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Non-tunneled haemodialysis catheter-related blood stream infections and associated factors among first time haemodialysis patients: a prospective study from a tertiary care hospital in Sri Lanka

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Abstract

Background A significant number of patients require non-tunneled haemodialysis catheters (NTHCs) in the event of an urgent need for immediate haemodialysis in developing countries. Catheter-related bloodstream infections (CRBSIs) are a major concern in haemodialysis, but there is a lack of local epidemiological data. This study aimed to determine the incidence of CRBSI, causative agents and associated risk factors in a tertiary care hospital in Sri Lanka.

Methods A prospective study was conducted at the dialysis unit of Colombo South Teaching Hospital, Sri Lanka from December 2019 to August 2020. Adult patients who had haemodialysis for the first time with NTHCs were included.

Results Of 149 dialysis patients (104—jugular vein and 45—femoral vein, mean age 58 ± 13.7 years, mean duration of catheterization 7.9 ± 3.4 days), the incidence of CRBSI was 13.58 per 1000 catheter days. Serum albumin levels, capillary blood sugar levels at admission, haemoglobin levels and duration of catheterization were significantly associated with CRBSI. Prescence of diabetes and patients with ESRD who started routine haemodialysis had a significantly higher risk of CRBSI. Gram-positive bacteria were the most common microorganisms associated with CRBSI (87.5%).

Conclusions Our results show high rates of infection with temporary vascular catheters in Sri Lanka, mainly due to Gram-positive bacteria. Diabetes mellitus, duration of catheterisation, low serum albumin, haemoglobin level and CBS on admission were identified as significant risk factors for CRBSI. Management strategies tailored to specific centers should be established in the nation to optimise catheter care and to monitor local microbiology for appropriate empirical antimicrobial treatment.

Keywords Haemodialysis, Non-tunneled haemodialysis catheters, Catheter-related bloodstream infections, Gram-positive bacteria, Sri Lanka

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Introduction

In developing countries, majority of patients (81%—100%), start haemodialysis (HD) with a non-tunneled haemodialysis catheter (NTHC) as their primary vascular access, especially when urgent vascular access is required for immediate HD [1–4]. Low socioeconomic status, low education level and limited financial support for treatment expenses often lead to late referrals to a nephrologist and thereby contribute to this higher frequency of emergency dialysis requirements [5].

Catheter-related blood stream infections (CRBSIs) are the most significant complication associated with HD catheters [6], with incidence rates ranging from 3.8 to 11.8 episodes per 1000 catheter days for temporary catheters [7–11]. They are a major barrier to the use of central venous catheters and are the second leading cause of mortality in HD patients after cardiovascular disease [7]. The primary agents responsible for causing CRBSIs are predominantly gram-positive bacteria, specifically *Staphylococcus aureus (S. aureus)* and coagulase-negative Staphylococci (CoNS), accounting for up to 80% of cases. Additionally, gram-negative bacteria such as *Pseudomonas aeruginosa*, *Escherichia coli*, and *Klebsiella pneumonia* have also been identified as causative agents [12–14].

Sri Lanka is a developing nation in South Asia and a significant number of patients require temporary vascular catheter access for HD. Currently, there are no local studies which provide epidemiological insights into catheter-related complications, risk factors and patient characteristics. Understanding the risk factors associated with CRBSIs is crucial for developing preventive strategies and determine the optimum duration of NTHCs. In this prospective study, we aimed to study the incidence rates, causative agents and risk factors of CRBSI among patients undergoing haemodialysis for the first time with NTHC.

Methods

Study design and setting

An observational, prospective study was conducted at the dialysis unit of Colombo South Teaching Hospital (CSTH), Sri Lanka from December 2019 to August 2020. We included only adult patients (≥ 18 years) who had haemodialysis for the first time with NTHC and who had the vascular catheter insertion for more than 48 h. We excluded patients who had a previous history of vascular catheter insertion in their lifetime and patients who required dialysis due to sepsis associated AKI (wound, urinary tract, gastroenteritis, respiratory tract, meningitis or any other infection prior to insertion of vascular catheter).

Configuration of the dialysis unit of CSTH

The dialysis unit consist of seven dialysis beds and one procedure room. The staff consist of one nephrologist, eight medical officers and thirteen nursing officers during this period. The unit provides haemodialysis for both acute and chronic kidney failure patients. On average, CSTH provides dialysis services to approximately 600 slots each month.

Catheter insertion

Strict sterile-barrier precautions were followed for the placement and maintenance of catheters. The skin insertion site was initially disinfected with 10% povidone-iodine and anaesthetized with 2% lidocaine. The catheters were then inserted percutaneously using real-time ultra sound guidance (Seldinger technique) and were secured to the skin with 2–0 silk sutures. After catheter insertion, the area around the catheter was cleaned using a sterile gauze soaked in povidone-iodine. Thereafter, a dry sterile gauze dressing was applied to cover the site. We did not use any topical antimicrobial ointment on the insertion sites [15]. Catheter insertions were performed by a team of trained doctors from the nephrology and dialysis unit of the CSTH. The decision to perform catheter insertion and the choice of insertion site were made by the nephrologist as the femoral vascular insertion was done for severe fluid overload and restless patients.

Catheter maintenance

Dressing change was done after each haemodialysis session.

Catheter in situ follow-up

We performed daily follow-up assessments on patients after catheter insertion for any local (erythema, pus discharge) or systemic signs and symptoms (fever, chills) until the removal of the catheter. Our center policy is to keep a maximum of 7 days for femoral vascular catheters and a maximum of 14 days for internal jugular vein vascular catheters (routine removal procedure).

Catheter removal (end point)

Reasons for catheter removal was made by the nephrologist based on the following:

- When the catheter was no longer needed
- Suspected catheter-related infection
- If catheter malfunction due to thrombosis/block

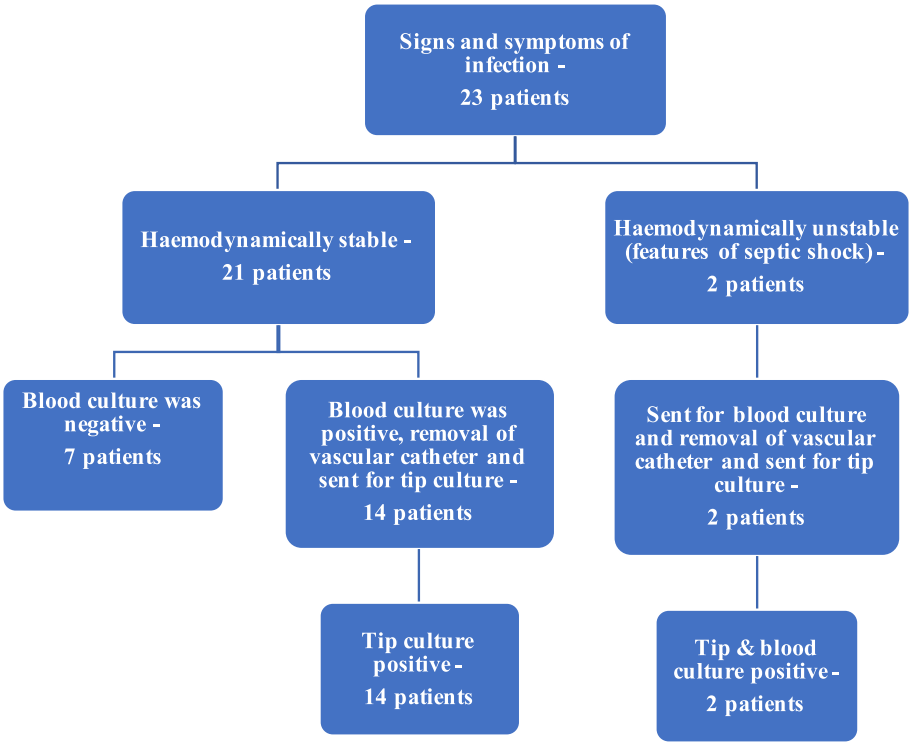

Fig. 1 Management of suspected catheter related infections

- As part of routine removal procedures
- Death of the patient

Definitions

Suspected catheter-related blood stream infection

Peripheral or central line culture positive with systemic or local signs of infection or clinically indicated (hemodynamically unstable patient). At this time, the vascular catheter is removed and sent for tip culture.

Catheter-related blood stream infection was defined as National Kidney Foundation's Kidney Disease Outcomes Quality Initiative (KDOQI) 2019 update [16]

- Catheter-related bloodstream infection (CRBSI) – Same organism from semi quantitative cultures of catheter tip (15 CFU) and from peripheral blood culture in a symptomatic patient with no other source of infection.

Management of patients suspected of CRBSI in our study population is depicted in Fig. 1. Of the participants, 23 patients had signs and symptoms of infection. Among them, 21 were haemodynamically stable; 7 had negative blood cultures and 14 had positive blood cultures, leading to removal of the vascular catheter for tip culture, which was positive in all cases. In addition, 2 patients were haemodynamically unstable with septic shock; both had positive blood and catheter tip cultures after catheter removal.

Identification of blood culture isolates

In CSTH, positive blood cultures are inoculated into Blood agar (human blood), MacConkey agar and chocolate agar. Identification of the Gram-positive organisms were done using colony morphology, gram stain, catalase test and coagulase test. For identification of *Streptococci*, Bile-esculin, Optochin sensitivity, Bile solubility tests were used. Identification of Gram-negative bacteria were done based on colony morphology, oxidase test and Kligler's iron agar (KIA) test. Due to poor resources, identification of Gram-negative bacteria in the hospital laboratory is limited to coliform/ Pseudomonas spp / non fermenters. Therefore, for further identification of Gram negatives, isolates were sent to the national reference laboratory, Medical Research Institute (MRI), Colombo, Sri Lanka.

Data collection

Data including socio-demographic factors (age, sex), laboratory parameters at catheter insertion (FBC, serum creatinine, blood urea, serum electrolytes, serum albumin, arterial blood gas), clinical data (fluid overload/dyspnoea before catheter insertion), type of vascular access, comorbidities (diabetes, hypertension, dyslipidaemia, ischaemic heart disease), use of erythropoietin injections, and blood glucose levels at admission were collected. In Sri Lanka the Bed Head Ticket (BHT) is the primary medical record used for inpatient care and patient management. Variables such as catheter duration, number of haemodialysis sessions, reason for catheter removal and microbiological data were collected using the BHT.

Data analysis

Data were analysed using SAS v 9.3. Binary and categorical variables were analysed using the chi-square and Fisher's exact tests. Independent sample t test was used to analysed continuous variables. Continuous data are presented as mean and standard deviation. Logistic regression analysis was employed to compare the independent variables between patients with and without CRBSI. Logistic regression modelling done on independent variables to eliminate confounding factors and get adjusted values. The results are presented in terms of p values, relative risk (RR), and 95% Confidence Interval (95% CI). A P value of <0.05 was considered statistically significant.

Rate of CRBSI was expressed in number of CVC days and was calculated by the following formula [17].

$$\text{CRBSI rate per 1000 catheter days} = \frac{\text{Number of CRBSI cases}}{\text{Number of CVC days}} \times 1000$$

Results

Patient demographics and baseline characteristics

The study included 149 first-time dialysis patients using temporary catheters (104 in the jugular vein and 45 in the femoral vein). The total duration of catheter use for all patients was 1178 catheter days (955 days for jugular vein catheters and 223 days for femoral vein catheters) and all patients had undergone 388 haemodialysis sessions. The mean age of the population was 58 (± 13.7) years, 54.69% were males and the mean duration of catheterization was 7.9 (± 3.4) days (Table 1). The major indication for catheter insertion for haemodialysis was acute kidney injury (AKI) (82.5%). Hypertension was prevalent in 76.51% and 69.13% of the patients had diabetes mellitus. The average frequency of haemodialysis was 2.6 times per vascular catheter and 53.1% received haemodialysis three

Table 1 Clinical and demographic characteristics of the participants ($N=149$)

Parameter	Value
Age (Years) (mean, ± SD)	58 (± 13.7)
< 65 years (*n*, %)	105 (70.4)
≥ 65 years (*n*, %)	44 (29.6)
Gender	
Male (*n*, %)	80 (53.69)
Female (*n*, %)	69 (46.31)
Comorbidities	
Diabetes mellitus (*n*, %)	103 (69.13)
Dyslipidaemia (*n*, %)	59 (39.6)
Hypertension (*n*, %)	114 (76.51)
Ischemic heart disease (*n*, %)	55 (36.91)
Indication for Haemodialysis	
ESRD HD regular (Maintenance) initiated (*n*, %)	26 (17.5)
AKI/AKI on CKD (*n*, %)	123 (82.5)
Biochemical parameters	
Serum Albumin (g/l) (mean, ± SD)	25 (± 6)
CBS at admission (mg/dl) (mean, ± SD)	139.4 (± 49.7)
Haemoglobin (g/dl) (mean, ± SD)	8.7 (± 2.3)
Platelet value (10^9/l) (mean, ± SD)	219.9 (± 101.5)
Serum Creatinine (umol/l) (mean, ± SD)	677.6 (± 236)
Blood urea (mmol/l) (mean, ± SD)	30.2 (± 15.3)
Serum sodium (mmol/l) (mean, ± SD)	133.6 (± 16.1)
Serum potassium (mEq/l) (mean, ± SD)	5.2 (± 1)
Arterial blood glass (ABG) HCO_3 value (mEq/l) (mean, ± SD)	12.1 (± 4.6)
ABG pH value (mean, ± SD)	7.2 (± 0.4)
ABG CO_2 value (mm Hg) (mean, ± SD)	21 (± 6.5)
Duration of vascular catheterisation (days) (mean, ± SD)	7.9 (± 3.4)
On regular erythropoietin s/c injection (*n*, %)	60 (40.27)
On oral haematinics (*n*, %)	88 (59.06)
Vascular catheter insertion site	
Internal Jugular vein (*n*, %)	104 (69.8)
Femoral vein (*n*, %)	45 (30.2)
Frequency of haemodialysis (mean, ± SD)	2.6 (± 0.8)
< 3 times (*n*, %)	70 (46.9)
≥ 3 times (*n*, %)	79 (53.1)
Catheter related infection	
CRBSI (*n*, %)	16 (10.7)
Indications of infection while on vascular catheter	
Systemic signs (*n*, %)	17 (11.5)
Local signs (*n*, %)	12 (8.5)
Both systemic and local signs (*n*, %)	6 (4)
Reason for Vascular catheter removal	
Suspected infection (*n*, %)	16 (10.7)
Not functioning or thrombosis (*n*, %)	4 (2.68)
No longer required (*n*, %)	87 (58.4)
Routine removal (*n*, %)	36 (24.2)
Death (*n*, %)	6 (4.02)

Table 2 Association of CRBSI with serum biomarkers and clinical parameters

Parameter	Catheter related blood stream infection		*p*-value
	Present,*n*-16 (mean ± SD)	Absent,*n*-133 (mean ± SD)	
Age (years)	58.9 (13.7)	57.7(14.3)	0.7
Serum Albumin (g/l)	21.3 (5.3)	25.6 (6.1)	**0.04**
CBS at admission (mg/dl)	157 (64)	134 (46.6)	**0.04**
Haemoglobin (g/l)	7.19 (1.9)	8.9 (2.2)	**0.03**
Platelet value (10^9/l)	190 (67.1)	222 (103)	0.3
Serum Creatinine (umol/l)	914.9 (326)	776.1 (326)	0.9
Blood urea (mmol/l)	35.2 (10.5)	29.6 (15.7)	0.1
Serum sodium (mmol/l)	134.7 (5.4)	132.4 (16.9)	0.6
Serum potassium (mEq/l)	5.2 (0.7)	5.2 (1)	0.1
ABG HCO_3 (mEq/l)	11 (4.2)	12.2 (4.6)	0.3
ABG pH value	7.23 (0.2)	7.21 (0.4)	0.9
Frequency of haemodialysis	2.8 (0.8)	2.5 (0.8)	0.8
Duration of catheterization (days)	9.3 (4.9)	7.6 (3.1)	**0.007**

times or more per vascular catheter. CRBSI occurred with a cumulative incidence of 10.7% and the incidence rate of CRBSI was 13.58 per 1000 catheter days. The most common reason for vascular catheter removal was no longer required (54.4%), followed by suspected infection (16.8%), routine removal (22.7%) and other reasons, including thrombosis and death.

Factors associated with CRBSI in haemodialysis patients

Patients with CRBSI exhibited significantly lower serum albumin levels (21.3 ± 5.3 g/l) ($p = 0.04$), had higher capillary blood sugar levels at admission (157 ± 64 mg/dl) ($p = 0.04$), and substantial lower haemoglobin levels compared to patients without CRBSI (7.19 ± 1.9 g/l) ($p = 0.03$). Further CRBSI was notable among patients with a higher duration of catheterization (9.3 ± 4.9 days) ($p = 0.007$). However, compared to patients without CRBSI, there was no significant association between CRBSI and age, platelet count, serum creatinine, blood urea, serum sodium, serum potassium, ABG HCO_3, ABG Ph and the frequency of haemodialysis (Table 2).

Factors influencing the risk of CRBSI in haemodialysis patients

Patients with jugular vein catheter insertion had a 49% lower risk of CRBSI, although the finding was not statistically significant. However, the presence of diabetes mellitus at the time of vascular catheter insertion significantly increased the risk, where patients with diabetes were 7.6 times more likely to develop CRBSI. Patients < 65 years had a 31% lower risk compared to patients who were ≥ 65 years, but this difference was not statistically significant. Gender had no notable effect on the risk of CRBSI or frequency of haemodialysis. In addition, comorbidities such as dyslipidaemia, hypertension and IHD did not show a significant association with CRBSI. However, patients with ESRD who started routine haemodialysis had a significantly higher risk, being 6.3 times more likely to develop a CRBSI (Table 3).

Table 3 Risk factors for catheter related blood stream infection

Parameter	Catheter related blood stream infection		Adjusted Relative Risk (95% CI)	*p*-value
	Present	Absent		
Age				
< 65 years	10	95	0.69 (0.27 – 1.8)	0.46
≥ 65 years	6	38	Referent	
Gender				
Female	8	61	1.18 (0.41 – 3.3)	0.75
Male	8	72	Referent	
Diabetes Mellitus				
Present	15	88	7.67 (0.98 – 19.93)	**0.04**
Absent	1	45	Referent	
Dyslipidaemia				
Present	10	49	2.86 (0.98 – 8.34)	0.51
Absent	6	84	Referent	
Hypertension				
Present	14	100	2.31 (0.50 – 10.67)	0.28
Absent	2	33	Referent	
Ischemic heart disease				
Present	9	43	2.42 (0.50 – 7.12)	0.30
Absent	7	90	Referent	
Type of Kidney Failure				
ESRD HD regular (Maintenance) initiated	8	18	6.30 (2.13 – 19.17)	**0.01**
AKI/AKI on CKD	8	115	Referent	
Vascular catheter site				
Jugular vein	9	95	0.51 (0.18—1.48)	0.22
Femoral vein	7	38	Referent	
Frequency of haemodialysis				
< 3 times	6	64	0.64 (0.13 – 3.14)	0.57
≥ 3 times	10	69	Referent	

Microorganisms associated with CRBSI in haemodialysis patients

Gram-positive bacteria were the most common microorganisms associated with CRBSI, accounting for 14

Table 4 Pathogenic organisms causing CRBSI

Type of microorganism	CRBSI (*n*)	Vascular catheter site (*n*)	
		Jugular	Femoral
MRSA	3	2	1
MSSA	11	7	4
E-coli	2	0	2

out of 16 cases. Methicillin-sensitive Staphylococcus aureus (MSSA) emerged as the predominant microorganism, responsible for 11 out of 16 cases of CRBSI. On the other hand, methicillin-resistant Staphylococcus aureus (MRSA) was responsible for 3 cases of CRBSI. Among the Gram-negative strains, two cases were attributed to *Escherichia coli* (E-coli) (Table 4).

Discussion

Temporary catheters (uncuffed, non-tunneled) can be inserted with relative ease through a bedside procedure under local anesthesia, guided by ultrasound without the need for a fluoroscopic facility [18]. In Sri Lanka it is the preferred vascular access for initiating emergency dialysis. To the best of our knowledge, this is the first study conducted in Sri Lanka investigating the rate and risk factors of blood stream infections associated with temporary vascular catheters. We identified 16 CRBSIs, with 9 cases occurring in jugular and 7 cases in femoral catheters. The overall incidence rate of CRBSI was 13.58 per 1000 catheter days (jugular 9.4/1000 catheter days and femoral 31.3 per 1000 catheter days).This was higher than that in other studies involving temporary catheters, which ranged from 0.34 – 11.4 per 1000 catheter days [1, 6–12, 19–21] (Table 5). This highlights a significant risk of CRBSI in our population. Factors such as the lack of a dedicated nephrology ward in CSTH, varying patient characteristics, catheter management protocols, and hygiene standards may have contributed to these observations.

Patients diagnosed with CRBSI had significantly lower serum albumin levels, higher capillary blood glucose levels on admission, and significantly lower haemoglobin levels when compared to those without CRBSI (Table 2). These findings suggest a possible association between nutritional status, glycaemic control and haemoglobin levels with the occurrence of CRBSI. Additionally, the presence of diabetes mellitus at the time of vascular catheter insertion was a significant risk factor for CRBSI, with patients with diabetes 7.6 times more likely to develop CRBSI. These factors have been recognised as risk factors for CRBSI in numerous other studies [7, 12, 21, 23–25, 31, 32]. Therefore, careful clinical assessment, improved nutritional support and effective diabetes management in haemodialysis patients could potentially reduce the incidence of bacteraemia.

Prolonged catheter use provides a greater opportunity for bacterial colonisation and subsequent infection. According to the KDOQI guidelines, NTHCs are recommended for temporary purposes for a limited time period (< 2 weeks internal jugular, < 1 week femoral) [16]. However, instances of longer periods have also been reported [17]. Despite the high incidence of CRBSI observed in our study, the mean duration of catheterization was relatively short in contrast to other studies on NTHCs (7.9 ± 3.4 days) [7, 23, 33]. Nevertheless, our findings highlight a significant association between catheterization duration and infection risk ($p = 0.007$). Hence, adherence to strict catheter care protocols, identifying risk factors for CRBSI and early recognition of signs of infection are vital for reducing the risk of CRBSI and improving patient outcomes.

Although the site of catheter insertion was not significantly associated with CRBSI in this study, the femoral site was more likely to develop CRBSI (Table 3). Similarly other studies have identified femoral site of catheter insertion having higher rates of infection [1, 9, 11, 21, 34, 35]. Therefore, this warrants the use of jugular catheters over femoral whenever feasible and to consider early removal of femoral catheters. In addition, a 6.3-fold increased susceptibility to CRBSI was found in patients with ESRD who started regular HD with NTHCs compared to those with AKI, as observed in 8 out of 26 ESRD patients. This observation suggests a potentially greater susceptibility in patients undergoing routine HD. This is likely to be due to disease-related factors and also implies the importance of permanent vascular access at the time of initiation of routine HD.

In the present study Gram-positive bacteria (*S. aureus*) were the predominant pathogens associated with CRBSI, accounting for 14 out of 16 cases (87.5%). Similarly, studies of temporary vascular HD catheters in different regions have reported a predominance of Gram-positive organisms, ranging from 48 to 100% [6, 8, 10, 12, 13, 20, 21, 24, 26, 27, 29, 30]. However, some studies have reported a significant presence of gram-negative bacteria causing CRBSI [7, 14, 19, 22, 23, 25]. This shift in epidemiology may be due to the emphasis on CVC care approaches aimed at controlling gram-positive bacterial infections or contamination at different sites [25].

Among gram-positive bacteria, MSSA was the predominant microorganism, responsible for 11 out of 16 cases. This finding highlights the significant role of *S. aureus* in CRBSI among patients undergoing HD. Similarly, other studies also reported *S. aureus* as the most common organism causing CRBSI ranging from 20%—68.7% [6–8, 10–12, 20–22, 24–26]. Whereas, CoNS was the most

Table 5 Rates of haemodialysis related infections caused by various types vascular access in different countries

Region	Country	Year	Type of CVC	Study design	Study group	Sample size	CRBSI definition criteria	Mean age (years)	Males (%)	CRBSI (laboratory confirmed)	Overall Incidence CRBSI	Gram positive microorganisms	Gram negative microorganisms	CRBSI due to gram positive cocci (%)
South Asia	Pakistan [22]	2013	NTC	PRSP		40 CRBSI suspected patients	-	45.63	65%	6	NA	*S. aureus* 40%	Pseudomonas aeruginosa 30%, coliform spp 30%	40%
	India [19]	2019	NTC (internal jugular vein only)	RET-ROSP	Adult (> 18 years) incident HD patients who underwent NTHC	169	CDC	47.2	64.5%	36	7.34	(15.1%), CONS, *S. aureus, Enterococcus faecium*	(54.7%) *Pseudomonas aeruginosa, Escherichia coli, Enterobacter cloacae*, NFGNB, *Acinetobacter baumanii, Burkholderia cepacia, Sphingobacterium multivorum, Citrobacter diversus, Aeromonas*	15.10%
	India [23]	2016	NTC	PRSP	Patients with ESRD	127	CDC	53	66.14%	19	NA	*S. aureus* (21%)	(79% in total) *Pseudomonas aeruginosa* 47.4%, *Escherichia coli* 10.5%, *Acinetobacter* spp.10.5%, *Stenotrophomonas maltophilia* 5.3%, *Burkholderia* spp5.3%	21%
	Nepal [24]	2019	NTC	PRSP	Patients with CKD and AKI	594	IDSA	53.1	70.7%	25	NA	*S. aureus* 36%, CONS 20%	*Klebsiella pneumoniae* 16%, Proteus species 8%, *Escherichia coli* 8%, Pseudomonas 8%, Candida spp 4%	56%
East Asia	China [11]	2015	NTC & TC	PRSP	CKD Patients	564 NTC, 385 TCs, total 865 patients		49.53	57.2%	NA	TCs—6.51, NTC-3.95	NA	NA	

Table 5 (continued)

Region	Country	Year	Type of CVC	Study design	Study group	Sample size	CRBSI definition criteria	Mean age (years)	Males (%)	CRBSI (laboratory confirmed)	Overall Incidence CRBSI	Gram positive microorganisms	Gram negative microorganisms	CRBSI due to gram positive cocci (%)
Middle East	Iran [8]	2014	NTC	PRSP	Acute and Chronic renal disease patients	236 catheters in 220 patients	CDC	58.5	54.5%	44	11.4	*S. aureus* (32%), MRSA (18%), CoNS (9%), Enterococci (9%), Streptococcus D (7%)	*E. coli* (14%), *Pseudomonas aeruginosa* (7%), Klebsiella pneumoniae (2%), Acinetobacter (2%)	
	Saudi Arabia [14]	2019	AVF -90 patients (56.3%). AVG – 1 patient ($n=69$, 43.1%) had tunneled CVCs	RETROSP	Patients with ESRD	160	NHSN Manual	48	60.60%	29	0.4 per 100 patient-months	CoNS 18.2%, *S. aureus* 9.1%, MRSA 9.1%, Corynebacterium spp 6.1%, Alpha-haemolytic Streptococcus 3%	*Klebsiella pneumoniae* 15.2%, *Acinetobacter baumannii* 9.1%, *Pseudomonas aeruginosa* 6.1%, *Stenotrophomonas maltophilia* 6.1%, *Serratia marcescens* 6.1%, *Enterobacter cloacae* 6.1%, *Escherichia coli* 3%, *Achromobacter xylosoxidans* 3%	Gram-negative (54.5%), Gram-positive (45.5%)
Africa	Ethiopia [7]	2023	TC -22, NTC-331	PRSP	Acute and Chronic renal disease patients	353 patients	CDC	39.3	57.5%	104	7.74	*S. aureus* (20%), Enterococci	*E. coli, K.Pneumonia, P. aeruginosa, Acinetobacter, K.Oxytoca, P.Mirabilis, Enterobacter cloacae, Citrobacter, K.Rihinoseles, K.Ozaenae, Morganella Morganii*	42.40%

Table 5 (continued)

Region	Country	Year	Type of CVC	Study design	Study group	Sample size	CRBSI definition criteria	Mean age (years)	Males (%)	CRBSI (laboratory confirmed)	Overall Incidence CRBSI	Gram positive microorganisms	Gram negative microorganisms	CRBSI due to gram positive cocci (%)
	Uganda [25]	2022	TC	PRSP	Adults with ESRD receiving chronic HD	121	NHSN manual	50	62.80%	54	5.2	MSSA 14.7%, MRSA 14.7%, Enterococcus spp. 8.8%, CoNS 1.5%	Acinetobacter spp. 20.6%, *Klebsiella pneumoniae* 14.7%, *Pseudomonas aeruginosa* 11.8%, *Escherichia coli* 10.3%, Enterobacter spp. 1.5%, *Citrobacter freudii* 1.5%	Gram-negative – 60.3%, Gram-positive – 39.7%
	Somalia [26]	2022	NTC	RET-ROSP	NA	137	NA	51	59.10%	59	NA	*S. aureus* and MRSA (31.8%), CoNS 16.5%, *Enterococcus faecalis* (5.9%)	E. coli and ESBL producing E. coli (15.3%), *Klebsiella pneumoniae* and ESBL producing Klebsiella (11.8%), *Acinetobacter baumannii* and ESBL producing enterobacter (4.7%), *Enterobacter cloacae* (3.5%), *Pseudomonas aeruginosa* (2.3%). Other Gram-negative bacteria and ESBL (8.2%)	54.20%
	Algeria [21]	2017	NTC	PRSP	All HD patients with temporary CVC	152 NTCs in 94 patients	CDC	NA	44.9%	22	10.8	CoNS 13.6%, *S. aureus* (36.4%)	*Klebsiella pneumoniae* 22.7%, *Acinetobacter baumanii* (9.1%), *Stenotrophomonas maltophilia* (9.1%), Candida spp (9.1%)	50%

Table 5 (continued)

Region	Country	Year	Type of CVC	Study design	Study group	Sample size	CRBSI definition criteria	Mean age (years)	Males (%)	CRBSI (laboratory confirmed)	Overall Incidence CRBSI	Gram positive microorganisms	Gram negative microorganisms	CRBSI due to gram positive cocci (%)
Europe	Netherlands [1]	2004	NTC & TC	PRSP	Patients with acute and chronic renal failure	149 patients (total of 272 catheters)		NA	55.03%	35	Tunneled 1.6, Non tunneled 4.6	48% of cases, predominantly *S. aureus* or *Staphylococcus epidermidis*	Gram-negative—36% The remaining cultures revealed multiple microorganisms or yeasts	48%
	Turkey [10]	2003	NTC	PRSP	Patients in need of emergency HD	67	CDC	NA	56.70%	11	8.1	MRSA 27.3%, MSSA 18.2%, MRCNS 9.1%, MSCNS 9.1%, Enterococcus 9.1%	E. coli 9.1%, *P. mirabilis* 9.1%, Acinobacter sp. 9.1%	72.70%
	Greece [12]	2013	Total-107 AV fistulas – 37.5%, AV graft –11%, NTC-36.%, TC – 15%	RET-ROSP	Outpatients undergoing chronic hemodialysis (ESRD)	239	CDC	NA	47%	148	Permanent fistulae (0.18/1,000 days); grafts (0.39); Permanent tunneled central catheter (1.03); temporary catheter (3.18)	*S. aureus* (36%) *Staphylococcus epidermidis* (17%), *Enterococcus faecalis* (4%), Streptococcus spp (3%), *Staphylococcus lugdunensis* (1%), *Streptococcus agalactiae* (1%), Staphylococcus coag.-negative 1 (1%), *Staphylococcus haemolyticus* 1 (1%), *Staphylococcus simuluns* 1 (1%), *Enterococcus faecium* 1 (1%)	*Escherichia coli* (9%), Klebsiella spp. (4%), Acinetobacter spp. (3%), Enterobacter spp. (3%), *Pseudomonas aeruginosa* (2%), *Stenotrophomonas maltophilia* (2%), Anaerobes (1%), Fungi (1%)	65%
	Serbia [20]	2004	NTC	PRSP	Acute and chronic renal failure	107		NA	NA	16	0.7 and 0.9 CRB per 100 catheter days for Jugular and Femoral catheter	*S. aureus* 68.7%, Enterococcus 25%	Pseudomonas 6.25%	93.70%

Table 5 (continued)

Region	Country	Year	Type of CVC	Study design	Study group	Sample size	CRBSI definition criteria	Mean age (years)	Males (%)	CRBSI (laboratory confirmed)	Overall Incidence CRBSI	Gram positive microorganisms	Gram negative microorganisms	CRBSI due to gram positive cocci (%)
	Spain [27]	2011	NTC	RET-ROSP	NA	19434 positive blood cultures	The international sepsis forum consensus conference on definitions of infection in the intensive care unit	NA	NA	1129	CRBSIs increased from 0.10 episodes/1000 patient-days in 1991–92 to 0.31 in 2007–08	CoNS 44.9%, *S. aureus* 19.8%, *Enterococcus faecalis* 3.4%, other enterococci 0.4%, Streptococcus spp. 0.2%, other 0.2%	Gram Negative -25.2%, *Pseudomonas aeruginosa* (7.1%), Klebsiella spp. (5.0%), *Escherichia coli* (3.6%), Enterobacter spp. (3.1%), Serratia spp. (2.5%), *Stenotrophomonas maltophilia* (1.3%), Acinetobacter spp. (0.7%), *Citrobacter freundii* (0.4%), *Morganella morganii* (0.4%), *Proteus mirabilis* (0.4%), other (0.7%) and Candida (6.2%) spp.	68.60%
	Germany [28]	2019	TC	RET-ROSP		130		68.8	157.7%	NA	2.26	NA	NA	NA
North America	USA [29]	2008	TC	RET-ROSP		NA		47.6	20%	153	NA	CoNS 23.2%%, Enterococcus sp (9.9%, MRSA 6.4%, Corynebacterium sp 4.9%, *S. aureus* 4.9%, *Strep viridans* 2.5%, Propionibacterium sp 1.5%, Micrococcus 0.5%, Pepto streptococcus sp 0.5%, Strep agalactiae 0.5%, Strep pyogenes 0.5%, Bacillus sp 0.5%	Enterobacter sp (18.7%), Pseudomonas sp 4.9%, Klebsiella sp 3.9%, Serratia sp3.4%, Stenotrophomonas sp 3%, E. coli 2%, Acinetobacter sp 2%, Citrobacter sp 2%, Proteus sp 1.5%, Morganella sp 1%, Aeromonas sp 0.5%, Candida sp 1%	55.70%

Table 5 (continued)

Region	Country	Year	Type of CVC	Study design	Study group	Sample size	CRBSI definition criteria	Mean age (years)	Males (%)	CRBSI (laboratory confirmed)	Overall Incidence CRBSI	Gram positive microorganisms	Gram negative microorganisms	CRBSI due to gram positive cocci (%)
	Canada [9]	2000	NTC	PRSP	Patients with acute renal failure and ESRD	211 patients—193 internal jugular, 91 femoral, and 34 subclavian catheters	Canadian definition	NA	NA	24	3.8	NA	NA	NA
	Canada [30]	2004	NTC, TC, AVF and AV Graft	PRSP		527 patients	NA	NA	NA	96	11.97 per 10,000 catheter days	CoNS 45%, *S. aureus* 28.1%, Enterococcus 8.8%	Aerobic gram-negative bacilli 8.6%, other 8.8%	81.90%
Oceania	Australia [6]	1999	NTC	PRSP	Patients with ESRD	52 patients and 105 catheters (jugular and subclavian only)		NA	59.6%	17	6.5	CoNS (41.2%), MSSA (35.29%), MRSA (23.5%)		100%

Abbreviations: *CDC* Centers for Disease Control and Prevention, *CoNS* Coagulase-negative staphylococci, *CRBSI* Catheter-related bloodstream infection, *ESRD* End-stage renal disease, *MRCNS* Methicillin Resistant Coagulase Negative Staphylococci, *MRSA* Methicillin-resistant Staphylococcus aureus, *MSSA* Methicillin-Sensitive Staphylococcus aureus, *MSCNS* Methicillin Sensitive Coagulase Negative Staphylococci, *NFGNB* Nonfermenting gram-negative bacilli, *NHSN* National Healthcare Safety Networks Dialysis Event Surveillance, *NTC* Non-tunnelled catheter, *PRSP* Prospective, *RETROSP* Retrospective, *TC* Tunnelled Catheter

common microorganism causing CRBSI several other studies [6, 27, 29, 30]. Interestingly, *Pseudomonas aeruginosa* was the most prevalent microorganism in India (47.4%) [23] (Table 5). Notably, 21.4% of the *S. aureus* isolates were methicillin-resistant. This was consistent with findings from Somalia [26] and India [23], while some studies reported higher prevalence of MRSA, ranging from 36.4% to 100% [6, 8, 10, 14, 21, 25, 29]. This highlights the need for a multifaceted approach to infection prevention and antimicrobial stewardship in HD settings [36].

Recent K-DOQI guidelines recommend empiric antibiotic therapy against the most likely causative organism, often a gram-positive isolate [16]. In view of the findings from global centers (Table 5), we strongly encourage multi-center studies within each dialysis unit in Sri Lanka and other countries to identify prevalent organisms and associated risk factors. Such studies could improve strategies for optimal management of HD catheters and patient characteristics, thereby reducing the risk of infectious complications. Understanding local microbial patterns may enable clinicians to make informed decisions about the choice of empiric antibiotics in this context.

Our study has several limitations. Firstly, we focused exclusively on CRBSIs where the catheter was removed, since there was no data on catheter exit site infection. Secondly, our inclusion criteria were restricted to patients who underwent HD for the first time with NTHC followed for two weeks, which may have led to an underestimation of the true infection rate. We lacked data on catheter care practices, hygiene measures (both patient and staff) and patient's socio-economic status which serve as proxies for personal hygiene. We did not have data on antibiotic sensitivity; therefore, we cannot comment on antibiotic resistance and multi drug resistant variants. Another limitation of our study is the use of admission CBS rather than HbA1c levels to assess glycaemic control. As a developing country with limited resources at our center, routine HbA1c testing on admission is not feasible due to financial and infrastructural constraints. As a result, HbA1c data were not available for most of our study participants. Nevertheless, CBS levels indicate the patient's glycaemic status upon admission and was the best available option within our current resources. Finally, our study was conducted at a single center with a relatively small sample size, in a short period of time which limits its generalisability and may not capture long-term trends in CRBSI. Although the study was conducted in a tertiary care hospital in an urban area of Sri Lanka, a significant proportion of the patients come to the center from outside the city. Therefore, we cannot definitively state that our findings are exclusively applicable to the local urban population. In addition, the sample size of patients with ESRD was relatively small, representing 17.5% of the total patient population. This limited representation of ESRD patients may affect the generalisability of our findings regarding risk factors specific to this group. The strength of this study would be greatly enhanced by a prospective multi-center randomised design with a larger and more diverse patient population for a longer-term.

Conclusion

In conclusion, temporary catheters are an essential means of acute haemodialysis access, especially in developing countries such as Sri Lanka. Our results show high rates of infection compared with previous studies in other countries. *S. aureas* was the major cause of CRBSI and is comparable to previous reports. Diabetes mellitus, duration of catheterisation, low serum albumin, haemoglobin level and CBS on admission are risk factors for CRBSI. The rate of CRBSI may vary between centres due to patient characteristics and catheter management protocols. Further larger multicentre studies are needed to determine the optimal management of haemodialysis catheters to reduce the risk of infectious complications and to monitor local microbiology for appropriate empirical antimicrobial treatment.

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Authors' contributions

C.M. conceived the research concept and formulated the research question. C.M. and V.S designed the study and A.M supervised the project. C.M. and L.L. designed the database. C.M and T.S conducted the analysis and interpreted the data. C.M, V.S and T.S. wrote the manuscript and edited the final manuscript. A.M critically revised the manuscript for publication. All authors discussed the results and implications and commented on the manuscript at all stages.

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Availability of data and materials

The dataset is available with the Primary Investigator, Dr. Arjuna Marasinghe and can be provided upon request.

Declarations

Ethics approval and consent to participate

Ethical clearance was obtained by the ethics committee of Colombo South Teaching Hospital, Sri Lanka. Written informed consent was obtained from all the participants. Participants had the autonomy to withdraw consent to participate at any point. Any identifiable data on the participants was not collected, maintaining the confidentiality. All methods were carried out in accordance with relevant guidelines and regulations of Declaration of Helsinki.

Consent for publication

All the participants involved in the research gave their consent and agreed upon for publishing the study findings in an online, open-access journal.

Competing interests

The authors declare no competing interests.

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