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Incidence of Catheter-Related Infections in Maintenance Hemodialysis Patients: A Critical Challenge in Balochistan, Pakistan

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Abstract

Background: Catheter-related infections (CRIs) are a major complication of central venous catheters in haemodialysis patients, contributing to morbidity, mortality, and healthcare costs. Data from resource-limited regions such as Balochistan remain sparse.

Methods: A cross-sectional study was conducted at Sandeman Provincial Hospital, Quetta, between January 2023 and December 2024. A total of 357 end-stage kidney disease patients undergoing maintenance haemodialysis via central venous catheters were enrolled.

Results: CRI incidence was 82.1% (293/357). Exit-site infections predominated (96.2%), while catheter-associated bloodstream infections (22.9%) required earlier catheter removal. Independent predictors included diabetes mellitus (OR 6.3), hypertension (OR 3.1), prolonged catheter duration, and non-sterile gauze dressing.

Conclusions: CRI rates in Balochistan far exceed international benchmarks. Interventions targeting vascular access planning, infection control, staff training, and antibiotic lock therapy are urgently needed.

Keywords: Hemodialysis, catheter-related infection, central venous catheter, Pakistan, Balochistan, infection control, Vascular access

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Introduction

Chronic kidney disease (CKD) is a global health challenge, disproportionately affecting low- and middle-income countries.[1] In Pakistan, haemodialysis remains the main renal replacement therapy due to limited transplantation access.[2]

Reliance on central venous catheters (CVCs)—often temporary and non-tunnelled—heightens the risk of catheter-related infections (CRIs).[3,4] CRIs contribute to hospitalization, mortality, and health system costs.[5,6] International guidelines recommend arteriovenous fistulas or grafts as preferred vascular access.[7]

However, in our Balochistan province of Pakistan, delayed referrals, low surgical expertise, and financial barriers sustain dependency on CVCs.[8,9] The rationale of the study was to assess the prevailing catheter related infections in our center. The main objective of the study was to evaluate the incidence, risk factors, and outcomes of CRIs among haemodialysis patients at the largest tertiary facility in Quetta, Pakistan.

Methods

A cross-sectional study was conducted at Sandeman Provincial Hospital, Quetta, Pakistan (IRB# 2025/23, Dated Jan 17, 2025) from January 2023 to December 2024. Inclusion criteria were adults (≥18 years) with ESRD receiving haemodialysis via CVCs for >48 hours.[10] Patients with systemic infections unrelated to catheter use were excluded. All 357 eligible patients were included. Data were collected using structured questionnaires and medical records. Statistical analyses included descriptive tests, chi-square, Mann-Whitney U, logistic regression, and Kaplan – Meier survival analysis using SPSS v28. (IBM Corporation, New York, USA) Significance was set at $P < 0.05$.

Results

Baseline characteristics and findings are shown in Table 1. CRI was observed in 293 patients. Exit-Site infections was observed in majority of patients 282 (96.2%) and CRI was observed in 67 (22.9%) patients, Figure 1.

Table 1. Baseline Characteristics of 357 maintenance hemodialysis patients undergoing hemodialysis using a ventral venous hemodialysis catheter.

Total patients	**N = 357**
Age	± (23–62) years
Gender	
Male	235 (65.8%)
Female	122 (34.2%)
Primary Diagnosis	
CKD	112 (31.4%)
ESRD	245 (68.6%)
Underlying Conditions	
Diabetes:	183 (51.3%)
Hypertension:	337 (94.4%)
Hepatitis C:	13 (3.6%)
Catheter Site	
Subclavian	306 (86%)
Femoral	43 (12%)
Catheter Duration	**Median:** 22 days (IQR: 18–25)

Over all 2 (0.7%) died related to the CRI. Significant association of diabetes with CRI was observed, Table 2, (Fischer Exact Test: $\chi^2 = 12.4$, $P < 0.001$). As shown in table 1, subclavian

catheters were frequent, nevertheless femoral catheter site was associated with higher CRBSI rates ($\chi^2 = 5.1$, P = 0.023).
Applying Mann-Whitney U Test for catheter duration in patients with CRI vs. Non-CRI, longer catheter duration of catheter correlated with higher infection risk (days= 22 vs 18, U = 7,532, P = 0.004).

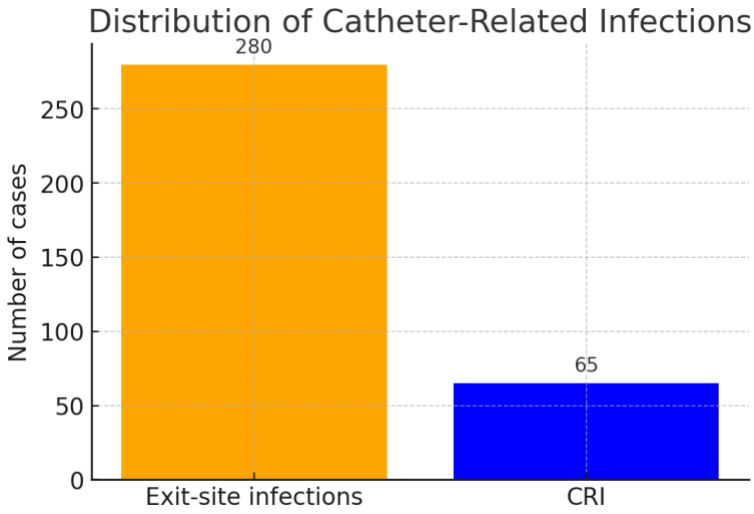

Figure 1: Type of infections related to hemodialysis catheter among 357 hemodialysis patients: Exit site and blood stream infection are shown in the bar graph.

Table 2: Association Between Diabetes and CRI

	CRI (N = 293)	**No CRI (N = 64)**	**P-Value**
Diabetes (N = 183)	163 (89.1%)	20 (10.9%)	<0.001
No Diabetes	130 (74.7%)	44 (25.3%)	

Spearman's Rank Correlation was applied to observe the catheter duration vs. mortality risk among patients with temporary catheter revealing a significant correlation (0.34 (P = 0.001), suggesting each additional day of catheter use increased mortality risk by 34%. Logistic regression analysis for CRBSI is shown in Table 3.

Earlier catheter removal was observed among patients with CRBSI vs exit site infection, 14 vs 28 days respectively (Log-rank $\chi^2 = 9.8$, P = 0.002).

We implemented the good practices for temporary catheter insertion in 2023, however the data from 2022 vs 2023 was not much difference in term of CRI, 78.9% vs 82.1%, p=0.12, modified Chi-Squared Test for trends.

Table 3: Logistic Regression Analysis was utilized to identify the independent predictors of CRBSI

Variable	Adjusted OR (95% CI)	P-Value
Diabetes	6.3 (3.1–12.8)	<0.001
Hypertension	3.1 (1.2–7.9)	0.015
Catheter Duration >30 days	0.1 (0.03–0.3)	0.006
Non-Sterile Gauze	4.2 (2.1–8.4)	<0.001

Model Fit: Hosmer-Lemeshow $\chi^2 = 4.1$ (*P = 0.85), AUC = 0.89.

Discussion

This study demonstrates that the incidence of catheter-related infections (CRIs) in Balochistan is alarmingly high compared to both international standards and other regional reports .[11-,14] The predominance of exit-site infections, combined with a substantial burden of catheter-associated bloodstream infections (CABSIs), highlights systemic issues in vascular access practices and infection control.[15] The findings reinforce the global consensus that temporary central venous catheters should be used only as a bridge to permanent access such as arteriovenous fistulas (AVFs) or grafts.[7] Unfortunately, in this setting, the reliance on temporary catheters remains widespread due to limited surgical expertise, delayed referrals, and socioeconomic barriers.[8,9]

Patient-related risk factors, particularly diabetes and hypertension, significantly amplified infection risk.[16,17] Diabetes impairs host immunity and accelerates colonization of catheter surfaces, while hypertension frequently coexists with other comorbidities that further weaken patient resilience. The high prevalence of these conditions in the dialysis population of Balochistan underscores the importance of comprehensive chronic disease management alongside dialysis care. Prolonged catheter duration also contributed substantially to infection risk, consistent with biofilm formation and microbial persistence described in the literature.[14]

Institutional and procedural gaps were striking. Hand hygiene compliance of only 73% falls short of WHO recommendations, while the absence of chlorhexidine use and universal reliance on povidone-iodine are departures from modern evidence-based standards.[10] Furthermore, non-sterile gauze use and inconsistent exit-site monitoring contributed to infection proliferation.[6,18] Equally concerning was the near absence of structured staff training programs. International evidence demonstrates that nurse-led infection control bundles and continuous staff education can reduce CRI rates by 40 – 60%.[15] This suggests a clear opportunity for intervention.

Microbiological and therapeutic concerns are also significant. Although most infections responded to vancomycin and amikacin, the absence of antibiotic stewardship raises risks of

resistance development.[5] Studies from similar regions have already reported vancomycin-resistant staphylococci and multidrug-resistant gram-negative organisms .[4,7] which, if unaddressed, could complicate treatment and worsen mortality outcomes.[2] Importantly, the implementation of antibiotic lock therapy—an evidence-based intervention—was absent in this centre, representing a missed opportunity to prevent recurrent bloodstream infections.[9]

From a policy perspective, this study highlights the urgent need to establish regional dialysis access programs that promote AVF creation, enforce infection control protocols, and ensure adequate resource allocation.[13] Patient education on catheter care and hygiene practices is equally vital, especially in populations with limited health literacy.[17] Broader systemic reforms, including integration of nephrology services into primary care and improved chronic disease management, could further reduce the burden of catheter dependency.[12]

Future research should explore the microbiological spectrum of CRIs in Balochistan, assess cost-effectiveness of implementing catheter care bundles, and evaluate long-term patient outcomes with interventions such as chlorhexidine dressings and antibiotic lock therapy.[8-10] Comparative multicentre studies would also clarify whether the high CRI rates observed here reflect a provincial or nationwide trend.[11]

In summary, the findings of this study not only highlight an urgent clinical issue but also serve as a call for systemic healthcare improvements. Addressing patient-level vulnerabilities, improving vascular access practices, and bridging institutional gaps are essential steps toward aligning Balochistan's dialysis care with international best practices [14,15]

Conclusion

Catheter-related infections are unacceptably prevalent among haemodialysis patients in Balochistan. Interventions such as improving vascular access, adopting catheter care bundles, and strengthening staff training are essential to mitigate this preventable complication.

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