC characteristics were also collected.

The primary endpoint was the rate of CRBSI at 30 and 90 days after TDC replacement, either via guidewire exchange or with TDC removal and reinsertion. CRBSI included any positive blood culture with bacterial growth noted in patients with TDCs and no alternative sources of infection. For primary analysis, patients were organized into 3 groups based on the indication for TDC replacement: (1) TDC removal with delayed reinsertion initiated because the patient had a catheter-associated infection; (2) TDC guidewire exchange initiated because of flow dysfunction; and (3) TDC guidewire exchange initiated because of exposed catheter cuff. For secondary analysis, data were also stratified into 2 groups: (1) TDC removal and delayed insertion and (2) TDC guidewire exchange.

Patients who had TDC removal and delayed insertion had the original catheter removed and a new catheter placed once repeat blood cultures showed at least 48 hours of no bacterial growth. New catheters were inserted in either the same vein or at a different location. Note that none of the patients in group 1 (presence of catheter-associated infection) had the catheter exchanged by a guidewire, whereas patients in groups 2 and 3 all had catheters exchanged via guidewire.

Patients in group 1 were treated with intravenous antibiotics guided by standard practice for their bloodstream infections. Infection clearance was determined based on absence of bacterial growth on repeat blood culture after catheter removal.

Infection rates at 30 and 90 days after TDC replacement were analyzed by two-sample chi- square test. For the 3 groups defined by reason for TDC replacement, a primary analysis of 3 pairwise comparisons were made to compare rates of downstream infection between all groups. A secondary analysis compared the guidewire exchange cohort (patients who had TDC replacement for flow dysfunction or exposed cuff) with the removal and delayed insertion cohort (patients who had TDC replacement due to presence of infection). Infection rates were calculated for each group as total infections per 1000 catheter days.

### Statistical Analysis

Fisher's exact test was used if the expected cell counts were less than 5. Statistical significance was determined using Hochberg's method to adjust for multiple testing, ensuring an overall P value of 0.05. Cox proportional hazard models were used to calculate hazard ratios (HR) for CRBSI at 30 and 90 days between each subgroup. All analyses were performed in SAS 9.4 (SAS Institute Inc., Cary, NC).

## RESULTS

A total of 1030 TDC replacements were performed during the study period, with 537 patients meeting the inclusion criteria (332 [62.4%] female and 205 [38.2%] male). Among these, 435 (81%) catheters were exchanged over a guidewire for flow dysfunction or exposed catheter cuff. An exposed catheter cuff was the reason for 130 (24%) TDC exchanges and mechanical dysfunction was the reason for 305 (57%) TDC exchanges. The remaining 102 (19%) TDC exchanges were performed because patients had an infection; these TDC replacements involved removing the original catheter with delayed insertion of the new TDC (Figure 1).

Comparison of patients who had catheters removed and replaced due to infection versus exchanged over a guidewire for exposed cuff or flow dysfunction revealed no significant difference in CRBSI at 30 days (2.3% vs 2.9%; P = 0.72) or 90 days (5.1% vs 9.8%; P = 0.07) (Table 1). Comparison of patients who had catheters removed and replaced due to infection versus exchanged over a guidewire for flow dysfunction revealed increased risk of infection at 90 days (9.8% vs 4.3%; P = 0.04) (Table 2). Comparison of patients who had catheters only exchanged over guidewire for exposed cuff or flow dysfunction revealed no significant difference in CRBSI at 30 days (3.1% vs 2.0%; P = 0.49) or 90 days (6.9% vs 4.3%; P = 0.25) (Table 2).

The rate of CRBSI per 1000 catheter days after catheter exchanges initiated for distinct reasons was also evaluated and did not reveal any significant difference (Figure 2). Hazard ratios for CRBSI were analyzed between the subgroups (Figure 3). We observed no significant difference in CRBSI for those who had catheters exchanged over a guidewire versus catheter removal with delayed reinsertion at 30 days (HR, 0.78; 95% CI, 0.21-2.82; P = 0.70) or 90 days (HR, 0.51; 95% CI, 0.24-1.07; P = 0.075). We observed no significant difference between patients who had catheters replaced because of infection versus those exchanged due to exposed cuffs at 30 days (HR, 0.95; 95% CI, 0.021-4.25; P = 0.948) or at 90 days (HR, 1.42; 95% CI, 0.58-3.51; P = 0.442). Comparison of patients who had catheters replaced by removal and delayed reinsertion because of infection versus those exchanged over a guidewire for mechanical dysfunction revealed no significant difference of CRBSI at 30 days (HR, 1.52; 95% CI, 0.38-6.06; P = 0.556), but showed a more than two-fold risk of developing infection at 90 days (HR, 2.36; 95% CI, 1.03-5.37; P = 0.042). Patients who had catheters exchanged over a guidewire because of exposed cuff versus those exchanged for flow dysfunction had no significant difference in infection rates at 30 days (HR, 1.59; 95% CI, 0.45-5.63; P = 0.474) or at 90 days (HR, 1.65; 95% CI, 0.71-3.87; P = 0.246).

## DISCUSSION

TDCs are a less desired form of vascular access due to their associated risks and complications. Understanding how catheters are associated with adverse outcomes is important for contextualizing patterns of mortality in patients who receive hemodialysis and for developing treatment protocols that reduce the risk of infection. In this study, our primary endpoint reveals that guidewire exchange of a TDC for exposed cuff or mechanical flow dysfunction was not associated with higher infection risk. TDC cuff exposure was not associated with an increased risk of subsequent CRBSI up to 90 days (about 3 months). However, despite performing catheter removal with a delayed insertion technique, a single episode of CRBSI may double the risk of future infections at 90 days. In previous studies, prior history of catheter-related infection, methicillin-resistant S. aureus

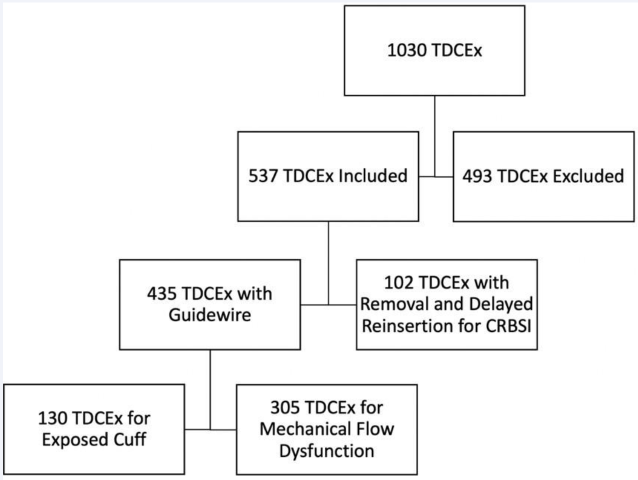


**Figure 1** Visual diagram of study sub-groups. Abbreviations: CRBSI: catheter-related bloodstream infection; TDCEx: tunneled dialysis catheter exchanges.

**Table 1.** Characteristics and secondary analysis of patients who had tunneling dialysis catheter exchange with or without a guidewire.

| Variable (N=537) | aGuidewire Exchange n=435) | bNon-guidewire Exchange (n=102) | *P* value |
|---|---|---|---|
| **Sex** | | | |
| Female | 282 (64.8) | 50 (49.0) | 0.002 |
| Male | 153 (45.2) | 52 (51.0) | |
| **Age, years, mean ± SD** | 63.3±15.1 | 60.5±13.1 | 0.051 |
| **Comorbidities and dialysis characteristics** | | | |
| Diabetes | 302 (69.4) | 78 (76.4) | 0.094 |
| Immunocompromised status | 42 (9.7) | 14 (13.7) | 0.179 |
| Peripheral arterial disease | 97 (22.3) | 26 (25.5) | 0.435 |
| Chronic kidney disease | 419 (96.3) | 94 (92.1) | 0.049 |
| Prior TDC infection | 133 (30.6) | 48 (47.1) | 0.002 |
| Right-sided catheter | 249 (57.2) | 58 (56.9) | 0.945 |
| Internal jugular site | 318 (73.1) | 82 (80.4) | 0.113 |
| **Infection outcome** | | | |
| CRBSI at 30 days | 10 (2.3) | 3 (2.9) | 0.720 |
| CRBSI at 90 days | 22 (50.6) | 10 (9.8) | 0.068 |

CRBSI: Catheter-Related Bloodstream Infection; SD: Standard Deviation; TDC: Tunneled Dialysis Catheter.
All data shown as number (%) unless otherwise indicated.
[a]The non-guidewire exchange group includes all patients from Group 1 in Table 2
[b](catheter exchanged because of infection).
The guidewire exchange group includes all patients from Groups 2 and 3 in Table 2 (catheter exchange due to mechanical dysfunction or exposed cuff). The non-guidewire exchange group had the TDC removed and replaced.

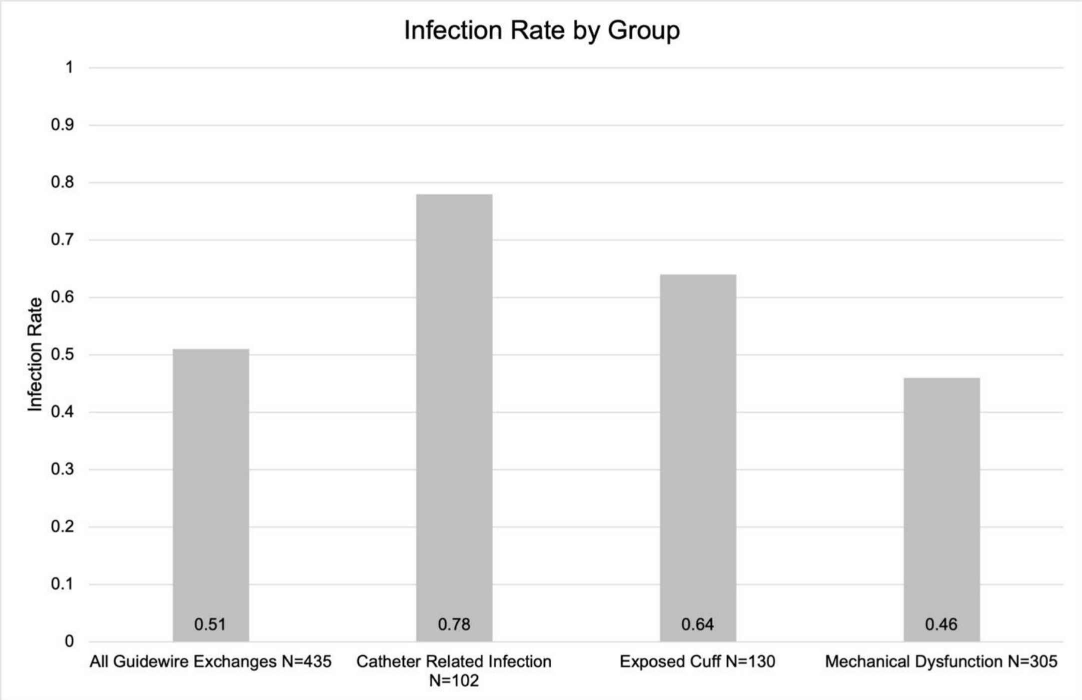


**Figure 2** Rate of infection per 1000 catheter days after catheter exchanges initiated for different reasons.

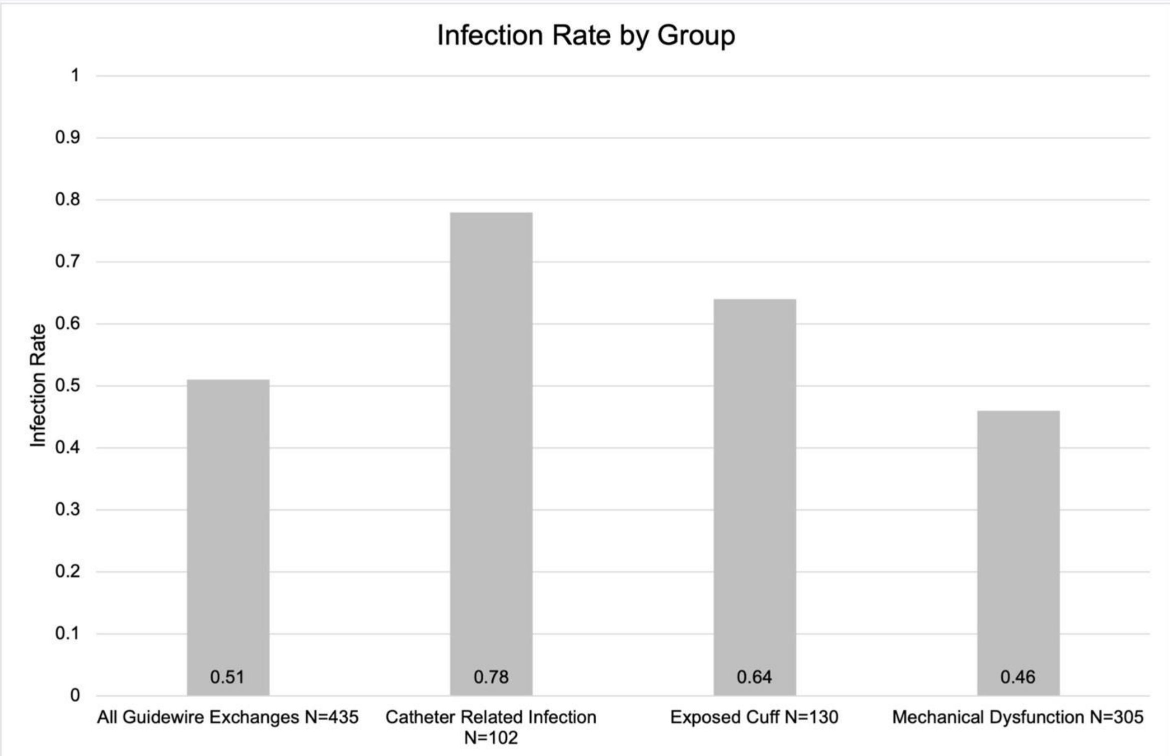


**Figure 3** Hazard ratio for catheter-related bloodstream infection at 30 and 90 days for each subgroup.

**Table 2.** Characteristics and primary analysis of patients who had tunneling dialysis catheterexchange because of infection, exposed cuff, or mechanical dysfunction.

| Variable | All Patients (N=537) | Infection (n=102) | Exposed Cuff (n=130) | Mechanical Dysfunction (n=305) | *P* value | *P* value | *P* value |
|---|---|---|---|---|---|---|---|
| | | Group 1 | Group 2 | Group 3 | 1 v 2 | 1 v 3 | 2 v 3 |
| **Sex** | | | | | | | |
| Female | 332 (62.4) | 50 (49.0) | 84 (64.6) | 198 (64.9) | 0.012 | 0.003 | 0.970 |
| Male | 205 (38.2) | 52 (51.0) | 46 (35.4) | 107 (35.1) | | | |
| **Age, years, mean ± SD** | 63.1±14.8 | 60.5±13.1 | 59.9±16.3 | 64.8±14.3 | 0.777 | 0.005 | 0.002 |
| **Comorbidities and dialysis characteristics** | | | | | | | |
| Diabetes | 380 (70.1) | 78 (76.4) | 80 (61.5) | 222 (72.8) | 0.008 | 0.324 | 0.017 |
| Immunocompro mised | 56 (10.4) | 14 (13.7) | 11 (8.5) | 31 (10.2) | 0.181 | 0.254 | 0.639 |
| Peripheral arterial disease | 123 (22.9) | 26 (25.5) | 19 (14.6) | 78 (25.6) | 0.031 | 0.946 | 0.011 |
| Chronic kidney disease | 513 (95.5) | 94 (92.1) | 130 (100.0) | 289 (94.7) | 0.001 | 0.272 | 0.007 |
| Prior TDC infection | 181 (33.7) | 48 (47.1) | 60 (46.2) | 73 (23.9) | 0.934 | 0.001 | 0.001 |
| Right-sided catheter | 307 (57.2) | 58 (56.9) | 67 (51.5) | 182 (59.7) | 0.419 | 0.618 | 0.117 |
| Internal jugular site | 400 (74.5) | 82 (80.4) | 76 (58.5) | 242 (79.3) | 0.001 | 0.814 | 0.001 |
| **Days TDC in place, mean ± SD** | 162.2±207.6 | 176.3±199.0 | 143.7±196.5 | 164.5±215.0 | 0.157 | 0.433 | 0.246 |
| **Infection outcome** | | | | | | | |
| CRBSI at 30 days | 7 (1.3) | 3 (2.9) | 4 (3.1) | 6 (2.0) | 1.000 | 0.697 | 0.494 |
| CRBSI at 90 days | 33 (6.1) | 10 (9.8) | 9 (6.9) | 13 (4.3) | 0.427 | 0.036 | 0.246 |

**Abbreviations:** CRBSI: Catheter-Related Bloodstream Infection; SD: Standard Deviation; TDC: Tunneled DialysisCatheter
All data shown as number (%) unless otherwise indicated.

carriage, and bacteremia or bacteriuria in the period of 3 months before catheter implantation were noted to be significant risk factors for developing CRBSI [9]. This reinforces the need for preventing initial CRBSIs to mitigate future infection episodes. Our study reinforces these findings.

While intended to be temporary access for many patients, the choice of vascular access with TDC sometimes becomes their final access. It has been observed that patients who initiate hemodialysis with a catheter die at a higher rate than patients who have hemodialysis initiated with permanent access [1]. Furthermore, infection-related causes of mortality are second only to cardiovascular events among patients with end-stage renal disease, and sepsis was the cause of death in 6.5% of patients with end-stage renal disease who died in 2019 [1]. The known risk factors for bloodstream infection in patients who have cuffed TDCs include the duration of the catheter's use, previous catheter-related bacteremia, left-sided internal jugular vein catheter location, hypoalbuminemia, and being on immunosuppressive therapy [10].

Previous studies in children have shown that wire-guided catheter exchange is safe in clinically stable children if the tunnel and the exit site are not infected [11]. In adults, no differences in terms of risk of infection when converting temporary dialysis catheters to long-term TDC over a guidewire have been noted [8,12].

Vessel preservation aims to protect future vascular access sites for arteriovenous fistulas and graft creation. Catheter removals are associated with venous stenosis and loss of venous patency. Frequent removal of catheters and placing the catheter to a new site can hasten the loss of venous entry sites for catheter insertion; therefore, removing and relocating catheters should be limited as much as possible. It is currently thought that when catheter hardware becomes exposed in catheters that have been in place for greater than 2 weeks, the exposure may potentially be caused by an active or developing infection. This scenario often prompts TDC replacement. However, if this were the case, we would expect a higher rate of infection at 30 and 90 days for patients with catheters exchanged over a guidewire because of an exposed cuff than for patients who had catheters exchanged due to mechanical dysfunction, which we did not observe. More recent studies have shown that cuff extrusion is actually common in long-term tunneled hemodialysis catheters [13]. The risk of infection does increase with obesity, history of previous cuff extrusion, certain catheter models, and absence of wing-sutures [13].

Our results suggest that using a guidewire to exchange catheters for mechanical dysfunction or exposed cuff may not increase the risk for CRBSI, and by doing so, we can preserve future vascular access sites. With this information, we may be able to more accurately risk stratify patients who need a change of dialysis access, and potentially decrease mortality. Larger prospective studies are warranted for further verifying the catheter-related risks of infection in patients on dialysis and the role for guidewire-based catheter exchange to preserve vascular access sites.

## LIMITATIONS

Limitations of our study include its retrospective nature and the fact that it was conducted at a single, urban academic tertiary care center, which may limit the generalizability of our findings. The study design does not establish causation, and the study population may not represent those in rural areas or other countries. Specific mechanical dysfunctions, such as poor flow, thrombosis, or broken clamps, were not individually analyzed.

## CONCLUSION

Our study observed that guidewire exchange of TDCs due to mechanical dysfunction or an exposed cuff may not increase the risk of subsequent infection in dialysis patients. Furthermore, using a guidewire for TDC exchange in the setting of exposed cuff or mechanical flow dysfunction does not appear to be associated with infection development, making it a preferred method in the appropriate clinical setting for preserving future venous access sites. It is important to evaluate the risks of CRBSI on a patient-by-patient basis, considering that an episode of CRBSI as a trigger for catheter exchange may double the risk of future infections at 90 days. Prospective randomized studies are needed to assess the underlying catheter-associated causes of downstream infection and compare catheter removal with delayed insertion strategies versus guidewire exchange.

## AUTHORS' CONTRIBUTIONS

Dr. Kumbar conceived the initial study design. Drs Bauer, Hana, and Kumbar participated in study design and applied for institutional review board approval. Drs Bauer, Hana, Kassab, Kumbar, and Rajagopal participated in data entry and data management. Drs Peterson and Kumbar participated in statistical analyses. Drs Rajagopal and Kumbar drafted, reviewed, and revised the manuscript. All authors approved the final manuscript as submitted.

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**Ethical Approval:** Approved by the Henry Ford Health System Institutional Review Board. Approval number 13216.

**Guarantor:** Lalathaksha Kumbar, MD

## REFERENCES

1. United States Renal Data System. 2021 USRDS annual data report: epidemiology of kidney disease in the United States. Bethesda, MD: National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, 2021.
2. Vats HS. Complications of catheters: tunneled and nontunneled. Adv Chronic Kidney Dis. 2012; 19: 188-194.
3. Schon D, Whittman D. Managing the complications of long-term tunneled dialysis catheters. Semin Dial. 2003; 16: 314-322.
4. Silverstein DM, Trerotola SO, Clark T, James G, Ng W, Dwyer A, et al. Clinical and Regulatory Considerations for Central Venous Catheters for Hemodialysis. Clin J Am Soc Nephrol. 2018; 13: 1924-1932.
5. Mermel LA, Allon M, Bouza E, Craven DE, Flynn P, O'Grady NP, et al. Clinical practice guidelines for the diagnosis and management of intravascular catheter-related infection: 2009 Update by the Infectious Diseases Society of America. Clin Infect Dis. 2009; 49: 1-45.
6. Atray N, Asif A. New tunneled hemodialysis catheter placement through the old exit site. Semin Dial. 2008; 21: 97-99.
7. Mokrzycki MH, Singhal A. Cost-effectiveness of three strategies of managing tunnelled, cuffed haemodialysis catheters in clinically mild or asymptomatic bacteraemias. Nephrol Dial Transplant. 2002; 17: 2196-2203.
8. Park HS, Choi J, Kim HW, Baik JH, Park CW, Kim YO, et al. Exchange over the guidewire from non-tunneled to tunneled hemodialysis catheters can be performed without patency loss. J Vasc Access. 2018; 19: 252-257.
9. Delistefani F, Wallbach M, Muller GA, Koziolek MJ, Grupp C. Risk factors for catheter-related infections in patients receiving permanent dialysis catheter. BMC Nephrol. 2019; 20: 199.
10. Kumbar L, Yee J. Current concepts in hemodialysis vascular access infections. Adv Chronic Kidney Dis. 2019; 26: 16-22.
11. Onder AM, Chandar J, Saint-Vil M, Lopez-Mitnik G, Abitbol CL, Zilleruelo G. Catheter survival and comparison of catheter exchange methods in children on hemodialysis. Pediatr Nephrol 2007; 22: 1355-1361.
12. Aboul Hosn M, Nasser Z, Elias E, Medawar W, Daouk M, Hoballah J, et al. Switching temporary hemodialysis catheters to long-term catheters: exchange versus de-novo placement, any difference in line infection?. Clin Nephrol. 2017; 88: 248-253.
13. Parvulescu F, Oliver MJ, Reyna ME, Pugash R, David E. Factors affecting cuff extrusion of tunneled hemodialysis catheters. Can Assoc Radiol J. 2022; 73: 410-418.