Original Article

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Reduction of Tunnelled Haemodialysis Catheters Related Infections by Intervention and Training: A 12 and 18-month Audit

Internal Medicine Section

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ABSTRACT

Introduction: Catheter-Related Blood Stream Infections (CRBSI) are an important complication of both non tunnelled and tunnelled haemodialysis catheters, but are often poorly reported for tunnelled haemodialysis-catheters.

Aim: To assess the rate, aetiology, and outcomes of CRBSI in patients using a tunnelled catheter at 12-month and 18-month audits at the newly-opened haemodialysis unit having care bundle as a part of routine catheter care.

Materials and Methods: A retrospective cross-sectional study involving two audits of CRBSI risk (12-month and 18-month audit) was conducted by the dialysis unit doctors and nursing staff at Medanta Super-Specialty Private Hospital, Indore, Madhya Pradesh, India. Centres for Disease Control (CDC) and prevention core intervention/care bundle for Blood Stream Infections (BSI) reduction were incorporated as a part of routine catheter care. The 12-month (May 2018 to April 2019) and 18-month (May 2018 to November 2019) internal clinical audit were evaluated to assess the impact of care bundle on incidence of CRBSIs. Kidney-Disease-Outcome Quality-Initiative (KDOQI)-2006-criteria was used to define CRBSI. Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) version 19.0 software (IBM Corporation, New York, United States). Descriptive and dispersion statistical analysis was done for studied variables.

Results: Total patients in 12-months audit with tunnelled haemodialysis catheter were 14 (7 male and 7 female) with median age 64 years and in 18-months audit patient with tunnelled haemodialysis catheter were 18 (11 male and 7 female) with median age 67.5 years. CRBSI incidence was 2.58 per 1000 catheter days at the end of 12-month, with 132 (71.25-202.25) days of median catheter use. Over the 18-month, the incidence of CRBSI dropped to 1.99 per 1000 catheter days. Median period of catheter use increased to 149.5 (83.5-294.5) days. The primary organisms isolated were predominantly gram negative bacterias.

Conclusion: Tunnelled catheters may be a reasonable alternative vascular access for haemodialysis in patients with arteriovenous fistula failure as implementation and maintenance of multidisciplinary care bundle reduces CRBSI rate in such patients.

Keywords: Blood stream infection, Central venous catheters, Hand hygiene, Permanent catheter

INTRODUCTION

The use of tunnelled Central Venous Catheters (CVC) (or permanent catheters) as haemodialysis access has increased considerably among Indian patients with end-stage renal disease despite strong recommendations for Arterio-Venous Fistula (AVF) [1]. Their prolonged dependence is often complicated by Catheter-Related Blood Stream Infections (CRBSIs), with incidence rates ranged from 0.19-5.5 per 1000 catheter days [2-6].

The CRBSIs may lead to prolonged hospitalisation, increases in costs, morbidity and mortality rates in patients undergoing haemodialysis through catheters [7,8]. In 2003, a five year prospective nested case-control study from Argentina found an additional cost of $ 4888.42 and an increase in hospital stay of 11.9 days for each episode [9].

Although, there is no consensus on the optimal approach to reduce the incidence of CRBSIs, several studies indicate that implementing care bundles and stringent surveillance can decrease the incidence of CRBSI by up to 80%, reaching a rate of zero in some cases [10-13]. However, audits of dialysis unit that has incorporated a multidisciplinary care approach to vascular access and infection management are underestimated and infrequently performed in India [14]. Also, continuous auditing play a vital role in the improvement of adherence to multidisciplinary care approach [15].

For this reason, this audit was conducted in one of the newly opened Indian haemodialysis unit to improve the adherence to multidisciplinary care approach in haemodialysis unit staff and to reduce the incidence of CRBSIs in haemodialysis patients.

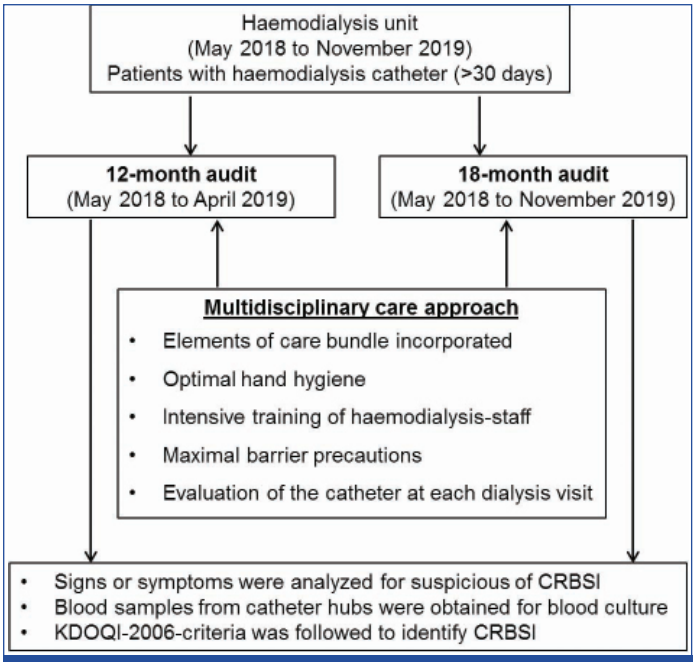
MATERIALS AND METHODS

This retrospective cross-sectional study involving two audits (1st May 2018 to 30th April 2019 and 1st May 2018 to 30th November 2019) was conducted at the newly-opened Haemodialysis Unit of a Medanta Super-Specialty Private Hospital, Indore, Madhya Pradesh, India. The unit has incorporated a multidisciplinary care approach to vascular access and infection management. Patients who were undergoing haemodialysis and had tunnelled haemodialysis catheter for more than 30 days were selected for audit. The audit was conducted by the dialysis unit doctors for the incidence, and aetiology of CRBSI on two different occasions as presented in [Table/Fig-1].

The audit was performed in accordance to Helsinki declaration for the ethical guidelines of humans in medical and health experimentation. The necessity of ethical approval was waived as the audit involved collection of existing data from patient records. The records were anonymised before the data analysis.

Audits

During the 12-month audit, the case-notes of all patients fulfilling the eligibility criteria and had haemodialysis between May 2018 and April 2019 were reviewed in May 2019 and baseline figures were recorded for the incidence of CRBSIs, duration of catheter use and aetiology of CRBSI. Re-audit was done between May 2018 and November 2019 which included patients undergoing haemodialysis. In this 18-month audit, the same parameters were recorded by the dialysis unit doctors. The parameters were assessed as per the routine protocol of the institute.



[Table/Fig-1]: Aetiology of CRBSI in patients with tunnelled haemodialysis catheter during two audits.

Multidisciplinary Care Approach

Centres for Disease Control (CDC) and prevention core interventions for Blood Stream Infections (BSI) reduction were incorporated as a part of routine catheter care in the newly-opened haemodialysis unit of the hospital [16]. These include surveillance and feedback using National Healthcare Safety Network (NHSN), hand hygiene observations, catheter/vascular access care observations, staff education and competency, patient education/engagement, catheter reduction, chlorhexidine for skin antisepsis, catheter hub disinfection and antimicrobial ointment [16]. Full-time Infection Control Nurses (ICNs) were trained by infection control officer to monitor the adherence of each element of this core intervention or bundle care. The healthcare personnel were educated regarding the importance of each element of bundle care and training was given as per the need of the centre. Training of implementation of catheter care bundle (both insertion and maintenance bundle) was conducted in batches, both for clinicians and paramedical staff. The 12-month and the 18-month internal clinical audits were evaluated to assess the impact of care bundle on incidence of CRBSIs.

Catheter-Related Blood Stream Infections (CRBSI)

The healthcare professionals screened patients for vascular access related infection as part of standard procedure during each haemodialysis session. The standard institutional protocol was implemented when the patient displayed signs or symptoms suspicious of CRBSI before or during the haemodialysis session, which included fever (>38.0°C before dialysis and >37.7°C during dialysis), chills, rigors, hypotension, and new unexplained malaise, with concurrent exclusion of catheter unrelated infectious foci. In such patients, the haemodialysis was stopped for as long as necessary to obtain blood samples from catheter hubs (typically ≤1 minute). Haemodialysis was not stopped to obtain peripheral vein or haemodialysis circuit blood cultures. Kidney Disease Outcomes Quality Initiative (KDOQI) 2006 criteria were used to define CRBSI [17]. A bloodstream infection was defined as a positive culture from the catheter with/without a positive peripheral venipuncture sample along with symptoms and signs of a blood stream infection. KDOQI recommendations for management of CRBSI's were followed.

For all patients, clinical and demographical data, including age, sex, history of diabetes, and hypertension were collected.

STATISTICAL ANALYSIS

Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) version 19.0 software (IBM Corporation, New York, United States). Descriptive and dispersion statistical analysis was done for studied variables. Absolute frequency (raw counts) was used to denote CRBSI episodes in two audits. Relative frequency (% of the total number of observation) was calculated for number of male and female patients, cases of diabetes and hypertension, and for number of isolated microorganisms. Dispersion statistics {median (Interquartile range)} was calculated for age of the patients and period of permanent tunnelled catheter use. Incidence of CRBSI was presented as CRBSI rate per 1000 catheter days.

RESULTS

The characteristics of the patients enrolled during 12-month and 18-month audits are presented in [Table/Fig-2]. Over the first 12 month, out of 26 patients on regular maintenance haemodialysis, 14 (53.85%, 7 males and 7 females) had AVF-failure or poor veins and were on tunnelled haemodialysis catheter. The median age was 64 (IQR, 49-70.5) years, and diabetes (78.57%) and hypertension (64.29%) were the most prevalent comorbid conditions. The median period of catheter-use was 132 (IQR, 71.25-202.25) days. Five episodes of CRBSI were identified in four patients; one patient being immunosuppressed had a recurrent infection and lost the catheter to candida infection. The incidence of CRBSI was 2.58 per 1000 catheter days during the first audit [Table/Fig-3].

Characteristics	12-month audit	18-month audit
Total patients	14	18
Male, n (%)	7 (50%)	11 (61.11%)
Female, n (%)	7 (50%)	7 (38.89%)
Median age (IQR) (years)	64 (49-70.5)	67.5 (49-69)
Diabetes mellitus, n (%)	10 (71.42%)	14 (77.78%)
Hypertension, n (%)	9 (64.29%)	11 (61.11%)

[Table/Fig-2]: Characteristics of the patients with permanent catheter.

Variables	12-month audit (n=14)	18-month audit (n=18)
CRBSI episodes, numbers	5	8
CRBSIs rate per 1000 catheter days	2.58	1.99
Period of permanent tunnelled catheter use in days, median (IQR)	132 (71.25-202.25)	149.5 (83.5-294.5)

[Table/Fig-3]: CRSBI rate in first data collection period and in second data collection period.
CRBSI: Catheter-related bloodstream infection

A total of 29 patients undergoing haemodialysis were included in the re-audit period. Of these 29 patients, 18 (62.07%; 11 males and 7 females) were on the tunnelled haemodialysis catheter; 14 continued from the previous audit and four patients fulfilling the eligibility criteria were newly included during the next audit. Two episodes of CRBSI were reported during next six months while prevalence estimate for patients with diabetes and hypertension were 77.78% and 61.11% respectively. The median period of catheter use increased from 132 (IQR, 71.25-202.25) at the first audit to 149.5 (IQR, 83.5-294.5) days at the second audit. The incidence of CRBSI reduced to 1.99 per 1000 catheter days at the second audit [Table/Fig-3].

In the second audit, the primary microbes isolated were gram negative organisms as shown in [Table/Fig-4]. The common microorganisms isolated from CRBSI infection cases were *Escherichia coli* (14.29%), *Candida tropicalis* (14.29%), *Burkholderia cepecia* (28.57%), *Entobacter cloacae* (14.29%), *Staphylococcus aureus* (14.29%) and *Staphylococcus epidermidis* (14.29%). Total 57.14% (4/7) were identified as gram negative organisms, obtained from positive blood cultures in this audit along with 28.57% of gram positive organisms (2/7).

Microorganisms	12-month audit (n=5)	18-month audit (n=7)
Escherichia coli, n (%)	1 (20%)	1 (14.29%)
Candida tropicalis, n (%)	1 (20%)	1 (14.29%)
Enterobacter cloacae, n (%)	1 (20%)	1 (14.29%)
Burkholderia cepecia, n (%)	1 (20%)	2 (28.57%)
Staphylococcus aureus, n (%)	1 (20%)	1 (14.29%)
Staphylococcus epidermidis, n (%)		1 (14.29%)
Total	5 (100%)	7 (100%)

[Table/Fig-4]: Isolated microorganisms from CRBSI cases.

DISCUSSION

The medical audit is a process of reviewing the delivery of health care to identify deficiencies so that it may be remedied. This audit demonstrated that introduction and maintenance of multidisciplinary care bundle appears to increase median duration of catheter use and reduce CRBSI. There was a gradual increase in duration of catheter use and decrease in CRBSI as shown by the first and second audits at the newly opened haemodialysis unit of the study hospital.

National and international guidelines along with national policy initiatives recommend the use of AVF whenever possible, as the risk of blood stream infection is highest in patients with CVCs [18-23]. Previous studies reported approximately 2.5-10 times higher incidence of infection with permanent catheter than AVF [2,24]. However, poor vein and AVF failure were the major reasons to tunnel catheter use among haemodialysis patients in the study unit. The hub of the catheter is a major source of colonisation leading to CRBSI [25]. Further, the comparison of the peripheral blood culture with blood cultures obtained simultaneously from the arterial or venous CVC are frequently impractical in patients on dialysis; blood cultures obtained from the dialysis circuit or catheter lumen are as sensitive and specific, and reasonable alternative [26]. Thus, blood cultures were obtained from the catheter hub in this audit only to salvage catheters and preserve vascular access.

Studies have reported infection rates of about 0.5-5.5 events per 1000 catheter days for tunnelled cuffed catheters [24,27-30]. In 2017, Lok CE classified facility performance based on CRBSIs rate and kept facility with CRBSI rate of 2.1-3.0 episodes per 1000 catheter days under good category [31]. However, the facility with CRBSI rate of <1 and 1.0-2.0 episodes per 1000 catheter days were categorised as excellent and very good [31]. The present audits showed a decrease in CRBSI rate from 2.58 events/1000 catheter days at the first 12-month to 1.99 events/1000 catheter days at the second 18-month, achieving a 22.87% reduction rate. Previous studies have also reported lower CRBSI rates after implementation of control bundles [32-34]. Hymes JL et al., reported a significant reduction in CRBSI to 0.67 per 100 patient months with the use of antimicrobial barrier caps [35]. In 2020, the findings from the Standardising Care to Improve Outcomes in Paediatric End Stage Renal Disease (SCOPE) collaborative showed a significant decrease in adjusted CRBSI rate from 3.3/100 patient months to 0.8/100 patient months after 48 months of care bundle implementation ($p<0.001$) [36]. The reduction in infection rate is surely attributable to increased skill and awareness of healthcare professionals as well as increased compliance with the surveillance and multidisciplinary care bundle elements. The encouraging findings emphasise the need for sustained quality improvement initiatives.

The risk of CRBSI increases with the duration of CVC dependence. A study of 472 haemodialysis patients receiving a first ever tunnelled dialysis catheter found CRBSI in 35%, 54%, and 79% of patients at three, six, and 12 months, respectively [37]. In contrast, the present audit showed 35.71% (5/14) CRBSI in positive culture at 12-month audit and 38.89% (7/18) at 18-month audit.

An increase in median period of catheter use from 132 days during initial 12-month to 149.5 days, over 18-month was found in this audit. However, a previous study involving the use of tunnelled catheter has reported a median period of seven months [1]. Thus, tunnelled catheters may be an alternative for patients with poor veins and having limited options for AV-Fistula/graft.

Although, previous studies from various countries have reported gram negative bacterial growth in 15% to 26% of positive cultures [24,38-42], Gram negative organisms were the predominant microbes (57.14%) from positive blood cultures in our audit, with only a smaller proportion of CRBSIs attributable to gram positive organisms (28.57%). The finding is consistent with few Indian studies who reported gram negative pathogens as the major causative agents for CRBSIs [43,44]. The proportion of gram negative CRBSI was much higher than that reported in western hospitals [43]. The higher prevalence of gram negative pathogens is mainly facilitated by poor hand hygiene, water contamination and inadequate disinfection or sterilisation of instruments or surfaces [44].

Limitation(s)

There are some limitations of this clinical audit. In most instances, only one sample per patient was obtained. The patients who had a recent catheter placement were not excluded. This might not have given enough time for the catheter to become colonised, as endoluminal colonisation of catheters may increase with time. Finally, in dialysis patients the outer surface of the extravascular segment of the catheter, rather than the endoluminal surface, may have a higher microbiological yield.

CONCLUSION(S)

In conclusion, tunnelled catheters may be used for vascular access in haemodialysis patients with arteriovenous fistula failure. Introducing and maintaining a multidisciplinary care bundle can lead to reduction in CRBSI.

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