Original Research

# ACUTE PRESENTATIONS, THEIR ETIOLOGIES AND OUTCOMES OF PATIENTS ON MAINTENANCE HEMODIALYSIS PRESENTING TO THE EMERGENCY DEPARTMENT

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## ABSTRACT

**Background:** Chronic kidney disease (CKD) patients on Maintenance Hemodialysis (MHD) frequently present to emergency departments with acute, life-threatening conditions, primarily cardiovascular emergencies, sepsis, and metabolic abnormalities. CKD is a significant global health burden with rising prevalence, particularly in India, where diabetic nephropathy is a leading cause of End-Stage Renal Disease (ESRD). Understanding acute presentations and their management is crucial to improving long-term outcomes and reducing morbidity and mortality in this vulnerable population.

**Methods:** This prospective observational study, conducted in the General Medicine Department of KIMS Hospital from November 2018 to September 2020, evaluated 50 CKD patients on maintenance hemodialysis (MHD) meeting NKF KDOQI criteria. Patients were assessed through history, clinical examination, and investigations, with interventions provided for life-threatening complications like hyperkalemia, metabolic acidosis, and pulmonary edema. Outcomes (improved, died, status quo) were documented, and data were analyzed using SPSS with statistical tests like Chi-Square and Mann-Whitney U, with significance set at *P* < 0.05.

**Conclusion:** The study highlighted sepsis as the leading cause of mortality in CKD patients, with cardiovascular diseases and acute pulmonary edema being major contributors to hospital admissions. Early risk identification, cardiovascular interventions, and maintaining optimal serum potassium, hemoglobin, and anemia levels can improve outcomes. Prompt recognition and treatment of uremic encephalopathy and reducing frequent ED visits are crucial for lowering morbidity and mortality. Effective assessment and management by ED physicians play a vital role in enhancing patient care and survival.

**Keywords:** Chronic Kidney Disease (CKD), Maintenance Hemodialysis (MHD), Pulmonary Edema, End-Stage Renal Disease (ESRD).

## INTRODUCTION

Chronic kidney disease (CKD) patients on maintenance hemodialysis (MHD) secondary to type 2 diabetes mellitus and hypertension comprise majority of the patient load presenting to the Emergency Department (ED) with acute conditions. Chronic kidney disease is a worldwide health crisis. It is a global health burden with increased risk of multi organ dysfunction resulting from pre-existing medical conditions as well as secondary complications of maintenance hemodialysis.[1]

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There has been an increase in the prevalence of CKD patients during the last few decades. Due to changes in patients' demographic characteristics and availability of long-term renal replacement therapy, the percentage of patients with preexisting renal dysfunction developing acute critical illnesses has progressively increased.[2]

The Global Burden of Disease 2015 study has ranked chronic kidney disease 17th among the causes of deaths globally and it has been estimated that about 1.2 million deaths have occurred as a result of kidney failure with an increase of 32% from 2005. The disease burden is rapidly rising and increasing number of patients is entering in the pool of those on hemodialysis. On an average, 1.9 million ESRD patients require hemodialysis worldwide.

In India, the age – adjusted incidence rate of ESRD has recently been estimated to be 229 per million

 

population (pmp) and >100,000 new patients enter renal replacement therapies annually.[3,4]

The exact burden of CKD prevalence in India is not known but with a rise in the incidence of diabetes among the younger Indians, there is an expected rise in the prevalence as diabetic nephropathy accounts for about 40-60% 0f cases of ESRD. In India, there are over 130,000 patients who require dialysis and the number is rising by about 232 per million population.[5,6]

CKD patients on MHD presenting acutely is not uncommon, often avoidable and are associated with adverse outcomes. The reasons are often multifactorial and hence they may present with a variety of emergency medical problems that are associated with increased morbidity and mortality.[7]

Acute conditions in CKD patients on dialysis are life threatening mostly involving pulmonary oedema, emergent acid base and electrolyte disorders, dysrhythmias and other cardiovascular emergencies. They are at high risk to develop acute respiratory failure which in turn further worsens the renal function. Myocardial Infarction, cardiac arrest and malignant arrythmias can lead to sudden death in these patients and it accounts for about 43% of all-cause mortality.

Following cardiac causes, sepsis is the second leading cause of death in patients with ESRD with the common sources being indwelling catheters, prosthetic A-V grafts and urinary tract infection.

ESRD patients have bounded capacity to maintain homeostatic control and hence present with metabolic abnormalities like life threatening hyperkalemia, hypocalcemia and hyperphosphatemia.[2]

There has been limited exploration about how patients with CKD on dialysis use the ED. Understanding the risk factors and clinical presentations of these patients to the ED is pivotal for targeting ways in which the disease complications and its acute presentations to the ED can be approached. Early recognition, diagnosis and its timely management have important implications on long term morbidity and mortality.[8]

In this background, this study is being conducted to describe the acute presentations of patients with CKD on dialysis, their various etiologies and outcomes.

## MATERIALS & METHODS

This prospective observational study was conducted from November 2018 to September 2020 in the Department of General Medicine at KIMS Hospital, Bangalore. After obtaining approval from the Institutional Ethics Committee and securing written informed consent, 50 patients diagnosed with chronic kidney disease (CKD) and initiated on maintenance hemodialysis (MHD) were enrolled based on the NKF KDOQI (National Kidney Foundation Kidney Disease Outcomes Quality Initiative) guidelines for defining CKD. Patients younger than 18 years and those with CKD not undergoing MHD were excluded from the study.

Each patient presenting to the emergency department (ED) underwent a thorough evaluation, including detailed history-taking, clinical examination, and investigations such as GRBS, ECG, arterial blood gas analysis, serum electrolytes, renal function tests, chest X-rays, and 2D echocardiography if required. Emergency treatments were administered as necessary. Socio-demographic data, diagnoses at presentation, previous similar episodes, and the duration of MHD were collected from the participants. Patients were followed throughout their hospital stay, and outcomes were categorized as improved, deceased, or status quo for those discharged against medical advice. Interventions for managing life-threatening complications of CKD included intravenous glucose/insulin infusion and calcium gluconate for hyperkalemia, oral or intravenous sodium bicarbonate for metabolic acidosis, intranasal oxygen therapy and high-dose intravenous loop diuretics for pulmonary edema, and noninvasive positive pressure ventilation (NIPPV) using CPAP, followed by intubation and ventilatory support when required.

Statistical analyses were performed using SPSS for Windows Version 22.0 (IBM Corp., 2013). Descriptive analysis was conducted using frequencies and proportions for categorical variables and mean ± SD for continuous variables. Chi-Square tests were applied to compare the distribution of categorical variables based on outcomes, while Mann-Whitney U tests were used for continuous variables. Statistical significance was set at a *P* value of <0.05.

## RESULTS

50 patients of CKD on MHD presenting to KIMS hospital's ED were studied during the period of November 2018 to September 2020. Following results were recorded and analysed.

Table 1: Age Distribution among Study Patients

| Variables | Category | n | % |
|---|---|---|---|
| Age | < 40 years | 3 | 6% |
| | 41-50 years | 13 | 26% |
| | 51-60 years | 19 | 38% |
| | 61-70 years | 8 | 16% |
| | > 70 years | 7 | 14% |

In the present study the age variation was from 39 to 77 years. Majority of the patients were in the age group of 51-60 years, which included 19 patients (38%) also male preponderance was seen (68%) in comparison to females (32%) as observed from Table 1 and 2 respectively.

Table 2: Gender Distribution among Study Patients

| Variables | Category | n | % |
|---|---|---|---|
| Gender | Males | 34 | 68% |
| | Females | 16 | 32% |

In our study, it was demonstrated that hypertension was the most common co morbid condition present among all the patients of study group of which 32(94.1%) of them survived over time whereas 16(100%) of them did not survive. Diabetes mellitus was also present in a significant proportion of patients among which about 25 of them survived while 15 of them died. Among those with IHD, 2.9% of patients survived while about 6.3% of them died. These results were not statistically significant as seen in Table 3.

Table 3: Distribution of Co-Morbid Conditions among Study Patients Based On the Outcomes Using Chi Square Test

| Variable | Category | Improved | | Death | | P-Value |
|---|---|---|---|---|---|---|
| | | n | % | n | % | |
| Co-morbidity | Diabetes Mellitus | 25 | 73.5% | 15 | 93.8% | 0.10 |
| | Hypertension | 32 | 94.1% | 16 | 100.0% | 0.32 |
| | Ischemic Heart Disease | 1 | 2.9% | 1 | 6.3% | 0.58 |

Our study demonstrated (Table 4) that overall diabetic nephropathy was the most common underlying kidney disease among the patient population (n=20, %=40%) of which 12 of them survived over time while 8 of them died. Chronic glomerulonephritis accounted to 18% of the population among which majority of them (23.5%) survived while rest 6.3% did not survive. Concomitant diabetic with hypertensive nephropathy was found in 16% of the patients, whereas chronic pyelonephritis was seen in 8% of them. Few other causes were adult polycystic kidney disease (6%) and hypertensive nephropathy (6%).

Table 4: Distribution of Etiology among Study Patients Based On the Outcomes Using Chi Square Test

| Variable | Category | Improved | | Death | | Total | | P-Value |
|---|---|---|---|---|---|---|---|---|
| | | n | % | n | % | n | % | |
| Aetiology | Adult Polycystic Kidney Disease | 3 | 8.8% | 0 | 0.0% | 3 | 6% | 0.19 |
| | Chronic Glomerulonephritis | 8 | 23.5% | 1 | 6.3% | 9 | 18% | |
| | Chronic Pyelonephritis | 1 | 2.9% | 3 | 18.8% | 4 | 8% | |
| | Diabetic + HTN Nephropathy | 5 | 14.7% | 3 | 18.8% | 8 | 16% | |
| | Diabetic Nephropathy | 12 | 35.3% | 8 | 50.0% | 20 | 40% | |
| | Hypertensive Nephropathy | 2 | 5.9% | 1 | 6.3% | 3 | 6% | |
| | Others | 3 | 8.8% | 0 | 0.0% | 3 | 6% | |

In the study (Table 5) it was seen that a significant proportion of patients (n=29, ,85.4%) who improved over time had a duration of MHD within the first 15 months of dialysis initiation whereas only about 14.7% of them improved who were on MHD for a period of 16 months and greater. Also, about 62.6% of the subjects who were on MHD for a duration of 6-15 months did not survive and these results were not statistically significant.

Table 5: Comparison of MHD Duration (In Months) Based On the Outcomes of the Study Patients Using Chi Square Test

| Variable | Category | Improved | | Death | | P-Value |
|---|---|---|---|---|---|---|
| | | n | % | n | % | |
| MHD Duration | 1-5 months | 9 | 26.5% | 3 | 18.8% | 0.90 |
| | 6-10 months | 9 | 26.5% | 5 | 31.3% | |
| | 11-15 months | 11 | 32.4% | 5 | 31.3% | |
| | 16-20 months | 72 | 5.9% | 2 | 12.5% | |
| | > 20 months | 3 | 8.8% | 1 | 6.3% | |

The frequency of hospital visits for similar complaints previously was studied and it was found that about majority of the patients (56.3%) who did not survive had at least visited the ED twice previously. About 41.2% of them who survived had also visited the ED 2 times previously and about 35.3% of them required hospitalization more frequently previously (>2 times) and these results were not statistically significant(P=0.74) as seen in Table 6.

Table 6: Comparison of Frequency of Hospital Visits Based On the Outcomes of the Study Patients Using Chi Square Test

| Variable | Category | Improved | | Death | | P-Value |
|---|---|---|---|---|---|---|
| | | n | % | n | % | |
| Frequency of hospital visits | 1 Time | 8 | 23.5% | 2 | 12.5% | 0.74 |
| | 2 Times | 14 | 41.2% | 9 | 56.3% | |
| | > 2 Times | 12 | 35.3% | 5 | 31.3% | |

The study demonstrates that certain etiologies like adult polycystic kidney disease, chronic glomerulonephritis , chronic pyelonephritis & certain other conditions have occurred predominantly 2 times, ranging from 55.6% - 75.0% as compared to diabetic nephropathy and hypertensive nephropathy alone, which have showed a frequency occurrence of more than 2 times in 37.5% - 66.7%. However, these differences in the frequency of complaints based on the different etiologies among study patients was not statistically significant (P=0.69) as observed from Table 7.

Table 7: Comparison of Frequency of Complaints Based On the Etiology among Study Patients Using Chi Square Test

| Aetiology | 1 Time | | 2 Times | | >2 Times | | P-Value |
|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | |
| Adult Polycystic Kidney Disease | 1 | 33.3% | 2 | 66.7% | 0 | 0.0% | 0.69 |
| Chronic Glomerulonephritis | 1 | 11.1% | 5 | 55.6% | 3 | 33.3% | |
| Chronic Pyelonephritis | 1 | 25.0% | 3 | 75.0% | 0 | 0.0% | |
| Diabetic + HTN Nephropathy | 3 | 37.5% | 2 | 25.0% | 3 | 37.5% | |
| Diabetic Nephropathy | 4 | 20.0% | 8 | 40.0% | 8 | 40.0% | |
| Hypertensive Nephropathy | 0 | 0.0% | 1 | 33.3% | 2 | 66.7% | |
| Others | 0 | 0.0% | 2 | 66.7% | 1 | 33.3% | |

The study demonstrated (Table 8) that a significant proportion of patients who did not survive presented with altered mental status (31.3%) as compared to those subjects who improved over time [5.9%], this difference was statistically significant at P=0.02. However, other symptoms like fever (31.3%), dysuria (12.5%), vomiting (43.8%) and pedal edema (25.0%) was relatively seen more in patients who did not survive as compared to patients who recovered, the difference was not statistically significant. Other clinical symptoms dyspnea, chest pain, head ache and generalized weakness also did not show any significant difference between the patients who survived and did not survive.

Table 8: Distribution of clinical presentation by study patients based on the outcomes using Chi Square Test

| Variable | Category | Improved | | Death | | Total | | P-Value |
|---|---|---|---|---|---|---|---|---|
| | | n | % | n | % | n | % | |
| Clinical Presentation | Dyspnoea | 12 | 35.3% | 4 | 25.0% | 16 | 32% | 0.47 |
| | Fever | 7 | 20.6% | 5 | 31.3% | 12 | 24% | 0.41 |
| | Chest pain | 5 | 14.7% | 2 | 12.5% | 7 | 14% | 0.83 |
| | Dysuria | 3 | 8.8% | 2 | 12.5% | 5 | 10% | 0.69 |
| | Headache | 7 | 20.6% | 3 | 18.8% | 10 | 20% | 0.88 |
| | Vomiting | 10 | 29.4% | 7 | 43.8% | 17 | 34% | 0.32 |
| | Pedal Edema | 4 | 11.8% | 4 | 25.0% | 8 | 16% | 0.23 |
| | Altered Mental Status | 2 | 5.9% | 5 | 31.3% | 7 | 14% | 0.02* |
| | Generalized Weakness | 20 | 58.8% | 9 | 56.3% | 29 | 58% | 0.86 |
| *** - Statistically Significant** | | | | | | | | |

The study showed (Table 9) that the patients who did not survive showed increased percentage of Pre-hypertensive condition (25.0%), Stage I hypertension (31.3%) and Stage II hypertension (37.5%) as compared to those patients who improved over time with 11% of patients showing normal blood pressure, 14.7 to 29.4% showing different hypertensive status. However, this

difference in hypertensive status between 2 groups was not statistically significant (P-0.36).

Table 9: Distribution of Hypertensive Status among Study Patients Based Outcomes Using Chi Square Test

| BP(mmHg) | Improved | | Died | | Total | | P-Value |
|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | |
| Hypotensive | 7 | 20.6% | 1 | 6.3% | 8 | 16.0% | 0.36 |
| Normal | 4 | 11.8% | 0 | 0.0% | 4 | 8.0% | |
| Pre-hypertensive | 5 | 14.7% | 4 | 25.0% | 9 | 18.0% | |
| Stage I HTN | 8 | 23.5% | 5 | 31.3% | 13 | 26.0% | |
| Stage II HTN | 10 | 29.4% | 6 | 37.5% | 16 | 32.0% | |

The above results (Table 10) demonstrated that the mean PH and HCO3 values among those patients who survived was (7.3±0.11) & (17.54±5.88) as compared to those who did not survive (7.22±0.16) & (15.16±5.37) respectively.

As seen from the above table, the total count and blood urea levels were relatively higher in those patients who did not survive as compared to those who recovered over time but this did not show any statistical significance.

The mean Hb levels, serum creatinine levels, serum phosphorus levels, serum calcium and serum albumin levels did not differ significantly among those who survived and those who died.

The study demonstrated that the mean serum potassium levels in patients who did not survive was significantly higher (5.56 ± 1.07) as compared to those patients who improved over time (4.96 ± 0.94). This difference in the mean serum potassium levels between 2 groups was statistically significant at P=0.04.

Table 10: Comparison of Mean Values of Different Study Parameters Based On the Outcome Using Mann Whitney Test

| Parameters | Outcome | N | Mean | SD | Mean Diff | P-Value |
|---|---|---|---|---|---|---|
| PH | Improved | 34 | 7.31 | 0.11 | 0.09 | 0.06 |
| | Died | 16 | 7.22 | 0.16 | | |
| HCO3 | Improved | 34 | 17.54 | 5.88 | 2.38 | 0.16 |
| | Died | 16 | 15.16 | 5.37 | | |
| HB(g%) | Improved | 34 | 8.70 | 1.63 | -0.24 | 0.69 |
| | Died | 16 | 8.94 | 1.20 | | |
| TC(cells/mm³) | Improved | 34 | 12454.71 | 5387.74 | -3311.54 | 0.27 |
| | Died | 16 | 15766.25 | 9108.56 | | |
| Serum Potassium (mEq/L) | Improved | 34 | 4.96 | 0.94 | -0.60 | 0.04* |
| | Died | 16 | 5.56 | 1.07 | | |
| Blood Urea (mg/dl) | Improved | 34 | 109.56 | 37.51 | -16.07 | 0.15 |
| | Died | 16 | 125.63 | 35.39 | | |
| Serum Creatinine (mg/dl) | Improved | 34 | 6.43 | 2.31 | -0.54 | 0.41 |
| | Died | 16 | 6.97 | 2.49 | | |
| Serum Phosphorus (mg/dl) | Improved | 34 | 5.75 | 1.65 | 0.60 | 0.18 |
| | Death | 16 | 5.15 | 1.62 | | |
| Serum Calcium (mg/dl) | Improved | 34 | 7.78 | 1.16 | -0.28 | 0.38 |
| | Death | 16 | 8.06 | 0.86 | | |
| Serum Albumin(gm/dl) | Improved | 34 | 3.15 | 0.54 | 0.00 | 0.96 |
| | Death | 16 | 3.15 | 0.58 | | |
| * - Statistically Significant | | | | | | |

ECG (Table 11) taken on arrival to the ED demonstrated hyperkalemia changes in 8 (16%) patients among which 3 (18.8%) of them did not survive and 5 (14.7%) of them recovered over time. 10% of the patients sustained anterior wall myocardial infarction while 8% of them presented with inferior wall myocardial infarction. ECG showed no significant changes in about 58% of the study population.

Table 11: Distribution of ECG Findings among Study Patients Based On the Outcomes Using Chi Square Test

| Variable | Category | Improved | | Died | | Total | | P-Value |
|---|---|---|---|---|---|---|---|---|
| | | n | % | n | % | n | % | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ECG | Anterior wall Myocardial Infarction | 3 | 8.8% | 2 | 12.5% | 5 | 10% | 0.69 |
| | Hyperkalemia Changes | 5 | 14.7% | 3 | 18.8% | 8 | 16% | |
| | Inferior Wall Myocardial Infarction | 2 | 5.9% | 2 | 12.5% | 4 | 8% | |
| | Left Ventricular Hypertrophy | 2 | 5.9% | 2 | 12.5% | 4 | 8% | |
| | Normal | 22 | 64.7% | 7 | 43.8% | 29 | 58% | |

Chest Xray (Table 12) was normal in about 70% of the patients while the rest 30% of them showed bilateral infiltrates on Xray. Among these 32.4% of them improved over time while 25% did not survive.

Table 12: Distribution of Chest X-ray findings among study patients based on the outcomes using Chi Square Test

| Variable | Category | Improved | | Died | | Total | | P-Value |
|---|---|---|---|---|---|---|---|---|
| | | n | % | n | % | n | % | |
| Chest X-Ray | B/L Infiltrates | 11 | 32.4% | 4 | 25.0% | 15 | 30% | 0.58 |
| | Normal | 23 | 67.6% | 12 | 75.0% | 35 | 70% | |

The most common acute presentation (Table 13) by our patients on arrival to the ED was acute pulmonary edema (30%) followed by sepsis (22%), hyperkalemia (16%), hypertensive crisis (10%), uraemic encephalopathy (10%), severe anaemia (8%) and CVA (4%). Acute pulmonary edema was either secondary to heart failure or volume overload. Majority (18%) of the patients presented with APE secondary to heart failure while about 12% of them secondary to volume overload. Sepsis due to catheter related blood stream infection accounted for 12% of the patients while sepsis due to UTI was presented by 10% of the patients. Majority of the patients who presented with APE due to volume overload(I=18%),hypertensive crisis(I=15%) and severe anaemia (I=12%) showed better recovery and survived over time as compared to those who presented with sepsis (D=26%),acute pulmonary edema due to heart failure(D=25%),hyperkalemia(D=19%), uraemic encephalopathy(D=19%) and CVA (D=13%) in whom mortality rates were higher.

Table 13: Distribution of Acute Presentations among study patients based on the outcomes using Chi Square Test

| Variable | Category | Improved | | Died | | Total | | P-Value |
|---|---|---|---|---|---|---|---|---|
| | | n | % | n | % | n | % | |
| Acute Presentations | Acute Pulmonary Edema due to Heart Failure | 5 | 15% | 4 | 25% | 9 | 18% | 0.08 |
| | Acute Pulmonary Edema due to Volume Overload | 6 | 18% | 0 | 0% | 6 | 12% | |
| | Cerebrovascular Accident | 0 | 0% | 2 | 13% | 2 | 4% | |
| | Hyperkalaemia | 5 | 15% | 3 | 19% | 8 | 16% | |
| | Hypertensive Crisis | 5 | 15% | 0 | 0% | 5 | 10% | |
| | Sepsis due to Catheter related Blood stream infection | 4 | 12% | 2 | 13% | 6 | 12% | |
| | Sepsis due to Urinary Tract Infection | 3 | 9% | 2 | 13% | 5 | 10% | |
| | Severe Anaemia | 4 | 12% | 0 | 0% | 4 | 8% | |
| | Uraemic Encephalopathy | 2 | 6% | 3 | 19% | 5 | 10% | |

The study shows that certain acute presentations like cerebrovascular accident, sepsis, hyperkalemia, APE due to pulmonary edema have occurred for at least 2 times previously ranging from 40%-100% as compared to other presentations like APE due to heart failure (44.4%) and severe anaemia (50%) which have showed a frequency occurrence of more than 2 times. These differences in the frequency of complaints based on acute presentations among study patients was not statistically significant. (P=0.61) as observed in Table 14.

Table 14: Comparison of frequency of complaints based on the Acute Presentations among study patients using Chi Square Test

| Acute Presentations | 1 Time | | 2 Times | | > 2 Times | | P-Value |
|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | |
| Acute Pulmonary Edema due to Heart Failure | 2 | 22.2% | 3 | 33.3% | 4 | 44.4% | 0.61 |
| Acute Pulmonary Edema due to Volume Overload | 2 | 33.3% | 3 | 50.0% | 1 | 16.7% | |
| Cerebrovascular Accident | 0 | 0.0% | 2 | 100.0% | 0 | 0.0% | |
| Hyperkalaemia | 0 | 0.0% | 5 | 62.5% | 3 | 37.5% | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hypertensive Crisis | 3 | 60.0% | 1 | 20.0% | 1 | 20.0% | |
| Sepsis due to Catheter related Blood stream infection | 0 | 0.0% | 4 | 66.7% | 2 | 33.3% | |
| Sepsis due to Urinary Tract Infection | 1 | 20.0% | 2 | 40.0% | 2 | 40.0% | |
| Severe Anaemia | 1 | 25.0% | 1 | 25.0% | 2 | 50.0% | |
| Uraemic Encephalopathy | 1 | 20.0% | 2 | 40.0% | 2 | 40.0% | |

Majority of our patients (68%) required HD immediately after admission whereas about 20% of them required to be dialyzed 12-24 hrs after admission and 12% of them required it 1-2 days after admission. Among those who were dialyzed immediately within 24 hrs of admission, a significant proportion of patients (n=24, 70. 6%) improved well while the rest of them (n=10, 62.5%) did not survive as seen in Table 15.

Table 15: Distribution of Requirement of Hemodialysis among study patients based on the outcomes using Chi Square Test

| Variable | Category | Improved | | Death | | Total | | P-Value |
|---|---|---|---|---|---|---|---|---|
| | | n | % | n | % | n | % | |
| Requirement of HD | Immediately after Admission | 24 | 70.6% | 10 | 62.5% | 34 | 68.0% | 0.33 |
| | 12-24 hrs after Admission | 5 | 14.7% | 5 | 31.3% | 10 | 20.0% | |
| | 1-2 days after Admission | 5 | 14.7% | 1 | 6.3% | 6 | 12.0% | |

Out of total of 50 patients (Table 16), 34 of them (68%) survived over time, while 13 of them died (26%) and about 3 of them were status quo (6%).

Table 16: Distribution of Actual Outcomes among study patients

| Variable | Category | n | % |
|---|---|---|---|
| Actual Outcome | Improved | 34 | 68.0% |
| | Status Quo | 3 | 6.0% |
| | Died | 13 | 26.0% |

## DISCUSSION

In our study, 50 cases of CKD on MHD were selected and clinically evaluated during a period of 2 years. Statistical data of age, gender, various etiologies, comorbidities, acute presentations and frequency of visits to the ED along with their outcomes were studied and compared with those published in literature.

Table 17: Comparison of Age distribution

| Study | Age Group | % |
|---|---|---|
| Bello et al[9] (2017) | 31-40 years | 22.2 |
| Nath et al[10] (2018) | 41-50 years | 33.3 |
| Chandrashekar et al[11] (2014) | >40 years | 50 |
| **Present study** | **51-60 years** | **38** |

Distribution of age group was studied in various studies. In our study the maximum incidence was seen in the age group between 51-60 years. This is in contrast to various other studies by Bello et al [9] and Nath et al [10] where in the incidence was higher in age groups between 31-40 years. This can be due to a delay in initiation of dialysis either due to accessibility or affordability issues or both.

Table 18: Comparison of Sex distribution

| Study | Males | Females |
|---|---|---|
| Chandrashekar et al[11] (2014) | 75% | 25% |
| Bello et al[9] (2017) | 65.8% | 34.2% |
| Lakshminarayana et al[12] (2017) | 65.6% | 34.4% |
| Nath et al[10] (2018) | 61.9% | 38.1% |
| USRDS Annual report[13] (2019) | 58.1% | 41.8% |
| **Present study** | **68%** | **32%** |

Majority of the studies including our study and data from USRDS[13] annual report showed higher incidence of ESRD among males as compared to females.

Table 19: Comparative data of Co morbid conditions

| Study | Co Morbidities | | |
|---|---|---|---|
| | HTN | DM | IHD |
| Chandrashekar et al[11] (2014) | 91.75% | 43.3% | 17.2% |
| Harel et al[14] (2015) | 90% | 62% | 68% |
| Lakshminarayana et al[12] (2017) | 96.8% | 59.7% | 52.3% |
| **Present study** | **64%** | **55%** | **4%** |

Hypertension was the most common co morbidity present among our study patients followed by diabetes and then IHD. This was comparable to few other Indian studies by Chandrashekar et al[11] and Lakshminarayana et al[12] but in a study conducted in the Canadian population by Harel et al[14] shows IHD to be present more commonly among CKD patients after hypertension which is probably due to rising trends in occupational associated health risks and due to an increase in the cardiovascular risks among CKD patients.

Table 20: Comparative data of Etiology of CKD

| Study | Etiology | | | | |
|---|---|---|---|---|---|
| | Diabetic nephropathy | Hypertensive nephropathy | DM+HTN | CGN | Others |
| Chandrashekar et al[11] (2014) | 44.7% | - | - | 23.95% | 17.7% |
| Lakshminarayana et al[12] (2017) | 59.7% | - | - | 11.9% | 28.3% |
| Nath et al[10] (2018) | 11.9% | 23.8% | 35.7% | 14.3% | 14.3% |
| USRDS Annual report[13] (2019) | 76% | 72.1% | - | 39% | 48.7% |
| **Present study** | **40%** | **6%** | **16%** | **18%** | **6%** |

The commonest cause for chronic kidney disease in the present study was diabetic nephropathy which was seen in about 40% of the study population followed by chronic glomerulonephritis seen in 18% of the population, DM+HTN in 16% and other causes in 6% of them. Due to the growing number of DM patients and aging population in India, there has been a parallel increase in the incidence of CKD. Diabetes is a leading cause of chronic kidney disease in high-income countries and it is now also the leading risk factor associated with renal failure death in India.

Similarly, in other Indian studies by Chandrashekar et al[11] and Lakshminarayana et al[12] and according to USRDS[13] annual data, diabetes was the most common cause of CKD.

In study conducted by Nath et al[10] in Bangladesh, DM+HTN was the most common etiology of CKD.

Table 21: Comparative data of Mean duration of MHD

| Study | Mean MHD Duration (Months) |
|---|---|
| Sankarasubbaiyan et al[15] (2007) | 13.47 |
| Lakshminarayana et al[12](2017) | 37.16±26.24 |
| **Present study** | **9.82±6.15** |

The mean duration on hemodialysis in the present study was 9.82±6.15 months which was lower as compared to the above-mentioned studies. From those who were on MHD for a period of about 15 months, about 85.4% of patients survived over time whereas 62.6% of them died.

There was decline in the improvement of patients after for duration of MHD greater than 15 months but this was not statistically significant.

**Frequency of Previous Visits to the ED**

Our study frequent ED visits by patients on MHD. Majority of the patients (56.3%) who did not survive had at least visited the ED twice previously. About 41.2% of them who survived had also visited the ED 2 times previously and about 35.3% of them required hospitalization more frequently previously (>2 times). Also, there was higher frequency of visits (at least 2 times or more) in those with sole diabetic nephropathy (80%) and sole hypertensive nephropathy (100%). Our results are comparable with the following studies wherein a similar trend of increase in ED visits and rehospitalizations was seen among CKD patients undergoing haemodialysis.

Study by Harel et al[14] (2015) - They conducted a population-based study of all adult patients receiving maintenance haemodialysis and found that more than one half of patients (54%) had at least one hospitalization in the 6 months before their index hospitalization, whereas 92% had visited the emergency department during this period.

More than one in four (27%) patients receiving maintenance hemodialysis visited an emergency department in the 30 days after their index hospitalization of which 46% resulted in a rehospitalization.

Study by Ronksley et al[16] (2017) -This large population-based found that the acuity of the ED visits was often higher among patients with more advanced CKD, with patients on dialysis having a higher proportion of urgent (38.2%) or emergent (22.4%) visits to the ED. Patients on dialysis had approximately 1798 ED visits per 1000 person-years.

Study by Nath et al[10] (2018) - This retrospective observational study conducted to identify the etiology and frequency of hospital admissions in maintenance hemodialysis patients in CKD. Among those with concomitant HTN and DM, 33.3% got admitted maximum thrice times, whereas 26.7% admitted for five times after starting dialysis. Among those who had solely HTN, about half of them (50%) got admitted twice times comparing to three times admission for diabetic patient (40%). Mean hospitalizations were 2.8 times, and the average duration of stays was 3.8 days in this study group.

Table 22: Comparative data of Clinical symptoms

| Study | Clinical Symtoms |
|---|---|
| M.P. Merkus et al[17] (1999) | Fatigue (80%)<br>Muscle cramps (62%)<br>Shortness of breath (45%)<br>Dizziness (45%)<br>Nausea (25%) |
| Weisbord et al[18] (2005) | Feeling tired/lack of energy (69%)<br>Swelling of legs (26%)<br>Shortness of breath (19%)<br>Vomiting (11%)<br>Chest pain (10%) |
| Jablonski et al[19] (2007) | Tiredness (77%)<br>Muscle weakness (51%)<br>Shortness of breath (33%)<br>Nausea / vomiting (32%)<br>Headaches (30%)<br>Chest pain (17%) |
| Present study | Generalized weakness (58%)<br>Vomiting (34%)<br>Dyspnoea (32%)<br>Fever (24%)<br>Headache (20%)<br>Pedal edema (16%)<br>Chest pain (14%)<br>Altered mental status (14%)<br>Dysuria (10%) |

Our study demonstrated varied clinical features with the most common symptom being generalized weakness (58%) which was consistent with various other studies conducted by Merkus et al[17] Weisbord et al[18] and Jablonski et al.[19] Shortness of breath, vomiting, headaches, swelling of limbs were few other common symptoms noticed among our study as well as the above studies.

Our study also found that a significant proportion of patients who did not survive presented with altered mental status [31.3%] as compared to those subjects who improved over time [5.9%] and this difference was statistically significant at P=0.02.

Table 23: Comparative data of different laboratory parameters

| Parameters | R. Kazancioglu et al[20] (2007) | Bello et al[9] (2017) | Rehman et al[4] (2016) | Present study |
|---|---|---|---|---|
| HB(g/dl) | - | 8.0(6.3-9.5) | 7.87±1.82 | 8.75±1.47 |
| TC(1000 cells/mm³) | - | - | 15.48 ±8.23 | 13.51±6.81 |
| Serum Potassium (mEq/L) | 4.81±1.073 | 4.9(4.2-5.8) | 5.41±1.35 | 5.15±1.0 |
| Blood Urea (mg/dl) | - | 75.89(39.2-112.01) | 349.04 ±77.6 | 114.7±36.88 |
| Serum Creatinine (mg/dl) | 7.85±4.8 | 9.22(4.98-17.41) | 14.44 ±4.41 | 6.6±2.3 |
| Serum Albumin(gm/dl) | 3.22±0.72 | - | - | 3.15±0.54 |

Table 24: Comparative data of Investigation profile in relation to patient outcome

| Parameters | Survived | | Death | |
|---|---|---|---|---|
| | Rehman et al[4] (2016) | Present study | Rehman et al[4] (2016) | Present study |
| HB(g/dl) | 7.88 ±1.83 | 8.70±1.63 | 7.76 ±1.79 | 8.94±1.20 |
| TC(cells/mm³) | 14.63 ±7.39 | 12.45±53.87 | 20.46 ±11 | 15.76±91.08 |
| Blood Urea (mg/dl) | 344.39 ±74 | 109.56±37.51 | 376.64 ±92.67 | 125.63±35.39 |
| Serum Creatinine (mg/dl) | 14.45 ±4.51 | 6.43±2.31 | 14.04 ±4.07 | 6.97±2.49 |

Present study results demonstrated that the total count and blood urea levels were relatively higher in those patients who did not survive as compared to those who recovered over time but this did not show any statistical significance. These findings were also comparable with study conducted by Rehman et al[4] in ESRD patients requiring hemodialysis.

The mean Hb levels, serum creatinine levels and serum albumin levels did not differ significantly among those who survived and those who died.

The study demonstrated that the mean serum potassium levels in patients who did not survive was significantly higher [5.56 ± 1.07] as compared to those patients who improved over time [4.96 ± 0.94] and this difference was statistically significant at P=0.04.

Table 25: Comparative data of ECG changes

| Study | ECG Changes | | | |
|---|---|---|---|---|
| | Arrythmias | Ischaemia | LVH | Normal |
| Krivoshiev et al[21] (1987) | 23.7% | 29.1% | 33.6% | 9.1% |
| Ramanan et al[22] (2005) | 4% | 16% | 30% | 14% |
| Sachdeva et al[23] (2017) | 4.3% | 8.7% | 30.43% | 26% |
| **Present study** | **16%** | **18%** | **8%** | **58%** |

In the present study, electrocardiographically determined cardiovascular abnormalities were observed in 42% of patients with 18% of them presenting with ischaemic changes, 16% of them presenting with arrythmias secondary to hyperkalemia and about 8% of them with LVH.ECG was normal in 58% of the population.

When compared with studies by Krivoshiev et al [21] Sachdeva et al [23] and Ramanan et al [22] majority of the patients had LVH followed by ischaemic changes and arrythmias.

Table 26: Comparative data of acute presentations

| Acute Presentations | Chandrashekar et al[11] (2014) | Bello et al[9] (2017) | Lakshminarayana et al[12] (2017) | Hemachandar et al[24] (2017) | Nath et al[10] (2018) | Present Study |
|---|---|---|---|---|---|---|
| Acute Pulmonary Edema due to Heart Failure | 26.3% | 7.1% | 38.23% | 30% | 34.3% | 18% |
| Acute Pulmonary Edema due to Volume Overload | 15.8% | 4.5% | - | 20% | - | 12% |
| Cerebrovascular Accident | 5.3% | 5.8% | 1.5% | | 1.9% | 4% |
| Hyperkalaemia | - | 0.7% | - | | - | 16% |
| Hypertensive Crisis | - | 12.9% | - | | - | 10% |
| Sepsis | 36.8% | 16.8% | 26.5% | 43.33% | - | 22% |
| Severe Anaemia | - | 9.7% | - | | - | 8% |
| Uraemia/ Uraemic encephalopathy | - | 21.3% | - | | 9.8% | 10% |

In our study, it was observed that the most common acute presentation on arrival to the ED was acute pulmonary edema (30%) followed by sepsis (22%), hyperkalemia (16%), hypertensive crisis (10%), uraemic encephalopathy (10%), severe anaemia (8%) and CVA (4%).

Majority (18%) of the patients presented with APE secondary to heart failure while about 12% of them were secondary to volume overload. Sepsis was most commonly due to catheter related blood stream infection (12%) followed by UTI (10%).

Majority of the patients who presented with APE due to volume overload (I=18%), hypertensive

crisis(I=15%) and severe anaemia (I=12%) showed better recovery and survived over time as compared to those who presented with sepsis (D=26%), acute pulmonary edema due to heart failure(D=25%), hyperkalemia(D=19%), uraemic encephalopathy(D=19%) and CVA(D=13%) in whom mortality rates were higher.

Our study findings are consistent with other Indian studies by Chandrashekar et al[11] Lakshminarayana et al[12] Hemachandar et al[24] and also study by Nath et al[10] conducted in Bangladesh which also showed the commonest presentations to be Pulmonary Edema (majority due to cardiovascular conditions) followed by Sepsis.

These findings differed from study conducted by Bello et al[9] in South Nigeria wherein they observed a spectrum of clinical indications for EC admission with uraemia (21.3%) sepsis (16.8%) and hypertensive crisis (12.9%) being the most common individual indications.

Pulmonary edema is common in patients with dialytic emergency and majority of the patients who came to our emergency with respiratory distress were diagnosed with APE. These complications typically occur when GFR falls below 10-15ml/min/1.73m$^2$.[25]

APE due to volume overload had better survival and improved with dialysis when compared to those presenting with heart failure. About 25% of the patients presenting with heart failure symptoms did not improve despite dialysis and succumbed to death.

Though there is a decline in the cardiovascular diseases in the general population presently, a similar trend has not been observed in dialysis patients owing to the fact that most dialysis patients are diabetic and many may have underlying cardiac disease at the initiation of dialysis therapy itself and also it has been established that CKD is an independent risk factor for cardiovascular disease.

In our study 2 of our patients were known to have IHD before presentation to the hospital and one of them presented with APE secondary to heart failure and the patient recovered over time after undergoing dialysis. Rest of the 8 patients who presented with heart failure symptoms had new onset ischaemic changes.

High levels of serum potassium (7-7.5mEq/L) and significant ECG changes were observed among patients who presented with hyperkalemia to the ED and it contributed to about 19% of deaths in our study.

Altered mental status was a significant clinical symptom in our study and these patients presented with either Uraemic encephalopathy (10%) or CVA (4%) to our ED.

8% of the study patients who presented with severe anaemia with mean haemoglobin levels 5.65±0.54 (g/dl) improved over time with appropriate treatment.

34 out of 50 patients (68%) from our study underwent emergency HD immediately after admission among which a significant proportion of patients (n=24, 70.6%) improved after HD.

The commonest indications for undergoing immediate HD were APE secondary to heart failure/ volume overload (n=15,30%), hyperkalemia(n=7,14%%) and sepsis (n=6,12 %). This was in contrast to studies by Bello et al[9] and Hemachandar et al[24] wherein the most common indication for dialysis was uraemia followed by acute pulmonary edema.

Table 27: Comparative data of Outcomes & Mortality

| | **Chandrashekar et al[11] (2014)** | **Bello et al[9] (2017)** | **Lakshminarayana et al[12] (2017)** | **Hemachandar et al[24] (2017)** | **Present study** |
|---|---|---|---|---|---|
| Overall Mortality | 63.12% | 8.9% | 50.7% | 16.54% | **26%** |
| Most Common Cause of Death | Sepsis | Cardio vascular events | Cardiovascular events | Sepsis | **Sepsis** |

Overall mortality in our study was 26% whereas it was significantly higher in studies by Chandrashekar et al[11] (63.12%) and Lakshminarayana et al[12] (50.7%). About 68% of patients recovered over time and survived in our study.

Sepsis was the second most common presentation but contributed for the most common cause of mortality in our study with the most common source being catheter related infections followed by urinary tract infection. Staphylococcus aureus was the common organism isolated from catheter related infections while for those with UTI,

Klebsiella was the common organism involved. Fever, dysuria and generalised weakness were the most common symptoms with which these patients presented to the ED.

Studies by Chandrashekar et al[11] and Hemachandar et al[24] also shows majority of the deaths occurring due to sepsis. In study by Chandrashekar et al about 36.8% of the deaths occurred due to sepsis alone, mostly as a result of vascular access-related infections like an abscess of the AVF and catheter-related bacteraemia whereas in study by Hemachandar etal about 43.33% of deaths were attributed to sepsis with the most common source being lower respiratory tract infection (38.64%) followed by catheter-related sepsis (29.55%) and urinary tract infection (11.36%).

In contrast to the above, studies by Bello et al[9] and Lakshminarayana et al[12] (51.5%) observed an

increase in mortality due to cardiovascular events mainly due to acute coronary syndrome.

## CONCLUSION

Our study recognized sepsis as the most common cause of mortality, especially the vascular access - related ones followed by urinary tract infection.

Acute pulmonary edema was the commonest cause of hospital admission with cardiovascular disease being the most important cause. Identification of the patients at risk at the start of dialysis itself and use of prompt cardiovascular interventions and preventive care could help in substantially decreasing the cardiovascular related deaths.

Maintaining the serum potassium within the normal limits (3.5 - 5.5 mEq/L), correcting anaemia and maintaining an optimal haemoglobin level, will aid in enhancing the myocardial oxygenation with effect on microcirculation and load on heart, and can improve survival outcomes.

Acute alterations of mental status in CKD patients presenting to the emergency, are often indicative of uraemic encephalopathy which may be rapidly progressive requiring urgent treatment with haemodialysis. Prompt recognition and identification of these presentations is crucial as encephalopathies may be reversible with treatment.

We also found a rise in mortality among those who presented frequently to the ED for similar presentations in the past.

Hence, strict vigilance, proper assessment and good clinical acumen by ED physicians helps in the early detection and appropriate management of these patients, thereby reducing frequent hospitalizations as well as the risk of morbidity and mortality among them.

## LIMITATIONS

- The sample size was limited because it was a single centre study.
- Majority of the patients were referred from other places, hence the quality of care prior to arrival, could not be looked into which could have possibly affected the outcome of the study.

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