A STUDY ON INCIDENCE OF ACUTE CARDIOVASCULAR COMPLICATIONS DURING MAINTENANCE HAEMODIALYSIS OF END-STAGE RENAL FAILURE PATIENTS

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ABSTRACT

BACKGROUND

To study the incidence of acute cardiovascular complications during haemodialysis in patients with chronic kidney disease with end-stage renal failure on maintenance haemodialysis.

METHODS

Patients with chronic kidney disease with end-stage renal failure on maintenance haemodialysis at King George Hospital, Andhra Medical College, Visakhapatnam, India, were studied during the period of June 2015 to August 2016. In our study, all the 100 patients underwent 8510 haemodialysis sessions during 1-year period of study.

RESULTS

Cardiovascular complications are the most common intradialytic complications occurred during the study. Hypotension is the commonest of all the intradialytic as well as cardiovascular complications with a frequency of 1278, which account for 15.01% of the haemodialysis sessions. This was followed by 879 episodes of hypertension (10.32%), 190 episodes of cardiac arrhythmias (2.23%), which include complex ventricular arrhythmias and supraventricular arrhythmias and 162 episodes of chest pain (1.90%). Of the 100 patients, 37% of patients developed cardiac arrhythmias during haemodialysis. The frequency of arrhythmic episodes was 190 (2.23%). Among these, Supraventricular Arrhythmias (SVA) and Complex Ventricular Arrhythmic (CVA) episodes account for 159 (83.68%) and 31 (16.31%), respectively. CVA and SVA occurred in 29% and 19% of patients in the study group, respectively. Both CVA and SVA occurred in 12% of patients.

CONCLUSION

Intradialytic hypotension is the most common acute intradialytic complication in patients with chronic kidney disease with end-stage renal failure undergoing maintenance haemodialysis. This is followed by intradialytic hypertension. Sudden cardiac arrest is the most common cause of death during haemodialysis in patients with end-stage renal disease on haemodialysis. Mortality is high in patients with end-stage renal failure in maintenance haemodialysis with ischaemic heart disease.

KEYWORDS

Haemodialysis, Intradialytic Complications, Acute Cardiovascular Complications.

HOW TO CITE THIS ARTICLE: Kumar DS, Rao SSP, Babu BAB, et al. A study on incidence of acute cardiovascular complications during maintenance haemodialysis of end-stage renal failure patients. J. Evid. Based Med. Healthc. 2016; 3(78), 4230-4235. DOI: 10.18410/jebmh/2016/901

INTRODUCTION: Haemodialysis, which is one of the renal replacement therapies is a lifesaving treatment. In the absence of this therapy, more than a million patients worldwide would have died within weeks. Haemodialysis was successfully performed for the first time in 1944 by Willem Kolff in patients with renal failure. However, haemodialysis is accompanied by several complications.

Financial or Other, Competing Interest: None.
Submission 09-09-2016, Peer Review 22-09-2016,
Acceptance 28-09-2016, Published 29-09-2016.
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DOI: 10.18410/jebmh/2016/901

Currently, the advances in technology, particularly those in the last 20 years, have reduced the complications. However, complications caused by the reasons other than the dialysis machine and water system remain as a significant cause of morbidity and mortality in haemodialysis patients. Cardiovascular complications are currently the most common complication of haemodialysis. Among these complications, the intradialytic hypotension, intradialytic hypertension, haemodialysis-associated arrhythmias (Complex Ventricular Arrhythmias and Atrial Fibrillation) and sudden cardiac death are important problems.

AIMS AND OBJECTIVES: To study the incidence of acute cardiovascular complications during haemodialysis in patients with chronic kidney disease with end-stage renal failure on maintenance haemodialysis at King George Hospital of Andhra Medical College, Visakhapatnam, India.

MATERIALS AND METHODS: Source of Data: Patients with chronic kidney disease with end-stage renal failure, on maintenance haemodialysis at King George Hospital, Andhra Medical College, Visakhapatnam, India, were studied during the period of June 2015 to August 2016. Before commencement of study, permission was obtained from Ethics Committee, Andhra Medical College, Visakhapatnam. All enrolled patients were informed about the nature of the study and their right to refuse. The informed written consent was taken before including them in the study.

Sample Size: 100 patients.
Study Design: Observational study.
Study Subjects: All patients to fulfil the inclusion criteria.

Inclusion Criteria: All patients with diagnosis of chronic kidney disease with end-stage renal disease undergoing maintenance haemodialysis were included in the study.

Exclusion Criteria: Patients with acute kidney injury and acute on chronic kidney disease were excluded from the study.

METHODS OF STUDY: All the patients were observed and monitored during the haemodialysis sessions and all the cardiovascular symptoms were recorded. All the patients underwent pre and postdialysis assessment for all the sessions to diagnose complications. In our study, over 1 year period, all 100 patients with ESRD receiving twice weekly haemodialysis sessions of 4 hours each were considered. Some of the patients left the study due to drop outs for various reasons such as dialysis elsewhere, renal transplantation and unknown causes. During the course of study, deaths occurred in some patients due to complications both during haemodialysis and causes other than haemodialysis. All the patients were dialysed with synthetic polysulfone membrane dialyser (Good biocompatibility) and bicarbonate buffer was used as dialysate. Sterile water prepared under strict aseptic in water sterilisation plant was used for prepare dialysate from the bicarbonate concentrate. The dialysers were reused at a range of 5 to 10 times. Dialyser reprocessing was done using Renalin 100 (A cold sterilant concentrate containing hydrogen peroxide (20.0%), peroxyacetic acid (4%) as active ingredients and 76% of inert ingredients). Heparin was the anticoagulant used for all patients. Arteriovenous fistula was the form of vascular access for all patients in all HD sessions.

All the patients' screening status with regard to HIV, hepatitis B (HBsAg) and hepatitis C (HCV antibodies) were recorded. Patients with HIV positive status were not included in this study. Intradialytic hypotension was defined as any recorded blood pressure of >25 mm of Hg fall in systolic blood pressure from the baseline blood pressure during the dialysis session accompanied by typical symptoms of hypotension like dizziness, weakness, nausea, cramps, blurred vision and fatigue or systolic blood pressure <90 mm of Hg with or without symptoms. Intradialytic hypertension can be defined as an average pre to post haemodialysis systolic blood pressure elevation of >10 mmHg an increase in mean arterial blood pressure (MAP) ≥15 mmHg during or immediately after haemodialysis.

In our study, cardiac arrhythmias were recorded as complex ventricular arrhythmias (Those defined as having a Lown's grading score of 3 and more) and supraventricular arrhythmias based on patients symptoms and continuous electrocardiographic monitoring.

OBSERVATIONS AND RESULTS:
Demographic Profile: Age Distribution:

Age (Yrs.)	No. of Patients	Percentage (%)
<20 yrs.	1	1%
21-30	14	14%
31-40	23	23%
41-50	28	28%
51-60	24	24%
61-70	8	8%
71-80	2	2%
Total	**100**	**100%**
Table 1		

In our study, most of the patients were in the age group of 31-40, 41-50 and 51-60 years with an incidence of 23%, 28% and 24% respectively and the mean age of the patients were 44.65 and the oldest patient was 72 years of age and youngest patient was 12 years of age.

Sex Distribution: In our study, out of 100 patients, 79 patients are males and 21 patients are females.

Sex	No. of Patients %
Male	79%
Female	21%
Table 2	

Distribution of Hypertension, Diabetes Mellitus and Ischaemic Heart Disease: In our study, out of 100 patients, 91 patients are having hypertension, 29 patients are having diabetes mellitus and 27 patients had Ischaemic Heart Disease.

	No. of Patients	Percentage (%)
Hypertension	91	91%
Diabetes mellitus	29	29%
Ischaemic Heart disease	27	27%
Table 3		

Total number of Haemodialysis Sessions:

No. of Dialysis Sessions	No. of Patients	Percentage (%)
<20	5	5%
21-40	9	9%
41-60	9	9%
61-80	8	8%
81-100	3	3%
>100	66	66%
Total	100	100%
Table 4		

Total no. of dialysis sessions in our study is 8510. In our study, out of 100 patients, 66% of patients who attended regularly underwent more than 100 haemodialysis sessions during one year period and 31% of patients had less than 80 dialysis sessions during the study period due to dropouts and deaths.

Dropouts: In our study, out of 100 patients, a total of 15 dropouts are recorded. 3 (20%) patients underwent renal transplantation, 5 (33.3%) patients had dialysis elsewhere and 7 (46.6%) patients due to unknown reasons did not attend to our hospital for maintenance haemodialysis.

Reason for Dropout	No. of Patients	Percentage (%)
Renal transplantation	3	20%
Dialysis elsewhere	5	33.3%
Unknown	7	46.6%
Total	**15**	
Table 5		

Deaths: In our study, out of 100 patients, deaths occurred in 19 patients during 1 year of study period. Off the 19 cases, sudden death occurred in 4 patients during haemodialysis. Remaining 15 patients died due to various complications other than haemodialysis. Ischaemic heart disease is the cause of death in 6 patients; stroke is the cause in 4 patients. 2 cases died due to pneumonia, 1 patient died due to sepsis and another 1 due to miliary tuberculosis. One patient died at home and the cause is not known.

Cause of Death	No. of Patients	Percentage (%)
Sudden death during haemodialysis	4	21.1%
Ischaemic heart disease	6	31.57%
Stroke	4	21.1%
Pneumonia	2	10.5%
Sepsis	1	5.2%
Miliary tuberculosis	1	5.2%
At home death	1	5.2%
Total	**19**	
Table 6		

Incidence of Acute Cardiovascular Complications During Haemodialysis: Cardiovascular Complications: In our study, all the 100 patients underwent 8510 haemodialysis sessions during 1-year period of study. Cardiovascular complications are the most common intradialytic complications occurred during the study. Hypotension is the commonest of all the intradialytic as well as cardiovascular complications with a frequency of 1278, which account for 15.01% of the haemodialysis sessions. This was followed by 879 episodes of hypertension (10.32%), 190 episodes of cardiac arrhythmias (2.23%), which include complex ventricular arrhythmias and supraventricular arrhythmias and 162 episodes of chest pain (1.90%).

Intradialytic Cardiovascular Complications	Incidence of Complications (%)	No. of Patients (%)
Hypotension	1278 (15.01%)	73%
Hypertension	879 (10.32%)	49%
Arrhythmias	190 (2.23%)	37%
Chest pain	162 (1.90%)	44%
Total	**2922**	
Table 7		

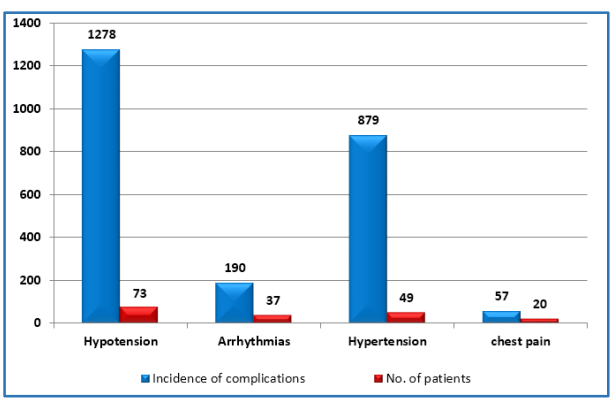

Fig. 1: Acute Intradialytic Cardiovascular Complications in Haemodialysis

Cardiac Arrhythmias: Of the 100 patients, 37% of patients developed cardiac arrhythmias during haemodialysis. The frequency of arrhythmic episodes was 190 (2.23%). Among these, Supraventricular Arrhythmias (SVA) and Complex Ventricular Arrhythmic (CVA) episodes account for 159 (83.68%) and 31 (16.31%), respectively. CVA and SVA occurred in 29% and 19% of patients in the study group, respectively. Both CVA and SVA occurred in 12% of patients.

Type of Cardiac Arrhythmias	Incidence of Arrhythmias (%)	No. of Patients (%)
CVA	159 (83.68%)	29%
SVA	31 (16.31%)	19%
Total	**190**	
Table 8		

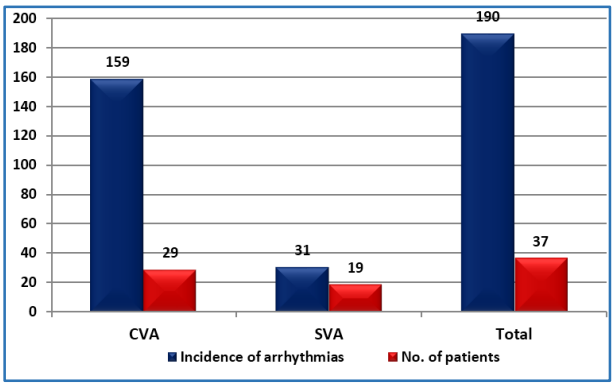

Fig. 2: Types and Incidence of Cardiac Arrhythmias During Haemodialysis

Acute Intradialytic Complications: In our study, the incidence of all acute intradialytic complications during haemodialysis is listed in the following table according to decreasing order of frequency.

Intradialytic Complications	Incidence of Complications (%)	No. of Patients (%)
Hypotension	1278 (15.01%)	73%
Hypertension	879 (10.32%)	49%
Muscle cramps	876 (10.29%)	84%
Nausea and vomiting	716 (8.4%)	92%
Headache	587 (6.89%)	67%
Back pain	401 (4.71%)	62%
Pruritus	323 (3.79%)	59%
Arrhythmias	190 (2.23%)	37%
Chest pain	162 (1.90%)	44%
Fever and chills	60 (0.71%)	32%
Dialyser reactions - Type B	12 (0.14%)	10%
Dialyser reactions - Type A	0	0
Seizures	7 (0.08%)	6%
Death during haemodialysis	4 (0.047%)	4%
Air embolism	2 (0.02%)	2%
Intracranial bleeding	1 (0.01%)	1%
Disequilibrium syndrome	0	0%

Table 9

DISCUSSION: In our study, a total of 100 end-stage renal failure patients who were undergoing maintenance haemodialysis at King George Hospital of Andhra Medical College, Visakhapatnam, were included in the study. The mean age of the patients was 44.65 years. Maximum number of patients was found in the age group of 31-40, 41-50 and 51-60 years; 23%, 28% and 24%, respectively. The oldest patient was 72 years of age and the youngest was 11 years of age. Male patients were predominant in the study, which included 79% of the total patients and females account for only 21%. According to the first report of the Indian chronic kidney disease registry by Rajapurkar et al[1], the mean age was 50.1±14.6 years with male-to-female ratio of 70:30. In our study, out of 100 patients, 91% of patients are suffering from hypertension and on antihypertensive medication, 29% are having diabetes mellitus and 27% of patients are having both hypertension and diabetes. In the study, total haemodialysis sessions were 8510 during the period of one year. Out of 100 patients, 66% of patients who attended regularly underwent more than 100 haemodialysis sessions during one year period and 31% of patients had undergone less than 80 haemodialysis session during one year study period due to dropouts and deaths. Remaining 66% of patients underwent 104 haemodialysis sessions each during 1-year period.

In the study group, a total of 15 dropouts are recorded. Among them, 3 (20%) patients underwent renal transplantation, 5 (33.3%) patients had dialysis elsewhere and 7 (46.6%) patients due to unknown reasons did not attend our hospital for maintenance haemodialysis.

In our study, out of 100 patients, death occurred in 19 patients during 1 year of study period. Of the 19 cases, deaths occurred in 4 (21.1%) patients during haemodialysis. Remaining 15 (15%) patients died due to various complications other than haemodialysis. Ischaemic heart disease is the cause of death in 6 (31.5%) patients; stroke is the cause in 4 (21.1%) patients; 2 (10.5%) cases died due to pneumonia; 1 (5.2%) patient died due to sepsis and another 1 (5.2%) due to miliary tuberculosis. One (5.2%) patient died at home and the cause is not known.

Acute Cardiovascular Complications During Haemodialysis: The present study aims to evaluate the incidence of acute cardiovascular complications during haemodialysis in patients with chronic kidney disease with end-stage renal failure on maintenance haemodialysis.

Intradialytic Hypotension: Hypotension which is the commonest complication during haemodialysis is due to many factors like the size of extracorporeal circulation, degree of ultrafiltration, changes in serum osmolality, autonomic neuropathy and alteration in body temperature due to dialysis temperature. According to Davenport A[2], its incidence has been reported from less than 5% to 40% of all treatments. According to Himmelfarb J[3], its incidence is 15% to 30%. Daugirdas JT et al[4,5,6,7,8], reported an incidence of 20% to 30% of all dialysis sessions. In our study, the incidence of hypotension was 15.01% of total haemodialysis sessions, which is the most common complication. It affected around 73% of patients undergoing haemodialysis. This is lower than the value reported by Daugirdas JT et al[4,5,6], but comparable to the value reported by Davenport A and Himmelfarb J[3]. The incidence of hypotension in our study is also comparable with various other studies by Alireza Ghahri Sarabi et al[9], Amira CO et al[10], which reported an incidence of 15.1% and 18.4%, respectively.

Intradialytic Hypertension: Intradialytic hypertension, which occurs usually towards the end of haemodialysis treatment was another frequent complication seen in our patients. In our study, this was the second most common complication seen in 10.32% of haemodialysis treatments and predominantly seen in older individuals. According to Chen J et al[11], it is known to affect 8% to 30% of treatments and is frequently seen in older patients and those on more antihypertensive medications. It was seen in 49% of patients in our study, which was similar to the value reported by Agrawal et al[12,13] (50% of haemodialysis patients). In our study, intradialytic hypertension occurred in >30% of treatments in 24.4% of patients who encountered intradialytic hypertension.

This is similar to the value reported by Van Buren et al[14] who reported 31% of the treatments in quartile of patients that encountered it most often.

Cardiac Arrhythmias: In our cardiac arrhythmia study, out of 100 patient, 37% of patients developed cardiac arrhythmias during haemodialysis at a frequency of 2.23% of haemodialysis sessions. Among these, complex ventricular arrhythmias (Lown's grading 3 and above) occurred in 29% of patients at a frequency of 1.86% of all haemodialysis sessions. This is followed by supraventricular arrhythmias occurred in 19% of patients at frequency of 0.36% of dialysis sessions. All the SVA recorded were atrial fibrillation. Both SVA and CVA occurred in 12% of patients in the study group. Premature ventricular contractions and atrial premature contractions are not reported in our study. In our study, cardiac arrhythmias occurred predominantly in older individuals and in patients with diabetes and hypertension. According to Wander GS et al,[15] cardiac arrhythmias are common during dialysis and between treatments with a frequency ranges widely from 5 to 75 percent. Ramirez G[16] et al also reported an incidence of 40% in ESRD patients while on haemodialysis.

In a clinical study done by Huseyin Bozbas et al[17], complex ventricular arrhythmias (Lown's classification, classes 3 and above) were detected in 37.2% of ESRD patients on haemodialysis and supraventricular arrhythmias were detected in 16% of ESRD patients on haemodialysis; all were identified as atrial fibrillation. According to them, hypertension, coronary artery disease and duration of dialysis therapy is an independent factor for development of cardiac arrhythmias in patients with ESRD on maintenance haemodialysis. De Lima JJ et al[18] also reported that CVA were observed in 50% of CKD patients on haemodialysis. They also reported that hypertension, hypertensive heart disease and coronary heart disease were significantly associated with complex ventricular arrhythmias. Burton et al[19] reported that complex ventricular arrhythmias (Those defined as having a Lown's score of 3 and more) prevail at a rate of 35% in the HD patient group. In another study done by Genovesi et al[20], the prevalence of cardiac arrhythmia was reported to be 5 to 75% and that of atrial fibrillation was reported to be 27% of HD patients both during and after dialysis. The results in our study are similar to the values in the above studies.

According to Andrew Davenport[2] reported that cardiac arrhythmias particularly multiform ventricular ectopics and couplets are very common during haemodialysis with estimates of up to 50% of treatments. Fortunately, these are usually asymptomatic and settle spontaneously post treatment. Atrial fibrillation is the most common sustained arrhythmia during dialysis occurring in up to 20% of treatments. According to the study done by S Vikrant et al[21] at the frequency of fatal arrhythmias were 1.5% of the HD sessions. The results in our study are comparable to the study by S Vikrant et al,[21] but compared to Andrew Davenport[2] report, the frequency of complex ventricular arrhythmias and supraventricular arrhythmias were less in our patients because arrhythmias are recorded by electrocardiogram monitoring not by continuous Holter monitoring during haemodialysis sessions.

Chest Pain: Chest pain during haemodialysis is associated with hypotension, dialysis disequilibrium syndrome and type B dialyser reactions. Other causes of chest pain should also be considered, which include angina, haemolysis and rarely air embolism. Its incidence has been reported as 2% to 5% according to Daugirdas JT et al. According to the study done by S Vikrant et al[22] at Indira Gandhi Medical College, Shimla, in 2003, the frequency of chest pain was 3% of HD sessions. In our study, the frequency of chest pain was 1.90% of total treatments, which is slightly lower than the above results. 44% of patients in the study group developed chest pain. In our study, the cause of chest pain mostly due to angina. It is also associated with hypotension. In some patients, it is associated with type B dialyser reactions; in 2 patients, it is associated with air embolism and in others cause is not known.

Death During Haemodialysis: In our study, there is high incidence of deaths in 4% cases at frequency of 0.047% of total haemodialysis treatments. Among these, 75% of deaths are due to sudden cardiac arrest. Of these, two (66.6%) patients developed ventricular fibrillation and one (33.3%) patient developed asystole. Remaining 25% of patients (that is one case) died due to fatal air embolism. All the sudden deaths occurred predominantly in elderly patients above 60 years of age except one. All the patients who sustained sudden death were ischaemic heart disease. In a study done by Karnik JA[22] et al, the cardiac arrest rate was 400 out of 5,744,708 corresponding to a rate of 7 per 100,000 haemodialysis sessions. Patients who suffered a cardiac arrest were on average older age of 66.3±12.9 years more likely to have ischaemic heart disease (61.8%). According to Davis TR[23], cardiac arrests occurring in haemodialysis centres found that the predominant rhythm was ventricular fibrillation (66%) followed by pulseless electrical activity (23%) and asystole (10%). 55 in the USRDS database, 60% to 65% of cardiac deaths in dialysis patients are attributable to arrhythmic mechanisms.

SUMMARY AND CONCLUSIONS:

1. Intradialytic hypotension is the most common acute intradialytic complication in patients with chronic kidney disease with end-stage renal failure undergoing maintenance haemodialysis. This is followed by intradialytic hypertension.
2. Cardiac arrhythmias are also common acute complications during haemodialysis in chronic renal failure.
3. Sudden cardiac arrest is the most common cause of death during haemodialysis in patients with end-stage renal disease, on haemodialysis.
4. Mortality is high in patients with end-stage renal failure in maintenance haemodialysis with ischaemic heart disease.

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