**Research article** **Medical research**

# A study of catheter-related blood stream infections and associating risk factors in hemodialysis patients

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## ABSTRACT

### Background
Catheter-related bloodstream infection (CRBSI) is a frequent cause of mortality and morbidity in dialysis patients with ESRD, and the organisms isolated varies across different dialysis centers.

### Objective
This Study is aimed to find the associating risk factors in our centre for catheter related bloodstream infections and see if there is any commonality between the risk factors in other centres mentioned in other studies.

### Methodology
This was an observational retrospective study at Saveetha Medical College and Hospital, Chennai, India. The data collected were related to patients' demographics, duration of renal failure, presence of comorbidities, site of catheter insertion and duration, presence of fistula failure, biochemical investigations. Furthermore, microbiological data including cultures from catheter sites and blood.

### Results
The data collected from 80 patients undergoing haemodialysis in our centre of which 49 were male and 31 were female, from Jan 2019 to June 2019 were analysed. Infection rate was 58.75%. Highest rate of infection was noted in patients with catheter placed greater than 30 days and in patients with femoral vein catheter and tunelled cuffed catheter. Staphylococcus was the most commonly isolated Species of organisms (54%).

### Conclusion
The factors which have a significant association with the occurrence of bloodstream infections in our study is the duration of catheter placed greater than 30 days, fistula failure, hypoalbuminaemia and the insertion site. Cephalosporins and Vancomycin were the commonly given antibiotics.

## INTRODUCTION

Hemodialysis is one of the procedures opted for patients with End-stage Renal disease (ESRD) with failing kidneys. Most of the patients present to the OPD when the disease has progressed to the end stage, when drugs have failed. In these cases, the immediate treatment is hemodialysis with a Central Venous Catheter (CVC).[1] CRBSIs are higher in immunocompromised individuals. Indwelling vascular catheters are colonised by microorganisms after insertion.

Major source of infection arises from bacterial biofilm that is produced externally and within catheter lumen. CRBSIs are major causes of morbidity and mortality in catheterised hemodialysis patients. Major sites of catheter insertion are: subclavian vein, IJV, femoral vein. [2] The aim of our study is to look into the blood stream infections (BSI) in hemodialysis patients and causative organisms and to assess the risk factors and discuss other contributing factors in our set-up.

## METHODOLOGY

Retrospective studies were conducted at Saveetha Medical College, Chennai, India on 80 patients in the Nephrology dialysis unit between January-June 2019. The history of CRBIs were collected from medical archives, case files, medical records. The data collected were demographic details, co-morbidities, catheter site, duration placed, type and side of fistula, grade of failure, C/S, presence/absence of fever or any other associated symptoms or complications, admitted with sepsis/CRBSI, Treatment/antibiotics given, biochemical investigations. Diagnosis was confirmed by collecting blood samples from suspected individuals and sending them for blood culture test. The data was analysed using spss software 19.

## INCLUSION CRITERIA

All patients who complain of fever and chills associated with catheter insertion despite the blood culture results.

## OUTCOMES

(n=80)

**Table 1**

| Demographic | Total | Fever +ve | Culture +ve | No growth |
|---|---|---|---|---|
| **Sex** | | | | |
| Male | 49 | 30 | 21 | 9 |
| Female | 31 | 16 | 10 | 6 |
| **Age** | | | | |
| <40 | 17 | 10 | 7 | 3 |
| 40-60 | 42 | 22 | 15 | 7 |
| >60 | 21 | 15 | 9 | 6 |
| **Co-morbidities** | | | | |
| Diabetes | 39 | 24 | 16 | 8 |
| Hypertension | 32 | 21 | 14 | 7 |
| **Duration of catheterisation** | | | | |
| $\leq$ 30 days | 28 | 14 | 10 | 4 |
| >30 days | 52 | 33 | 21 | 12 |
| **Fistula failure** | 27 | 20 | 16 | 4 |
| **No Fistula failure** | 53 | 27 | 15 | 12 |
| **Insertion site** | | | | |
| R. IJV | 69 | 37 | 24 | 13 |
| L. IJV | 5 | 4 | 2 | 2 |
| Femoral | 4 | 4 | 4 | 0 |
| Perm catheter | 2 | 2 | 2 | 0 |
| **BSI admission** | 24 | 24 | 18 | 6 |
| **Septic shock** | 18 | 18 | 12 | 6 |
| **Biochemical investigations** | | | | |
| Albumin | | | | |
| $\leq$3.4g/dl | 42 | 36 | 25 | 11 |
| >3.5g/dl | 38 | 11 | 6 | 5 |
| **Deaths** | 4 | 4 | 4 | 0 |

**Table 2: Frequency of organisms leading to CRBSIs in hemodialysis patients**
**Gram Negative**

| | |
|---|---|
| Enterobacter cloacae | 5 |
| E. coli | 3 |
| Enterococcus faecalis | 2 |
| Strenotrophomonas | 2 |
| Burkholderia | 2 |
| **GRAM POSITIVE** | |
| Staph. Epidermis | 2 |
| Staph. aureus | 4 |
| MRSA | 2 |
| MR-CONS | 5 |
| Staph hemolyticus | 4 |
| **No growth** | 16 |

## GRAM SENSITIVE ORGANISMS



Gram Negative
45%

Gram Positive
55%
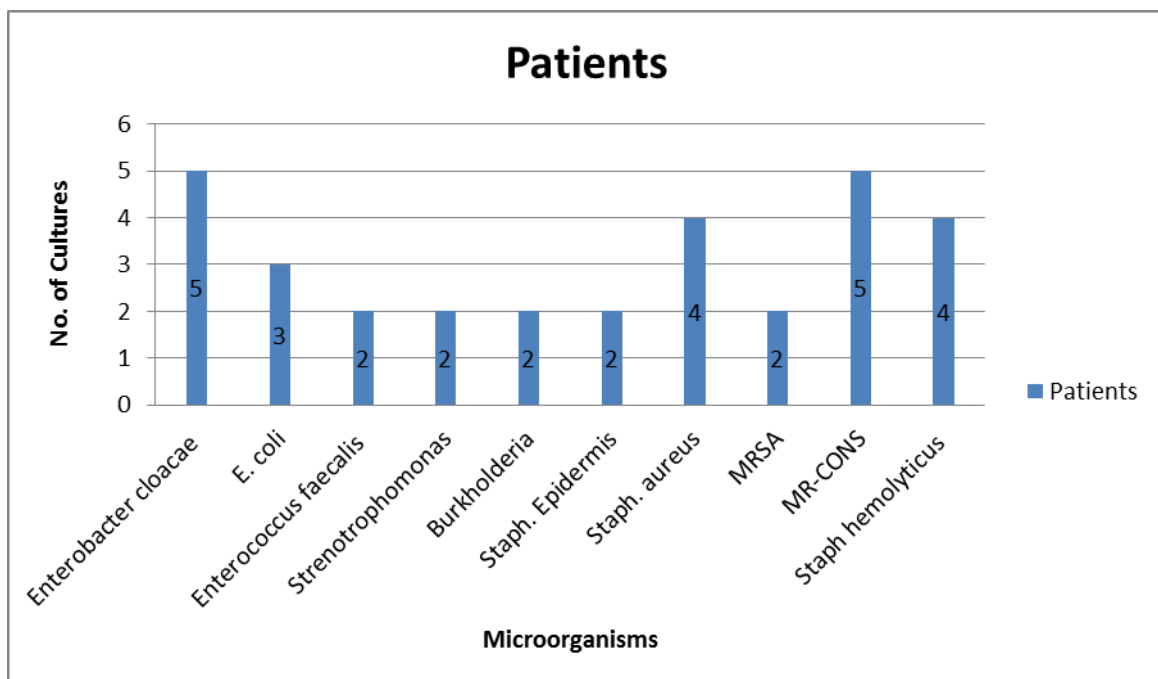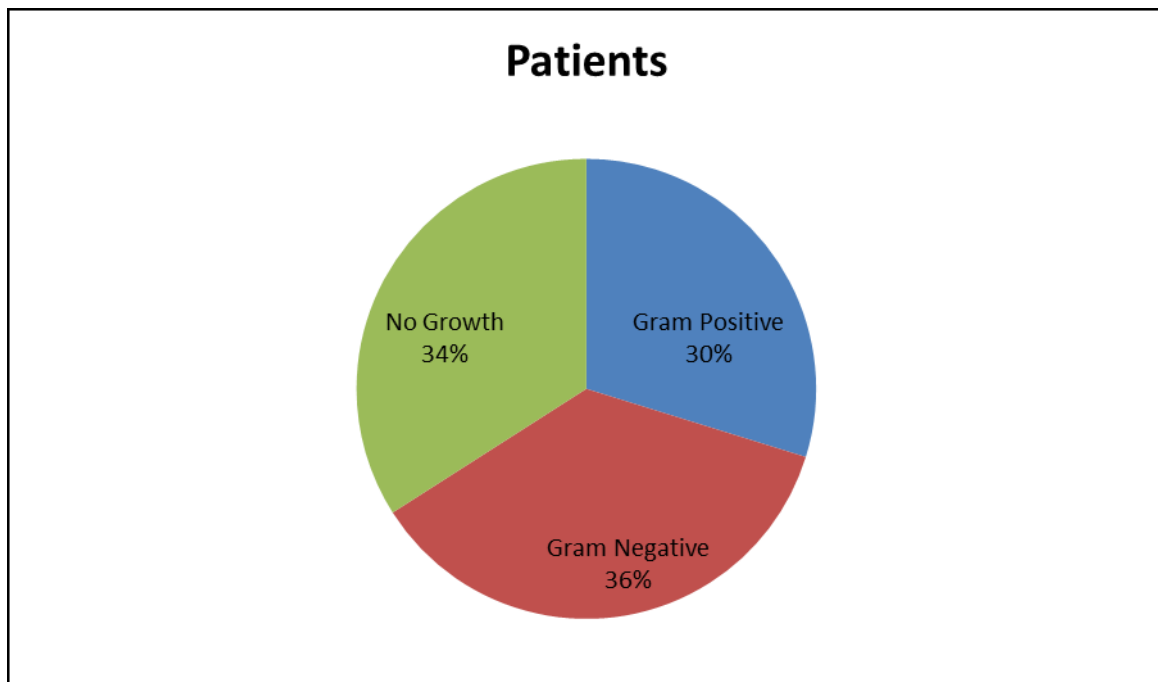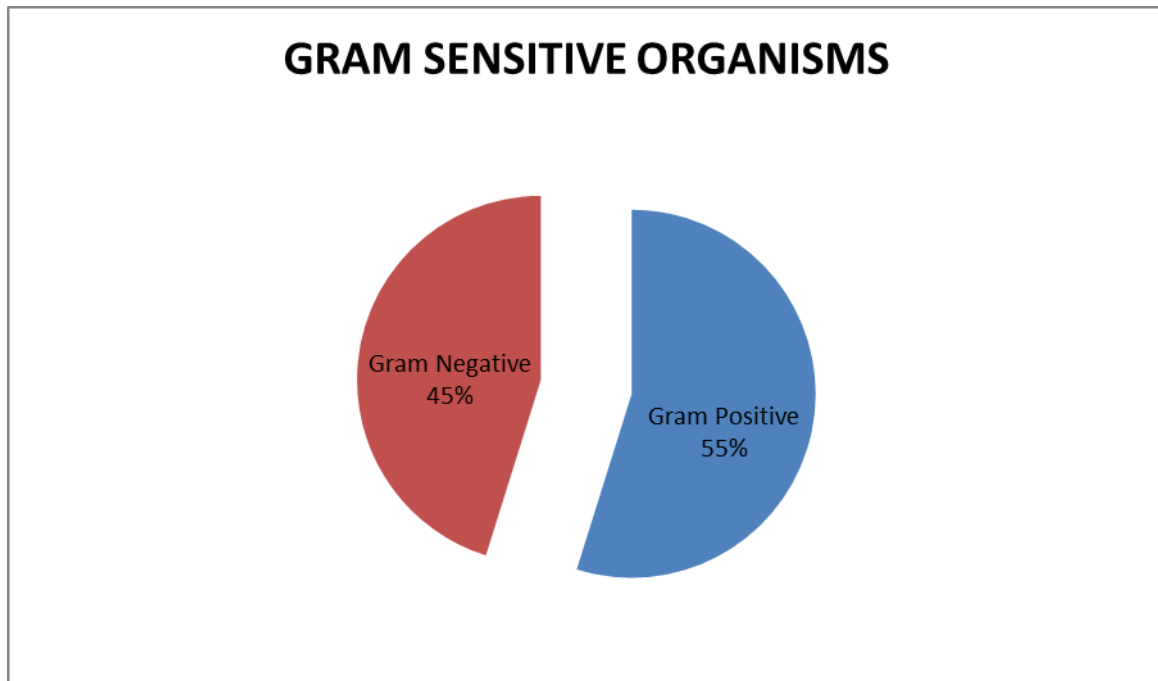
## RESULTS

The study was conducted on a total of 80 dialysis patients of which 49 were women and 31 were females of mean age as 51.588 and standard deviation of 13.3091. Out of 80 patience 48.75 % patients are diabetes and 40 % patients had hypertension. 86 % of the patient were on the right IJV catheter and 6.25 % were on left IJV 5% were on femoral vein catheter and 2.5% on perm catheter. Basically, perm catheter is tunnelled cuffed catheter and right and left IJV are non tunnelled temporary catheters.

Duration of catheter was placed in patients which were less than 30 days were 35 %, and greater than 30 days were placed in 65% of the patients with mean of 42.100 and standard deviation of 25.7906
Hypoalbuminaemia was present in 52.5% of patients. And there was still a failure in 33.75% of the patients. AVF failure was present in 32.6% patients. Number of deaths recorded were 5%.
58.75% of patients complained with presence of fever and chills. 51.25%of the patients had culture sensitivity positive and 20% of the patients had no growth on culture sent. 30% of patients were admitted due to bloodstream infections in the ICU and 21.25% of patients had septic shock and were treated.

The predominant complication was hypertension (28%) and vomiting (23%), with other complications such as dizziness (13%), muscle cramps (5%), hypoglycaemia (10%) and no complications (12%) and we could see other minor complications (0-1%) like thrombus formation in the catheter, itching, chest pain, stomach pain, back pain, headache.

## DISCUSSION

The occurrence of bloodstream infections in haemodialysis patients have contributing risk factors which vary according to geographic location, handling of instruments, adequate staff knowledge, financial basis, demographic basis etc. We are going to look into the contributing risk factors in our area and in our hospital and draw a match if these risk factors are universal.

In a study done by Masashi Suzuki et al, it was reported that half to 3/4ths of the causative organisms of bacteremia in hemodialysis patients are Gram-positive bacteria.The remaining less than 1/4 are Gram-negative. Among the causative organisms, S. aureus, including methicillin-resistant S. aureus (MRSA), is the most common causative organism. Other staphylococci, including S. epidermidis and coagulase negative staphylococcus (CNS), are also common Gram-positive organisms. Escherichia coli (E. coli), Enterobacter species and Klebsiella species are the common Gram-negative organisms isolated from blood samples. [1]

According to our study, there is a predominance of Gram positive organisms (55%) amongst which the most commonly isolated species is that of Staphylococcus; MR-CONS (16%), Staph. Aureus and Staph. Hemolyticus (12%), and Staph. Epidermis and MRSA (6%). The remaining (45%) is of Gram negative bacteria consisting of Enterobacter cloacae

(16%), E. coli (9%), Strenotrophomonas (6%) and Burkholderia (6%).

We have also come across 16 blood samples of No growth (34%), which may be due to the fact some of our patients from lower socio-economic strata avoid the additional out-of-pocket expense of investigations like cultures in favour of broad spectrum antibiotics following the occurrence of fever.

Our study shows a significant association between Insertion site and occurrence of Bacteremia (p=0.019). Majority of the catheters inserted were at the Right IJV (86%) out of which 53.6% are found to have CRBSI. Insertion at the Left IJV in 6.25% patients out of which 80% are found to be infected while the Femoral vein accounted for 5% patients with all of them being infected and Perm Catheter in 2.5% patients with all infected. Our data suggests that patients on Femoral and Right IJV catheters are more likely to acquire an infection in comparison to Left IJV catheters. The tunnelled catheter numbers are likely too small to make a meaningful interpretation.

According to the study done by Masashi Suzuki, the most important risk factor for bacteremia in hemodialysis patients is the use of central venous catheters. Hemodialysis catheter uses were at higher risk of bacteremia compared with arteriovenous fistula or graft uses. [1] In another tertiary setup, Right femoral catheter insertion site had higher infection rates (39.6%) followed by the right jugular site (35.1%) and the left subclavian site had the least percentage of infection (0.9%). [2]

Long-term use of acute catheters is not recommended, but does occur, with acceptable infection rates, in dialysis centers where tunnelled, cuffed catheters are not available. [1] Concerning the indwelling time for catheter access, the acute catheter lacks a subcutaneous cuff, and it should be restricted to the first 1 or 2 weeks of HD, knowing that beyond 1 week, the infection rate increases exponentially. Moreover, guidelines recommend that temporary catheters should remain in place no longer than 5 days at the femoral vein. [1]

In a study Ibrahim Masoodi and others reported that the the highest rate of infection (36.8%) in this study was observed in catheter inserted for 1 week. [2] In our hospital, the catheters are placed for a minimum of 25-30 days to wait for the arteriovenous fistula to mature and also due to low socioeconomic conditions of the patients.

35% of patients have had their catheters removed before 30 days out of which 50% have been found to have infection. Whereas 65% patients have had their catheter for longer periods out of which 62% have had infection. We have found a significance in the association with duration of catheterisation and occurrence of CRBSI (p=0.002) and goes in agreement with other studies (reference multiple papers here). Hence, if we reduced the duration of catheter usage we could lessen the chance of bacteremia.

Hypoalbuminemia is an indication of poor immune status of ESRD patients. A sizable proportion of subjects in a study done in a tertiary hospital in Northern India were hypertensive and had low albumin levels perhaps suffering from malnutrition. Hypoalbuminemia (<3.5) has been reported to be a risk factor for recurrent bacteraemia. [3]

In our study, we have found a significant association with the albumin levels and occurrence of CRBSI and 52.5% of patients have low albumin levels and 85% are associated with bacteremia. (P=0.001).

Multiple puncture of the fistula leads to the destruction of natural barriers of the skin and subcutaneous tissue causing an increase in the incidence of CRBSI in a study done in Germany. [4] And our results are consistent as there is a significant association in fistula failure and incidence of CRBSI (p=0.046).

In a study conducted in Iranian hemodialysis patients, it shows that males have a higher incidence of CRBSI than females. [5] On the other hand, the incidence of CRIs has been higher in females than males in a study done in Bangalore, India. [10] However, in a research dome by Elizabeth Young and others have reported no difference in the incidence of CRBSIs comparing males and females. [6] This is consistent with our study of 61% males and 31% females where the results also asserted no significant association between gender and the risk of CRBSIs in patients undergoing hemodialysis.

According to a study done in Iran, the highest incidence of CRBSIs was observed in patients with 61-70 years old. In line with their findings, patients > 70 years old had also shown increased incidence of CRIs.[5] On the contrary, Hemmati et al and Tokars et al reported a decrease of about 60% in the incidence of CRIs with increasing age. [7]

In our study there was no significant association with the age and with incidence of

CRBSIs which might be due to low sample size, which is one of the limitations of our study.

In a study done by Sahli F & colleagues, diabetes has been associated with a higher risk of CRBSIs in hemodialysis patients [8]. On the other hand, a study done by Taylor G & others showed no relationship between the incidence of CRIs and diabetes [9]. That would be in line with our results as well, stating no significant association with co-morbidities and CRBSIs.

In the reviewed literature, hypotension is the most common acute complication (20-50%) of HD, followed by muscle cramps (20%), nausea and vomiting (5-15%), dialysis disequilibrium (10-20%), headache (5%), chest pain (2-5%), itching (5%), fever and chills (< 1%), arrhythmias, hypoglycaemia, hemorrhage, blood-membrane interaction like the first use syndrome and acute hemolysis.[10]

According to the study done in our hospital, the predominant complication is hypertension (28%) and vomiting (23%), with other complications such as dizziness (13%), muscle cramps (5%), hypoglycaemia (10%) and no complications (12%) and we could see other minor complications (0-1%) like thrombus formation in the catheter, itching, chest pain, stomach pain, back pain and headache.

Prevention by reducing the use of a catheter for HD to a minimum, periodic surveillance of BSI, hand hygiene care, catheter access care observation to assess staff to aseptic technique when connecting and disconnecting catheters and during dressing changes, staff education and skill, adequate nurse to Staff ratio, patient education, catheter reduction, chlorhexidine for skin antisepsis, the application of antibiotic ointment or povidone-iodine ointment to catheter exit-site change can be adopted. [6]

In our hospital, 95% patients get the dialysis via a state-government sponsored scheme where the dialysis is given free of charge. However, medications and tests are to be paid for out of pocket and due to low socioeconomic conditions of the patients they don't agree for a culture unless absolutely necessary which could explain the high number of "no growth" cultures.

Since the most commonly isolated organism usually we suspect are gram positive organisms we employ a predominantly Gram positive antibiotic coverage and this increases the risk of antibiotic resistance.

Due this socioeconomic reason, majority of patients stay on catheters despite occurrence of fevers and treatment and beyond the advised time limit as they cannot afford a transplant or if their fistula hasn't matured to convert to dialysis via a fistula. As most patients present directly in ESRD we haven't been able to implement a Fistula first policy with any degree of success.

## LIMITATIONS OF STUDY

One limitation of our study was that our results may not be generalizable to other nephrology centers in India because of low sample size. Also, the pattern of microbial resistance was not determined in our study.

## CONCLUSION

Conclusions drawn from our study is that the duration of catheter placed greater than 30 days is a risk factor in occurrence of bloodstream infections(BSI). Also hypoalbuminaemia is a risk factor for BSI. Fistula failure also contributes to easy susceptibility of infection. The most commonly associated organism was from the Staphylococcus species.

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