A Cross-Sectional Analysis of Hyperkalemia and Estimated Glomerular Filtration Rate (Egfr) and its Correction was Carried Out in Patients Receiving Maintenance Hemodialysis (MHD) In a Tertiary Care Institution in Salem, Tamilnadu, India.

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Abstract:
A major global health concern and leading cause of death is chronic renal failure (CRF). Hyperkalemia is a problem that many people with End Stage Renal Disease (ESRD) deal with. The goal of the current study is to compare the serum electrolyte levels, serum creatinine levels, eGFR, systolic and diastolic blood pressure, and weight of maintenance hemodialysis (MHD) patients before and after dialysis. 44 MHD patients were selected to assess their serum electrolytes by Ion selective electrode, Creatininie was estimated by Jaffe's method in an autoanalyser in Biochemistry department of Vinayaka Mission's Kirupananda Variyar Medical College & Hospital (VMKVMCH), Salem, Tamil Nadu. The eGFR was calculated by using MDRD (Modification of Diet in Renal Disease) formula. The pre hemodialysis K^+ was 4.9 ±0.9 mEq/L and post hemodialysis K^+ was 3.7 ± 0.5 mEq/L. The pre hemodialysis $Na^+$was 135.8 ±14.9 mEq/L and post hemodialysis Na^+ was 138.7 ± 9.2 mEq/L. The pre hemodialysis Cl^- was 107.7 ±15.6 mEq/L and post hemodialysis Cl^- was 106.7 ± 9.7 mEq/L. The pre hemodialysis Creatinine was 8.5 ±3.1 mg/dL and post hemodialysis Creatinine was 3.7 ± 1.4 mg/dL. The eGFR was 7.6 ±4.5 mL/min/1.73m^2 prior to hemodialysis and it was was 19.1 ± 8.1mL/min/1.73m^2 after hemodialysis. In our study, out of 44 MHD patients 21 patients are hyperkalemic. The average Potassium level increased along with renal function decreases(stage 4: 5.2 ± 0.14, stage 5: 6.5 ± 0.75 mEq/). The Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) were reduced from 165.9 ± 20.8 mm of Hg to 146 ±15.2 mm of Hg and 90.2 ±13.5 mm of Hg to 84.7± 6.6 in post hemodialysis. Patients with MHD lost weight, going from 64.4± 13.4 kg to 61.7 ±13.3 kg. We conclude that eGFR improved and serum K^+ and serum creatinine were significantly lower than pre-hemodialysis. Serum Na^+ and Cl^- levels were not statistically significant in the post-hemodialysis phase. Weighing, SBP, and DBP were statistically significant.

Keywords: Chronic kidney disease, End stage renal disease, maintenance hemodialysis, Serum electrolytes, Creatinine, Estimated Glomerular filtration rate.

Introduction:

Chronic kidney disease is defined as either kidney damage or Glomerular filtration rate (GFR) < 60mL/min/1.73 m^2 for ≥ 3 months. Kidney damage associated with several pathophysiological processes, abnormal kidney function and progressive decline in GFR[1]. A patient's wellbeing may be more affected by the abnormalities in acid-base and electrolyte balance that occur in CKD, which also increases morbidity and mortality[2,3]**.** Hemodialysis (HD) is the most common renal replacement therapy modality in India and about 175,000 patients are thought to be receiving chronic hemodialysis in India, giving to a prevalence of 129 per million people in 2018[4]**.**

The major intracellular cation Potassium has a major role in maintaining intracellular osmotic pressure and excess Potassium is primarily eliminated through the kidney[5]**.** Hyperkalemia occurs very commonly in CKD patients due to reduced urinary output, reduced potassium clearance, shift of potassium from the intracellular to the extracellular space. Increased membrane excitability brought on by the increasing potassium levels can result in ventricular arrhythmia and ventricular fibrillation which results a 2.7-fold increase in the risk of sudden cardiac arrest in CKD[6,7,8,9]**.** Elevated serum creatinine and a decline in eGFR indicate that renal damage is progressing. Therefore, estimating serum Creatinine contributes to the clinical picture of various stages of renal disease and aids in eGFR assessment[10,11]**.** Cardiovascular morbidity and death in hemodialysis patients are directly correlated with the prevalence of hypertension in the general population. Hemodialysis can be predicted to extend the lives of patients with hypertension[12, 13]**.**

Aim of the study:

Assessing the frequency of electrolyte problems in end-stage renal disease (ESRD) patients undergoing maintenance hemodialysis (MHD) both before and after the procedure was performed. The outcome might be useful in reducing cardiovascular disease-related mortality.

Objectives:

- To measure the electrolytes, creatinine levels in serum of maintenance hemodialysis patients before and after dialysis.
- To assess the relationship between hyperkalemia and eGFR before patients receiving maintenance hemodialysis.
- To evaluate the relation between systolic and diastolic blood pressure in pre & post maintenance hemodialysis patients.
- To determine the relationship between patients' weights before and after hemodialysis.

Materials and Methodology:

It is a cross-sectional study, and blood samples were taken from 44 MHD patients' arteriovenous fistulas before hemodialysis and from peripheral veins after hemodialysis. The mean duration of dialysis was 3.5 to 4 hours. Blood flow rate was 300 ml per minute and dialysate flow was 500ml per minute. The study was conducted after obtaining Institutional ethical clearance from Vinayaka Mission's Kirupananda Variyar Medical College & Hospital, Seeragapadi, Salem-636308, Tamil Nadu and each participant's consent and informed permission was obtained.

Study design: Cross sectional study

Study location: Vinayaka Mission's Kirupananda Variyar Medical College & Hospital, Seeragapadi, Salem-636308, Tamil Nadu, India.

Study population and selection method: The 44 ESRD patients undergoing maintenance hemodialysis were selected from dialysis unit of Vinayaka Mission's super speciality hospital, Seeragapadi, Salem-636308, Tamil Nadu, India.

Inclusion criteria: Between the ages of 18 and 75, both male and female patients receiving maintenance hemodialysis.

Exclusion criteria:

1. The patients having liver diseases, inter-current illnesses (infectious diseases, cancer and prolonged hospitalization), mental retardation and dementia were eliminated from study.
2. Those patients are already taking medications like Angiotensin converting enzyme (ACE) and Antagonize receptor binding (ARB) inhibitors.

Procedure methodology:

For the study, 44 maintenance hemodialysis patients had 5 ml of venous blood drawn from them both pre- and post-hemodialysis from arteriovenous fistulas (AVF) and peripheral blood. All patients had their weight and blood pressure checked before and after hemodialysis. Analysis was done on creatinine, sodium, potassium, and chloride. The Creatininie was estimated by modified Jaffe's method in an

autoanalyser. Ion selective electrode was used to assess the serum electrolytes sodium, potassium, and chloride. The MDRD (Modification of Diet in Renal Disease) formula was used to determine eGFR. [eGFR (mL/min/1.73 m^2) = 175 × $(S_{cr})^{-1.154}$ × $(Age)^{-0.203}$ × (0.742 if female)].

Statistical analysis:
Data were entered in MS EXCEL 2007 version and further analysis were done by SPSS -2020.

Descriptive analysis: The categorical variable was analyzed by using frequency and percentage and continuous variable were analyzed by calculating mean ± SD.

Inferential analysis: The numerical data were analyzed by using paired 't' test. The categorical data were analyzed by using chi-square test and p value ≤ 0.05 were considered as statistically significant.

RESULTS

There are 44 patients included for the study, out of that 33 (75%) male and 11 (25%) female with age distribution ≥50years are 54.5% and <50years are 45.5% with a mean hemodialysis of 306.4±167.1.

Table 1: Age distribution of the study participants

Age (years)	Frequency	Percentage (%)
<50years	20	45.5%
≥50years	24	54.5%
Total	**44**	**100**

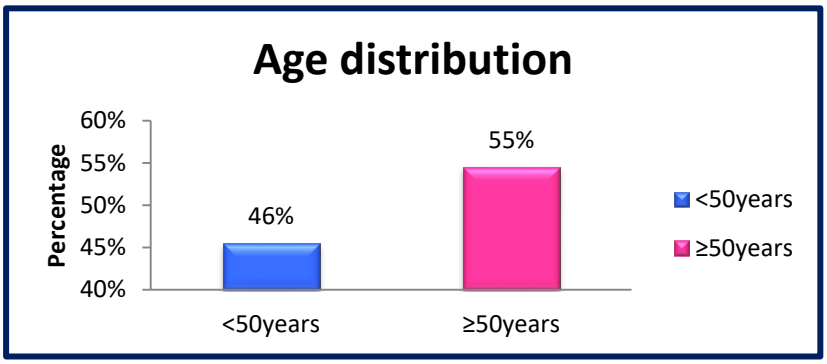

Fig 1: Age distribution of the study participants

Table 2: Distribution by SEX of the study participants

SEX	Frequency	Percentage (%)
Male	33	75.0%
Female	11	25.0%
Total	**44**	**100**

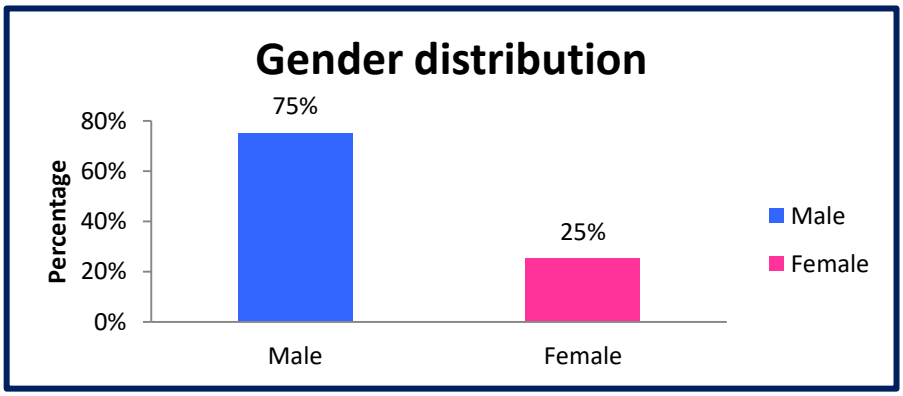

Fig 2: Distribution by SEX of the study participants

Table 3: Mean and SD of hemodialysis of the study participants

Variable	Mean	SD
Hemodialysis number	306.4	167.1

Table 4: Comparison of Pre and Post hemodialysis Mean and SD of Clinical variables in relation of study subjects

Variable	Pre-hemodialysis		Post-hemodialysis		'p'- value	Result
	Mean	SD	Mean	SD		
Systolic blood pressure(SBP)	165.9	20.8	146	15.2	<0.0001*	*Significant
Diastolic blood pressure (DBP)	90.2	13.5	84.7	6.6	0.0001*	*Significant
Weight	64.4	13.4	61.7	13.3	<0.0001*	*Significant
Sodium	135.8	14.9	138.7	9.2	0.2179	Not Significant
Potassium	4.9	0.9	3.7	0.5	<0.0001*	*Significant
Chloride	107.7	15.6	106.7	9.7	0.6798	Not Significant
Creatinine	8.5	3.1	3.7	1.4	<0.0001*	*Significant
Estimated glomerular filtration rate	7.6	4.5	19.1	8.1	<0.0001*	*Significant

***p<0.05 is statistically significant**

The table above compares the electrolyte, creatinine, eGFR, weight, systolic blood pressure (SBP), and diastolic blood pressure (DBP) readings before and after hemodialysis. Statistically significant values for potassium, creatinine, eGFR, weight, and SBP were found with a p- value of <0.0001. The DBP has a p-value of 0.0001 and is statistically significant.

Correlation of hyperkalemia with eGFR

e GFR (ml/min/1.73m^2)	S.K$^+$ (mEq/l)	No. of pt (n=21)	Percentage (%)	Mean	SD
≥90 (CKD S-I)	5.0-6.90 ≥7	0 0	0 0	-	-
60-89 (CKD S-II)	5.0-6.90 ≥7	0 0	0 0	-	-
30-59 (CKD-S-III)	5.0-6.90 ≥7	0 0	0 0	-	-
15-29 (CKD-S-IV)	5.0-6.90 ≥7	2 0	9.5 0	5.2	0.14
< 15 (CKD-S-V)	5.0-6.90 ≥7	18 1	85.7 4.8	5.65	0.75

p<0.05 is statistically significant

Discussion:

Multiple factors are responsible for determining serum Potassium concentrations in patients undergoing maintenance hemodialysis, including the individual patient's diet, the dialysis prescription, medications, and other conditions or comorbidities [14,15,16]. Most patients with ESRD choose for hemodialysis as their

first line of treatment, which can postpone kidney transplantation[17,18,19].

Each session of HD typically removes 70 to 100 mmol of potassium, so in patients on a 3-times-weekly schedule, the total weekly potassium removal is 210 to 300 mmol[18]. The extracellular fluid, which only contains 2% of the body's total potassium (the other 98% is intracellular), is depleted of potassium during HD. The serum-dialysate potassium gradient is the primary determinant of potassium removal, and diffusion accounts for 85% of potassium dialysis clearance; convection only accounts for 15% of dialysis clearance[13,19]. As a result, the rate of potassium removal is mostly determined by the potassium concentration in the dialysate solution. A rapid decrease in potassium (typically 1 mmol/l) occurs in the first hour of dialysis, when the difference between serum and dialysate potassium concentrations is the largest. This is followed by a gradual decrease of a further 1 mmol/l over the next 2 hours as this gradient is reduced. The final hour of dialysis results in stable serum potassium concentration, as an equilibrium is reached between the rate of potassium dialytic removal and the shift of potassium from the intracellular space [18]. This suggests that the dialysis session must be prolonged in order to be effective if the load of total body potassium is large and elimination is required. In present study after hemo dialysis the serum Potassium value significantly reduced from 4.9 ±0.9 mEq/L to 3.7 ± 0.5 mEq/L. The obtained result is consistent with the reported by Pun PH et al[18], Bansal et al [19] Sreenivasulu et al [20], Abdul Majeed H et al [21] , Seethalakshmi C et al [22] and Monisha. M et al [23].

Creatinine is a resultant of muscle metabolism and its level is a significant biomarker as it plays a vital role in diagnosis and monitor kidney disease. Prehemodialysis serum creatinine levels in ESRD patients were found to be high and to have a low GFR. Plasma levels of creatinine increases when the GFR decreases because of glomerular filtration and tubular secretion, which remove the creatinine. Hemodialysis has been proven to be a successful treatment for high levels of blood creatinine, which is decreased in post-hemodialytically, improving the eGFR. Our study showed that serum creatinine level reduced from 8.5 ±3.1 mg/dL to 3.7 ± 1.4 mg/dL and eGFR value improved from 7.6 ±4.5 mL/min/1.73m^2 to19.1 ± 8.1mL/min/1.73m^2 which is consistent with the reported by Nisha R et al[11], Monisha. M et al [23] and Meenakshi [24]. Chronic kidney disease is characterised by a progressive loss of nephrons, which results in an increase in extracellular volume and sodium retention. This leads to weight gain and dry weight is the post-dialysis weight in which the patient remains normotensive without taking antihypertensive medication until the next dialysis[13,25].More than 86% of MHD patients undergoing long-term hemodialysis have been shown to have hypertension, which may raise the morbidity of cardiovascular diseases (CVD)[13,26]. In comparasion to pre and post hemodialysis the Systolic blood pressure, Diastolic blood pressure and weight of study participants are statistically significant. In post dialysis Systolic blood pressure decreased from 165.9 ± 20.8 mm of Hg to 146 ±15.2 mm of Hg and Diastolic blood pressure 90.2 ±13.5 mm of Hg to 84.7± 6.6 mm of Hg. The weight of undergoing hemodialysis patients reduced from 64.4 ±13.4 kg to 61.7 ±13.3 kg. In our present study the analytical values of SBP, DBP and weight are corroborating with Aaron Stern et.al[13], Agarwal R et al[25] and Coomer RW et al[26]. Out of 44 MHD patients 21 patients in our study had hyperkalemia, or a serum potassium level greater than 5.0 mEq/l. Stage-V kidney disease affected 19 people, while Stage-IV affected two patients. Additionally, several studies revealed that patients with CKD had higher rates of hyperkalemia as their eGFR gradually declined. In this investigation, there were 21 hyperkalemic patients, 20 of them had mild to moderate hyperkalemia (serum potassium levels between 5.0 and 6.9 mEq/l); two had stage-IV chronic kidney disease, and the remaining 18 had stage-V CKD. Remaining one Stage-V CKD patient with severe hyperkalemia (serum potassium level > 7 mEq/l) was involved. The average K+ level increased along with renal function deterioration in the late stages of CKD (stage4: 5.2±0.14; stage 5: 6.5±0.75mEq/L, $p<0.05$) are corroborates with Tanzina Akhter et al[27], Einhorn LM et al[28] and Ahmed SS et al[29]. In patients with CKD, hyperkalemia increased along with the progression of the eGFR go down.

Conclusion:

Significant changes in serum potassium, serum creatinine, eGFR, weight, SBP, and DBP have been observed during

hemodialysis. Serum Sodium and Chloride does not have significant changes after hemodialysis. Hemodialysis is the ideal procedure for treating individuals with ESRD who have abnormal serum electrolytes and also an effective process for eliminating unwanted metabolites and increasing the life expectancy of MHD patients by keeping levels of substances like creatinine within a reasonable range.

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