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Original Research Article

Dialysis Events-A Retrospective Observational study

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ABSTRACT
Background: Persons receiving hemodialysis are at risk for various complications including bloodstream and vascular access infections. We summarize 2011-2023 data regarding dialysis events in our tertiary care hospital.
Aim: To analyse various dialysis events in our tertiary care hospital.
Methods: In this retrospective observational study, dialysis related various adverse events including vascular access infections were analysed. The three types of dialysis events (positive blood culture; intravenous antimicrobial start [ABX]; and pus, redness, or increased swelling [PRS] at the vascular access site) were reported using a standard data collection form. All types of vascular access that the patient has at the time of the event were reported. Facilities also report patient demographic data, associated clinical symptoms (e.g., fever, chills, and drop in BP), and select event-related outcomes (i.e., hospitalization and death).
Results: Large number of hemodialysis sessions were noted. Predominant events were various infection episodes followed by non-infective events like dialysis catheter blocks, AVF failure, steal syndrome, AVF aneurysm, AVF thrombus, venous hypertension edema, gastrointestinal (GIT) bleeding, hypoglycaemia, hypotension, accelerated hypertension, seizures, muscle cramps was noted in 198 patients, cerebrovascular events, cardiovascular events, dialysis dysequilibrium, malignancy, discontinuation/shifting to other dialysis mode and death were noted in decreasing frequency.
Conclusions: Infection was the most common event. Dialysis catheter infection followed by respiratory tract infection were the most common site of source of infection. Most common non-infective complications were due to muscle cramps, hypoglycaemia followed by hypotension episodes.
Local and regional efforts and surveillance are needed to reduce infections among this vulnerable patient population should incorporate this established system of measurement.
Keywords: Hemodialysis, Infection, Surveillance.

INTRODUCTION

Many patients receive hemodialysis at outpatient dialysis centers in India. Patients on hemodialysis are at high risk for infection because of their impaired immune defences and repeated access of the bloodstream through vascular access sites. Common hemodialysis vascular access types in order of increasing infection risk are arteriovenous fistulas (AVFs), arteriovenous grafts (AVGs) and central venous catheters (CVCs). Infections in patients on hemodialysis increase mortality, hospitalization, health care costs, and need for antimicrobials. Frequent administration of antibiotics to patients on hemodialysis contributes to antimicrobial resistance and multidrug-resistant organisms (MDROs). Tracking of infections and other adverse events among patients on hemodialysis is useful to facilitate quality improvement and monitoring of the effectiveness of infection prevention measures.

Background and Objectives

Persons receiving hemodialysis are at risk for various complications including bloodstream and vascular access infections. We summarize 2011-2023 data regarding dialysis events in our tertiary care hospital.

Design, Setting, Participants, & Measurements

Dialysis facilities report various types of dialysis events, like infections (bloodstream infections, respiratory tract infection, urinary tract infection, seroconversion to viral hepatitis infection), hemodialysis vascular access site complications like infection, hematoma, thrombosis, aneurysm, failure, venous hypertension, arm edema, intravenous antimicrobial starts, needle stick injuries, muscle cramps, dialysis dysequilibrium syndrome, cardiovascular events, hypotension, accelerated hypertension, cerebrovascular events, hypoglycaemia, gastro-intestinal bleeding, dialysis outcome like dialysis recovered, discontinued, shifted elsewhere, death). We calculated dialysis events in both outpatients and inpatients settings.

MATERIALS AND METHODS

In this study, dialysis related various adverse events including vascular access infections were analyzed.

The three types of dialysis events (positive blood culture; intravenous antimicrobial start [ABX]; and pus, redness, or increased swelling [PRS] at the vascular access site) were reported using a standard data collection form. All types of vascular access that the patient has at the time of the event were reported. Facilities also report patient demographic data, associated clinical symptoms (e.g., fever, chills, and drop in BP), and select event-related outcomes (i.e., hospitalization and death).

Ethics committee Approval

Ethics approval was obtained from Vydehi Institute of Medical Sciences and Research Centre, Bengaluru, VIEC/2023/APP/156.

Definitions of Dialysis Events

A positive blood culture is reportable if the blood specimen was collected in the outpatient setting or within 1 calendar day after a hospital admission (i.e., on the day of or the day after admission to the hospital). For each positive blood culture, the suspected source is indicated as (1) vascular access, (2) another site, (3) contamination, or (4) uncertain. All reportable positive blood cultures were defined as BSIs, regardless of suspected source. Susceptibility to antibiotics were reported as susceptible, intermediate, resistant, or not tested. An intravenous ABX is any outpatient initiation of intravenous antibiotics or antifungal drugs in a patient who has not received antimicrobials in the previous 21 days. Facilities also report when the patient has one or more symptoms of PRS at a vascular access site. There must be 21 or more days between the onset of one episode and the onset of a second episode for both to be reported as separate events.

From the three main dialysis event types reported, other measures are also defined: (1) access-related bloodstream infection (ARBSI) is a BSI with the suspected source reported as the vascular access or uncertain, (2) local access site infection is PRS of the vascular access site when an ARBSI is not present, and (3) vascular access infection is either a local access site infection or an ARBSI.

Major cardiovascular event is characterized with anginal chest pain, dynamic troponin change, cardiogenic shock and Electrocardiogram showing ST, T changes. Ischemic cerebrovascular stroke is defined as an acute focal neurologic deficit attributed to the occlusion of a cerebral artery by a thrombus, supported by CT or MRI results.[1]

The primary failure of AVF is defined as thrombosis or inability for cannulation of fistula for HD within 3 months of creation. Early thrombosis of AVF is defined as an immediate failure due to thrombosis of the fistula within 24 hours of creation.[2]

Hemodialysis catheter dysfunction is defined as Blood flow rate (BFR) <300 mL/min. Causes of catheter dysfunction include mechanical kinking, malpositioning of the catheter tip, thrombus accumulation, and growth of a fibrin sheath. Early dysfunction which has been defined as occurring within the first two weeks of placement is most often caused by mechanical problems. Delayed or late dysfunction is typically caused by thrombus accumulation with or without the presence of a fibrin sheath.[3]

Major cardiovascular event is characterized with anginal chest pain, dynamic troponin change, cardiogenic shock and Electrocardiogram showing ST, T changes. Ischemic cerebrovascular stroke is defined as an acute focal neurologic deficit attributed to the occlusion of a cerebral artery by a thrombus, supported by CT or MRI results.[1]

Data Analyses

We also summarized the frequency of select antimicrobial-resistant pathogens. These were methicillin-resistant Staphylococcus aureus (MRSA), vancomycin-resistant Enterococcus spp., Escherichia coli resistant to third

generation cephalosporins, Klebsiella spp. resistant to cephalosporins, and Enterobacter spp. resistant to carbapenems.

RESULTS

A total of 78616 hemodialysis sessions being done was noted. A total of 1794 dialysis events, including 59 bloodstream infections, 59 intravenous antimicrobial starts, and 11 pus, redness, or increased swelling at the hemodialysis vascular access site events. All bloodstream infections and access-related bloodstream infections occurred in patients with a central venous catheter. Staphylococcus aureus was the most commonly isolated bloodstream infection pathogen (70%). Dialysis catheter blocks were noted in 75 patients, AVF failure were noted in 33 patients, AVF infection were noted in 9 patients, AVF rupture was noted in 1 patient, AVF bleeding was noted in 1 patient, steal syndrome was noted in 8 patients, AVF aneurysm was noted in 26 patients, AVF thrombus was noted in 33 patients, venous hypertension edema was noted in 48 patients, urinary tract infection (UTI) was noted in 113 patients, lower respiratory tract infection (LRTI) was noted in 162 patients, skin, soft tissue infection was noted in 5 patients, gastrointestinal (GIT) bleeding was noted in 18 patients, hypoglycaemia was noted in 148 patients, hypotension was noted in 140 patients, accelerated hypertension was noted in 98 patients, seizures was noted in 8 patients, muscle cramps was noted in 198 patients, infection episodes was noted in 358 patients, hepatitis C viral conversion was noted in 14 patients, cerebrovascular events was noted in 8 patients, cardiovascular events was noted in 6 patients, dialysis dysequilibrium was noted in 7 patients, malignancy was noted in 1 patient, missed hepatitis B vaccination noted in 60 patients, no needle stick injuries noted, renal failure recovery was noted in 11 patients, discontinuation/shifting to other dialysis mode was noted in 100 patients, death was noted in 33 patients.

Events/Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Details of number of Hemodialysis													
Total intermittent hemodialysis	3000	3600	6000	8400	9600	7200	6699	6960	5040	5872	5565	5599	5081
CRRT	0	0	0	0	0	0	0	0	0	0	1	14	7
SLED	12	14	21	44	76	91			40	35	7	41	8
HDF	0	0	0	0	0	0	0	0	0	0	108	119	39
Dialysis in ICU	30	41	63	78	99	88	112	80	261	719	686	337	242
Details of Hemodialysis Access													
Non-tunnelled catheter	112	121	131	143	301	278	301	298	275	232	295	300	49
AVF	20	16	10	19	108	122	102	47	27	11	40	25	12
Tunnelled catheter	0	0	0	2	1	0	0	0	0	0	3	7	3
AVG	0	0	0	0	0	0	0	0	0	0	0	0	0
Details of special form Dialysis													
Plasmapharesis	0	0	1	0	0	0	0	0	0	0	3	3	11
Charcoal hemoperfusion	0	0	0	0	0	0	0	0	0	0	5	1	0

Table 1: Characteristics of facilities reporting to Dialysis Event

Characteristics of facilities reporting to Dialysis Event: Hospital based dialysis unit with 11 bedded facility. Predominant form of dialysis was intermittent hemodialysis, predominant form of vascular access was non-tunnelled dialysis catheter.

Complications in hemodialysis/ Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Catheter block	5	12	13	2	3	7	2	15	13	1	2	0	0
CRBSI	5	8	3	11	15	3	4	2	2	3	0	1	2
AVF failures	1	2	5	3	0	0	0	1	3	4	5	8	1
AVF infection	1	2	0	0	0	0	1	2	3	0	0	0	0
AVF rupture	0	0	0	0	0	0	0	0	0	0	0	0	1

AVF bleeding	0	0	0	0	0	0	0	0	0	0	0	0	1
AVF Steal syndrome	2	1	0	0	0	0	1	2	1	0	0	0	1
AVF aneurysm	5	3	6	1	0	1	2	3	4	1	0	0	1
AVF thrombus	4	11	2	4	5	1	0	1	2	0	0	0	3
Venous hypertension, edema	4	9	7	11	2	0	0	1	3	2	2	4	3
UTI	7	10	11	14	12	20	11	10	3	2	2	1	10
LRTI	9	12	20	14	18	23	12	14	7	7	8	2	16
Skin, soft tissue infections	1	0	0	0	0	1	1	2	0	0	0	0	0
GIT bleeding	2	1	3	0	0	4	5	2	0	0	0	1	0
Hypoglycaemia	50	23	24	13	15	4	5	3	2	1	0	6	2
Hypotension	10	12	3	24	25	23	20	3	4	2	5	6	3
Accelerated hypertension	12	11	2	10	13	14	18	3	2	4	5	1	3
Seizures	1	3	0	0	0	0	1	2	0	0	1	0	0
Muscle cramps	35	33	43	23	22	10	17	3	4	6	2	0	0
Infection episodes	24	35	36	41	45	47	29	30	17	12	10	3	29
Viral hepatitis conversion	1	3	2	2	0	0	0	0	2	3	0	0	1
Cerebrovascular events	1	0	0	2	2	0	0	0	1	0	1	1	0
Cardiovascular events	0	1	0	0	0	1	2	1	1	0	0	0	0
Dialysis dysequilibrium	3	0	0	0	0	1	3	0	0	0	0	0	0
Malignancy incidence	0	0	1	0	0	0	0	0	0	0	1	0	0
Missed hepatitis b vaccination	5	21	11	2	3	4	1	0	1	5	6	1	0
Needle stick injuries	0	0	0	0	0	0	0	0	0	0	0	0	0
Recovered	2	0	3	0	1	0	2	0	0	0	1	2	0
Discontinued dialysis/shifted elsewhere	4	2	13	12	23	14	10	9	2	3	1	4	3
Deaths	0	0	0	0	0	0	0	0	0	0	13	12	8

Table 2: Complications in hemodialysis year wise

Predominant complications/events were muscle cramps, infection episodes, hypoglycaemia, hypotension, accelerated hypertension, attained adequate anti HBs titre, UTI, LRTI and dialysis catheter blocks.

Type of Organsims	Frequency (%)
Gram positive organisms	70%
Gram negative organisms	23%
Miscellaneous	7%

Table 3: Type of organsims

The most common BSI and ARBSI organisms were S. aureus followed by Staphylococcus epidermidis and other coagulase-negative Staphylococci. Gram-negative organisms, such as E. coli, Enterobacter cloacae, Klebsiella pneumoniae, Pseudomonas aeruginosa, and Serratia marcescens, collectively accounted for 12% and 11% of BSI and ARBSI isolates, respectively. Other pathogens that might point to a water source of infection (i.e., Proteus mirabilis, Stenotrophomonas maltophilia, Bukholderia cepacia and Candida) collectively accounted for 7% of BSIs.

Among pathogens with susceptibility testing, 40% of S. aureus were methicillin resistant, and 36% of those resistant S. aureus were from patients with CVC. Other important drug-resistant pathogens included E. coli resistant to cephalosporins (45%), Klebsiella spp. resistant to cephalosporins (43%), Enterococcus resistant to vancomycin (12%), and Enterobacter spp. resistant to carbapenems (5%).

DISCUSSION

Main form of hemodialysis was intermittent hemodialysis followed by sustained low efficiency dialysis (SLED). With installation of chronic renal replacement therapy (CRRT) and hemodiafiltration (HDF) dialysis machine there were rise in CRRT and HDF form of dialysis from 2021 onwards. Even there was rise in dialysis in intensive care unit (ICU) patients, plasmapharesis and charcoal hemoperfusion of late.

Main form of hemodialysis access was non-tunnelled dialysis catheter followed by arteriovenous fistula (AVF) (Table 1).

Among the bloodstream infection (BSI), majority were vascular access related infection followed by respiratory tract infection (Table 2). These events were BSI, local access site infection (LASI), access-related bloodstream infection (ARB), and vascular access infection (VAI). Among the dialysis events, there were IV antimicrobial starts in (<5%), positive blood cultures in cases (<10%) and pus, redness, or increased swelling at the vascular access site in cases (<3%). Among the cases with BSI (positive blood cultures), 83% were ARB and the remaining cases were either primary BSI without known infection sites or BSI secondary to other infections were secondary to pneumonia, to URTI, to skin and soft tissue infections , to liver infection, to UTI and to gastrointestinal infection. There were <5% cases with LASI (pus, redness, or increased swelling at the vascular access site) and the number of cases with VAI (i.e. either ARB or LASI) was therefore <3%. Of the isolates from blood, 70% were Gram-positive and 23% were Gram-negative (Table 3). Staphylococcus aureus was most common microorganism, accounting of all isolates recovered. Intravenous antimicrobial agents instead of oral were most commonly-used agents cephalosporins, penicillins, Vancomycin, aminoglycosides and fluoroquinolones.[4]

Blood access infection especially related to central venous catheter is the most common cause of infection in hemodialysis patients with Gram positive bacteria being predominant organisms.[5]

Among the cases with dialysis events admitted to hospital, the corresponding rate of hospitalization was 10%. There were less death cases and the mortality rate was <1% (Table 2).

There was lesser incidence (<1%) of arteriovenous fistula (AVF) related complications like failure, infection, rupture, bleeding, thrombus, steal syndrome, aneurysm, venous hypertension and arm edema. Fistula thrombosis was seen as the most common complication. The early complication was bleeding, hematoma. As late complications, we encountered steal syndrome, ischemic pain in the relevant extremity, pseudoaneurysm and high-output heart failure. Steal syndrome, venous hypertension and edema in the arm were noted in proximal AVF. Bleeding, hematoma, aneurysm formation and steal syndrome were noted in Basilic vein transposition AVF. Our pseudoaneurysm rate was <1% with patients at the one-year follow-up.[6]

Dialysis event rates were higher among patients with tunnelled or non-tunnelled central lines than in patients with fistula or graft.[7]

The early complication were Fistula thrombosis, bleeding, hematoma. As late complications, we encountered steal syndrome, ischemic pain in the relevant extremity, pseudoaneurysm and high-output heart failure like in other studies. Steal syndrome, venous hypertension and edema in the arm were noted in Brachio-Cephalic AVF. Bleeding, hematoma, aneurysm formation and steal syndrome were noted in Basilic vein transposition AVF like in other studies.[6]

The intradialytic cramps associated with hypotension secondary to excess fluid volume removal, carnitine deficiency was noted in which showed prompt response to correction of hypotension by saline administration and discontinuation of ultrafiltration like in other studies.[8-10]

Lower gastrointestinal bleeding events secondary to uraemic platelet dysfunction and use of anticoagulants were noted in patients possibly because of frequent precautionary screening and preventive measures undertaken in our hospital.[11]

Paradoxical rise in blood pressure during or immediately after dialysis, intradialytic hypertension defined as rise in mean arterial pressure >15 mmHg within or immediately post dialysis were noted in considerable numbers. These were either due to inappropriate volume withdrawal, volume overload, worsening of pre-existing hypertension or new-onset hypertension after administration of erythropoietic-stimulating agents (ESAs).[12]

Hypoglycaemia due to decreased gluconeogenesis deranged metabolic pathways, inadequate nutrition, decreased

insulin clearance were noted in significant numbers.[13]

Intradialytic hypotension (IDH) is secondary to reduced cardiac reserve, to reactions with the extracorporeal circuit and medications, inappropriate setting of postdialysis target weight, inappropriate ultrafiltration rate and profiling which was noted in considerable patients in this study.[14]

The leading causes of hospitalization for infection were dialysis access or central venous catheter-related infections (55%), bloodstream infections or sepsis (35%), and pulmonary infections (9%) which were noted in considerable numbers in this study. These data also indicated that blood access infection is the most common cause of infection in hemodialysis patients and second most common cause of mortality in dialysis patients.[5]

The incidence of cancer is significantly higher noted in CKD which needs frequent screening and was noted in lesser numbers in this study possibly because of frequent precautionary screening and preventive measures undertaken in our hospital.[15]

In our dialysis unit, there was lesser incidence (<1%) of documented cardiovascular and cerebrovascular events. Cardiovascular disease is significantly higher noted in CKD which needs frequent screening and was noted in lesser numbers in this study possibly because of frequent precautionary screening and preventive measures undertaken in our hospital.[16]

Accidental needle-stick injuries and mucocutaneous exposure to blood and body fluids was noted in lesser numbers in this study due to adequate precautionary measures undertaken in our hospital, though underreported across globe.[17]

Recovery of renal function was noted in Renovascular disease (1), Rapidly progressive renal failure due to vasculitis (5), Interstitai nephritis (4), Lupus nephritis (1) like in Ekholm study.[18]

Majority of cases who discontinued dialysis were due to either shifting to another dialysis centre due to logistical issue or financial contraints.

Overall death incidence was <1% which was predominantly out of hospital. Cardiovascular diseases (31.0%), stroke (20.3%) and infection (19.9%) were the main causes of death for Hemodialysis patients in China.

Dialysis Disequilibrium Syndrome (DDS) which is a set of neurological signs and symptoms that can occur during or following dialysis secondary to reserve osmotic shift, intracerebral acidosis, and idiogenic osmole. DDS was found in <1% due to preventive care taken in our hospital.[19]

Hepatitis B, C infection due to skin breaches, exposure to blood products, and sharing of dialysis machines. Hepatitis B vaccination is recommended in all patients with end-stage kidney disease (ESKD). In our study, (38%) achieved seroconversion with adequate HBsAb titers like in Hettenbaugh study. In advanced CKD patients, there is a lack of response by the immune system, which leads to inadequate seroconversion and continues to be a cause of both low rates of seroconversion.[20]

To the best of our knowledge, there are only few surveillance on dialysis events in India. This surveillance generated the baseline information of infections and associated dialysis events among dialysis patients in a single tertiary centre. In general, to counter dialysis events in India, the awareness among healthcare workers and hemodialysis patients should be raised and more efforts on prevention such as establishing a national initiative should be taken. The surveillance would generate useful information to guide the prevention in practice.

Previous studies have shown that vascular access is one of the most important risk factors for infection in hemodialysis patients and it has been reported that the use of arterio-venous fistula (AVF) is associated with less incidence of complications including infections compared to the use of central lines. The use of fistula should be continuously promoted and the use of central line should be minimized.

Second, IV antimicrobial start accounted for the majority of dialysis events and was mainly used to treat infections other than vascular access infections (VAI), particularly respiratory tract infections including pneumonia.

Third, there were cases of access related blood stream infection (ARB) among those using central lines as the vascular access.[4]

Potential reasons for the differences in rates and burden estimates include (1) success in widespread blood stream infection (BSI) prevention efforts conducted by dialysis providers (2) potential under-reporting of BSIs (shown in several studies) like in other studies.[4]

The incidence of dialysis events was much lower among HD outpatients in other studies than those in this study. Exact reasons for lower incidence were not known. Nonetheless, there were several possible reasons contributing to the low incidence of dialysis events in this study. First, the data of NHSN report on dialysis events were from 10 years ago, which is likely to be outdated. It would be more meaningful to compare our data with newer data of the NHSN but such data except those for BSI are not available yet. Second, patients with high severity of underlying or kidney diseases in China were prone to be admitted to the hospital and then receive HD during their hospitalization rather than were dialyzed in outpatients. It will be useful to perform a surveillance of dialysis events for those receiving HD during hospitalization in India. Our hospital has strictly restricted the use of antimicrobial agents, which may have significantly reduced IV antimicrobial use among HD outpatients and therefore contributes to the low incidence of dialysis events like in other studies.[4]

CONCLUSIONS

Infection was the most common event. Dialysis catheter infection followed by respiratory tract infection were the most common site of source of infection. Most common non-infective complications were due to muscle cramps, hypoglycaemia followed by hypotension episodes.

Local and regional efforts to reduce infections among this vulnerable patient population should incorporate this established system of measurement.

Author's contributions

Dr. Girish P Vakrani (Fist author) contributed towards management of patients, data collection and manuscript preparation.

Dr. Nambakam Tanuja Subramanyam (Second author) contributed towards data collection, literature search

Mr. Shashikumar D.K. (Third author) contributed towards data collection, analysis and statistics

Declaration

Conflict of Interests

The authors have no conflict of interest to declare.

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