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A Prospective Observational Study Among Patients on Long Term Hemodialysis for Changes in Serum Electrolytes with Varying Urine Outputs and Impact of Patient Counselling on their Quality of Life- A Pilot Study

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ABSTRACT

BACKGROUND

Chronic kidney disease (CKD) is defined as a progressive loss of function occurring over several months to years and is characterized by the gradual replacement of normal kidney architecture with parenchymal fibrosis. End stage renal disease (ESRD) is defined as irreversible decline in a person's own kidney function, which is severe enough to be fatal in the absence of dialysis or transplantation. Since hemodialytic patients with greater urine output have a greater ability to excrete electrolytes, acids, and fluid compared to patients low urine output, they are likely to have less body accumulation of these elements. Health-related quality of life (HRQOL) is a critically important outcome for patients with ESRD.

AIM

To study changes in serum electrolytes with varying amount of urine outputs in chronic hemodialysis patients and assessing the impact of patient counselling on their quality of life.

OBJECTIVES

- To evaluate the serum electrolyte level based on varying amount of urine outputs.
- To assess the impact of patient counselling on quality of life.

MATERIALS AND METHODS

A prospective observational study was carried out in 30 patients undergoing hemodialysis. The study was conducted by categorizing them into three groups based on urine output per day i.e. <200ml/day, 200-500ml/day and >500ml/day. Their electrolytes are analysed for variation according to varying amount of urine outputs. Quality of life in patients is assessed by using Kidney Disease Quality Of Life-36 Questionnaire Form (Validated) before and after the patient counselling.

RESULT

Patients with greater urine output per day (>500ml/day) have significantly lower serum sodium, potassium, phosphate, urea and creatinine. These patients also have higher serum calcium and bicarbonate levels in their body as compared to other groups with lower urine output per day. The overall quality of life in chronic hemodialysis patients after the patient counselling has been improved as the score has decreased to 37 ± 3.51 from 96.26 ± 8.94.

CONCLUSION

Urine output has significant role in maintenance of electrolytes level in our body since the patients having greater urine output have better control on serum electrolytes level. The quality of life in patients undergoing hemodialysis have been markedly improved after the patient counselling which is assessed by KDQOL-36 Questionnaire Form (Validated).

KEYWORDS

Hemodialysis, End stage renal disease, Urine Output, Electrolytes, Kidney Disease Quality of Life

INTRODUCTION

Chronic kidney disease (CKD), also called chronic renal insufficiency is defined as a progressive loss of function occurring over several months to years and is the gradual replacement of normal kidney structure with parenchymal fibrosis. According to kidney function, CKD is divided into stages 1 to 5, with each higher number signifying a more advanced stage of the condition[1].

- Stage 1: normal eGFR ≥ 90 mL/min per 1.73 m^2 and persistent albuminuria
- Stage 2: eGFR between 60 to 89 mL/min per 1.73 m^2
- Stage 3: eGFR between 30 to 59 mL/min per 1.73 m^2
- Stage 4: eGFR between 15 to 29 mL/min per 1.73 m^2
- Stage 5: eGFR of < 15 mL/min per 1.73 m^2 or end-stage renal disease

ESRD refers to individuals with an estimated glomerular filtration rate below 15 mL per minute per 1.73 m^2 body surface area, or those requiring dialysis irrespective of glomerular filtration rate. Reduction in or absence of kidney function leads to a host of maladaptive changes including fluid retention (extracellular volume overload), anaemia, disturbances of bone and mineral metabolism, dyslipidaemia, and protein energy malnutrition. This review deals with ESRD in adults only[2].

CLINICAL PRESENTATION OF ESRD

Symptoms

- Uremic symptoms (fatigue, weakness, shortness of breath, mental confusion, nausea and vomiting, bleeding, and loss of appetite), as well as itching, cold intolerance, weight gain, and peripheral neuropathies are common in patients with stage 5 disease[2].

Signs

Edema, changes in urine output, "foaming" of urine (indicative of proteinuria), and abdominal distension[2].

Laboratory Tests

- Decreased: creatinine clearance, bicarbonate, hemoglobin/hematocrit, iron stores, vitamin D levels, albumin, glucose, calcium, HDL.
- Increased: serum creatinine, blood urea nitrogen, potassium, phosphorus, PTH, blood pressure, glucose, low-density lipoprotein and triglycerides, calcium
- Other: May be hemoccult-positive if GI bleeding occurs secondary to uremia[2].

Other Supportive Investigations

- Left ventricular hypertrophy may be observed, as well as increased homocysteine levels and increased C-reactive protein.

COMPLICATIONS OF CKD

The most frequent complications of CKD include fluid and electrolyte abnormalities, anemia, CKD-related mineral and bone disorder (CKD-MBD) and renal osteodystrophy, hypertension, hyperlipidemia, and metabolic acidosis[2].

Fluid and Electrolyte Abnormalities

- Sodium and Water
  Significant sodium retention is more common when the GFR is less than 10 ml/min./1.73 m^2. Volume overload with pulmonary edema can result, but the most common manifestation of increased intravascular volume is hypertension, which may further contribute to progressive kidney damage[1].
- Potassium Homeostasis
  More significant and life-threatening elevations are likely to be observed in those with stage 4 and 5 CKD[1].
- Metabolic Acidosis
  In advanced CKD, all filtered bicarbonate is reclaimed. This decrease in urinary buffer results in decreased net acid excretion and consequently, metabolic acidosis develops[1].

Anemia

The primary cause of anemia in CKD patients is a decrease in production of erythropoietin by the proximal tubular cells of the kidney, where approximately 90% of production occurs. In contrast, there is no correlation between the degree of anemia and erythropoietin concentrations in anemic ESRD patients. The result is a normochromic, normocytic anemia[1].

Hypertension

The pathogenesis of hypertension in CKD is multifactorial, but for many, fluid retention is a major contributor. In addition to the other pathophysiologic mechanisms responsible for the development of hypertension, patients with ESRD may also have increased sympathetic activity, decreased activity of vasodilators such as nitric oxide, hyperparathyroidism, and structural changes in the arteries as contributing factors[1].

DIALYSIS

The main role of dialysis is the filtration of blood with the help of artificial equipment. Dialysis is the process where the waste products and excess fluid from the blood was removed when the kidney stop working. It involves the removal of solute across a semipermeable membrane down the concentration gradient by diffusive clearance and convective clearance mechanisms[2].

INDICATIONS of HD in CKD

- Uremic encephalopathy
- Uremic Pericarditis
- Hyperkalemia resistant to medical management
- Metabolic acidosis resistant to medical management
- Fluid overload resistant to medical management
- Oliguria not responding to medical management

CONTRAINDICATION

- Difficult vascular access
- Cardiac failure
- Coagulopathy

COMPLICATIONS

- Intradialytic hypotension
- Muscle cramps
- Dialyzer reactions
- Hemolysis

TYPES OF DIALYSIS

Mainly of two types:

1. Hemodialysis
2. Peritoneal dialysis

HEMODIALYSIS

Hemodialysis is achieved through vascular access, either via arteriovenous fistula, graft, or central venous catheter. Toxins and waste products are removed from the bloodstream by connecting the vascular access site to a machine, a dialyzer, which works as a pump that circulates and filters the blood and returns it back to the patient[4].

The most common side effect of hemodialysis is,

- Infection
- Hypotension
- Electrolyte imbalances
- Fluid overload

Advantages of hemodialysis

1. Higher solute clearance allows intermittent treatment.
2. Technique failure rate is low.
3. In-center hemodialysis enables closer monitoring of the patient.

Disadvantages of hemodialysis

1. Vascular access is frequently associated with infection and thrombosis.
2. Decline of residual renal function is more rapid compared with peritoneal dialysis.
3. Disequilibrium, dialysis-induced hypotension, and muscle cramps are common.

ELECTROLYTES AND FLUID STATUS IN HEMODIALYSIS PATIENTS

As hemodialysis (HD) is not actual kidneys, they do not possess the same physiologic regulation of both fluid and electrolytes. In renal failure, acute or chronic, patients who have a tendency to develop hypervolemia, hyperkalemia, hyperphosphatemia, hypocalcemia, and bicarbonate deficiency (metabolic acidosis). Sodium is generally retained but may appear normal, or hyponatremic, because of dilution from fluid retention[5].

CALCIUM: The majority of calcium resides extracellularly, and it is crucial for the function of neurons, muscle cells, function of enzymes, and coagulation.

CHLORIDE: Chloride is part of gastric acid which plays a role in absorption of electrolytes, activating enzymes, and killing bacteria.

MAGNESIUM: Magnesium is important in control of metabolism and is involved in numerous enzyme reactions.

POTASSIUM: Potassium is mainly inside the cells of the body, so its concentration in the blood can range anywhere from 3.5 mEq/L to 5 mEq/L.

SODIUM: Sodium is the most abundant electrolyte in the blood. Sodium and its homeostasis in the human body is highly dependent on fluids.

QUALITY OF LIFE IN HEMODIALYSIS PATIENTS

Quality of life is an increasingly important factor in the assessment of the management of chronic kidney disease patients undergoing hemodialysis. Several studies have shown a decreased quality of life and increased depression in the hemodialysis patient population[13]. Poor quality of life itself is also reported to increase complications such as depression and malnutrition and even increase mortality. For checking the quality of life Kidney Disease Quality of Life questionnaire form is used it includes 13 questions and the patients who score more shows a better quality of life and patients who score low score show a poor quality of life. Quality of life is assessed before and after patient counselling. The 13 questions include the; Patient's health-related questions, limitations in daily activities, emotional status, pain during the therapy, effect of kidney disease in day-to-day life, sleep patterns, diet restrictions and educaton[12].

DIET AND DIALYSIS

Calorie intake: Amounts of fat and carbohydrate can be adjusted so the diet provides enough calories and still follows dietary guidelines for people with diabetes.

Protein intake: Before dialysis a low-protein diet is required followed by high protein diet after dialysis.

Potassium intake: Potassium is very important because it affects the ability of muscles to contract. Too much or too little potassium can harm the heart by disturbing the heart rhythm.

Sodium intake: Too much sodium increases thirst, but drinking too many liquids can cause swelling and increase blood pressure. High blood pressure can harm the heart or even cause a stroke.
Phosphorus intake: In kidney disease, the body can't keep a balance between calcium and phosphorus.
Calcium intake: Need to be sure that getting enough calcium to prevent bone disease, without drinking too much milk or eating too many dairy products[9].

MATERIALS AND METHODS

Data source: All the relevant information regarding the study was collected from case records and direct interview with patients and care givers. Data from case records and care givers was collected by using suitably designed proforma. The study was approved by Research and Ethical Committee of Cosmopolitan hospital, Thiruvananthapuram.

Study population: Patients were taken from Nephrology Department of Cosmopolitan Hospital. Informed consent was obtained. The study was conducted for the period of 1 month.

Assessment of Electrolytes: Details were collected from case records of the hemodialysis patients.

Assessment of QOL: Details were collected from case records of the hemodialysis patients and direct interview with the patients and caregivers which is been recorded in Kidney Disease Quality of Life- 36 questionnaire Form (Validated).

Statistical Analysis: Comparison of quantitative variables between three groups were analysed by ANOVA according to the nature of the data.

OBSERVATION AND RESULTS

The proposed study entitled, "Evaluating Changes in Serum Elecrolytes among Patients on long term Hemodialyisis and Impact of Patient Counselling on their Quality of Life " was a prospective observational study carried out in a multispeciality tertiary care hospital. In this study, the data was collected from 30 patients undergoing hemodialysis and were analysed. These 30 patients are classified into 3 groups based on varying amount of urine output per day, 10 patients in each group (Group1: <200ml/day; Group2: 200-500ml/day and Group3: >500ml/day).The study aimed to evaluate changes in serum electrolytes with varying urine outputs in chronic hemodialysis patients and assessing the impact of patient counselling on their quality of life.

AGE WISE DISTRIBUTION

The percentage distribution of patients based on age is shown in the following table

Table no1: Percentage of patients based on age

AGE CATEGORY	NUMBER OF PATIENT (n=30)	PERCENTAGE (%)
20-40	3	10%
41-60	9	30%
ABOVE 60	18	60%

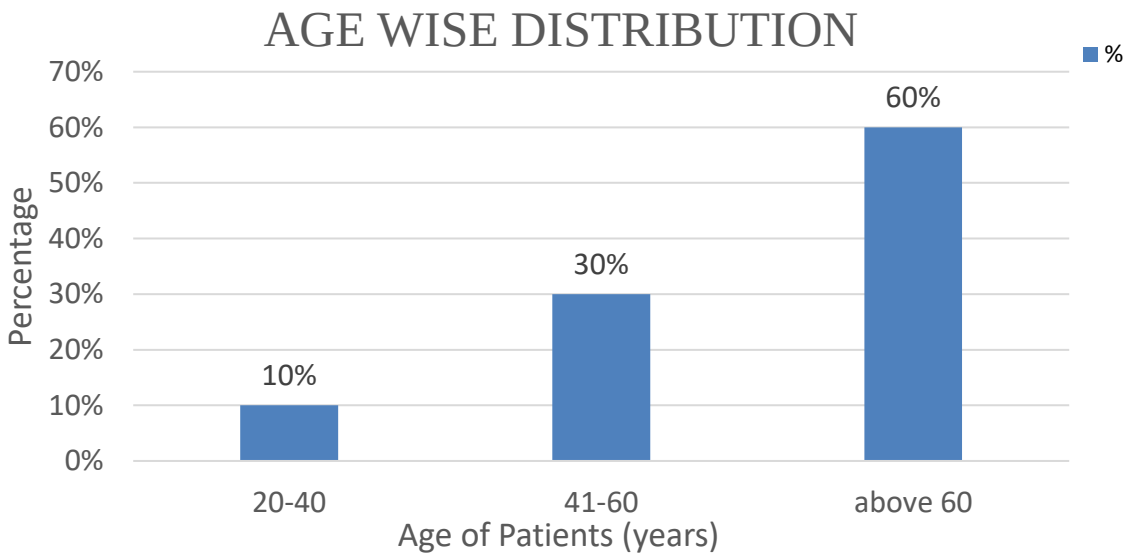


Figure 1: Diagrammatic representation of patients based on age.

From the table 1, it was observed that out of the total patients undergoing hemodialysis, there are only 10% of patients between age 20-40 years, 30% of patients are of age between 41-60 years and the 60% of patients on hemodialysis are of age above 60 years.

GENDER WISE DISTRIBUTION

The percentage distribution of patients based on gender is shown in the following table

Table no.2: Percentage distribution of patients based on gender

GENDER	NUMBER OF PATIENTS (n=30)	PERCENTAGE (%)
MALE	26	86.6%
FEMALE	4	13.3%

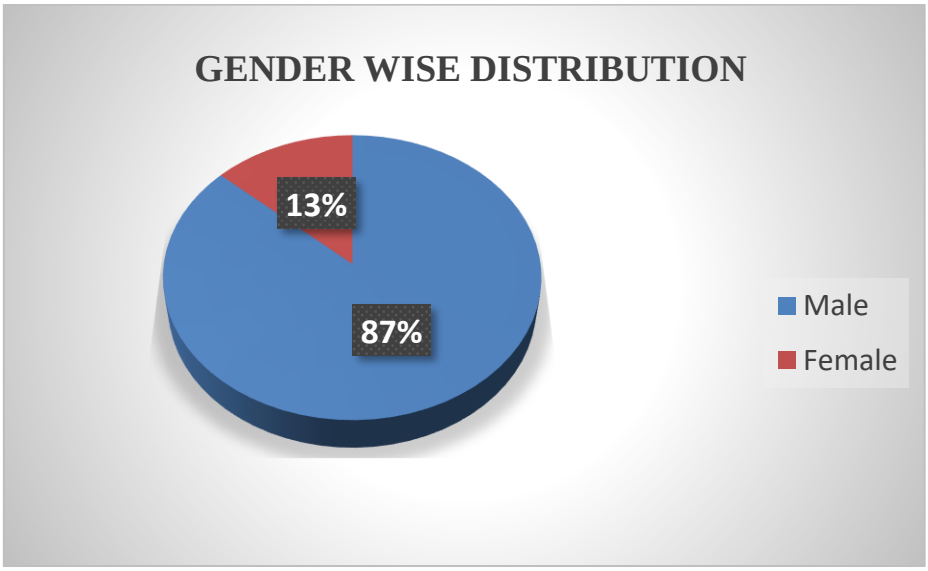


Figure 2:-Diagrammatic representation of patients based on gender.

From the Table 2, it was observed that out of the total patients undergoing hemodialysis, 87% were male and only 13% were female. Thus, from the above table we concluded that there is a higher incidence of males on hemodialysis as compared to that of females.

EVALUATION OF THE SERUM ELECTROLYTE LEVEL IN PATIENTS WITH VARYING URINE OUTPUTS

SODIUM LEVEL BASED ON URINE OUTPUT

Table No.3: Serum Sodium level according to urine output

URINE OUTPUT	NO. OF PATIENTS	MEAN ± SD	p value
Group1 (<200ml/day)	10	147.5 ± 0.8	<0.01
Group2 (200-500ml/day)	10	141.15 ± 1.4	
Group3 (>500ml/day)	10	137.2 ± 1.2	

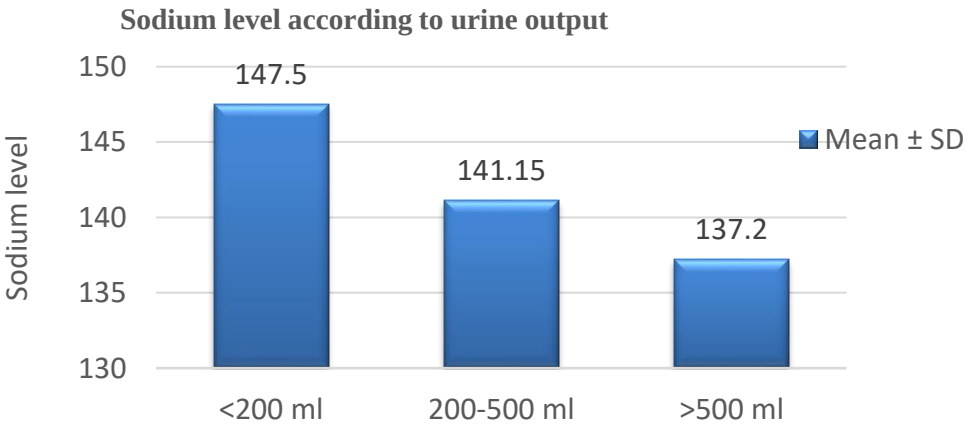


Figure 4: Diagrammatic representation of Serum Sodium based on Urine Output

From table no.4, it was observed that patients with urine output greater than 500ml/day have mean serum sodium level 137.2mEq/l, patients with urine output between 200-500ml have 141.15mEq/l while patients with urine output less than 200ml/day have 147.5mEq/l. Thus from above table, it can be concluded that patient with greater urine output/day have serum sodium levels within normal range.

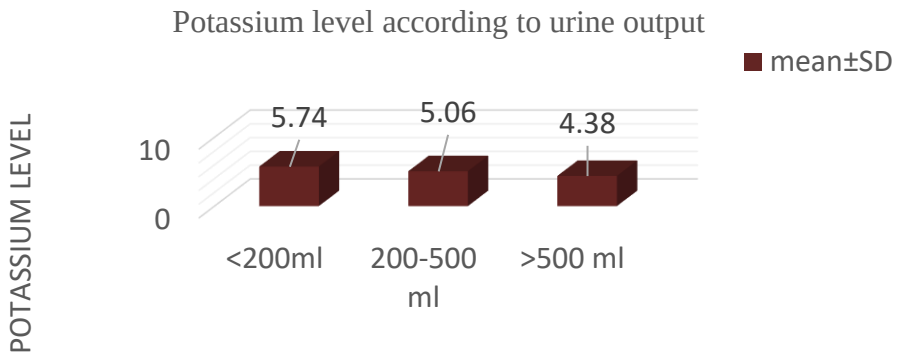
POTASSIUM LEVEL BASED IN URINE OUTPUT

Table no.5: Serum potassium level according to urine output

URINE OUTPUT	NO. OF PATIENTS	MEAN ± SD	p value
Group1 (<200ml/day)	10	5.74±0.12	<0.01
Group2 (200-500ml/day)	10	5.06±0.24	

Group3 (>500ml/day)	10	4.38±0.35	

Figure5:Diagrammatic representation of Serum Potassium based on Urine Output



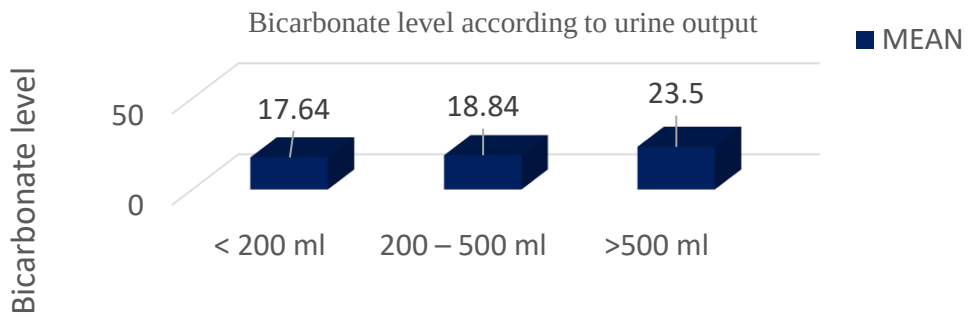
From the table no.5, it is observed that the mean serum potassium of patients with urine output >500ml/day have 4.38 mEq/l, patients with urine output between 200-500ml have 5.06mEq/l while patients with urine output < 200ml/day have 5.74mEq/l. Thus from above table, it can be concluded that patient with greater urine output/day have serum potassium levels within normal range.

SERUM BICARBONATE BASED ON URINE OUTPUT

Table no.6: Serum bicarbonate level according to urine output

URINE OUTPUT	NO. OF PATIENTS	MEAN ± SD	p value
Group1 (<200ml/day)	10	17.64± 0.3	<0.01
Group2 (200-500ml/day)	10	18.84± 0.63	
Group3 (>500ml/day)	10	23.5± 1.26	

Figure 6: Diagrammatic representation of Serum Bicarbonate based on Urine Output



From the table no.6, it is observed that the mean serum bicarbonate of patients with urine output >500ml/day have 23.5mg/dl, patients with urine output between 200-500ml have 18.84mg/dl while

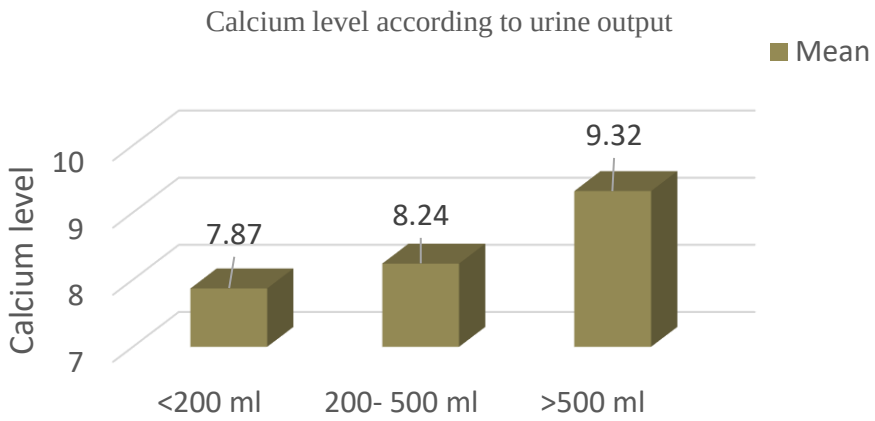
patients with urine output < 200ml/day have 17.64mg/dl. Thus from above table, it can be concluded that patient with greater urine output/day have serum bicarbonate levels within normal range.

SERUM CALCIUM BASED ON URINE OUTPUT

Table no.7: Serum Calcium level according to urine output

URINE OUTPUT	NO. OF PATIENTS	MEAN ± SD	p value
Group1 (<200ml/day)	10	7.87± 0.2	<0.01
Group2 (200-500ml/day)	10	8.24± 0.36	
Group3 (>500ml/day)	10	9.32± 1.8	

Figure 7: Diagrammatic representation of Serum Bicarbonate based on Urine Output



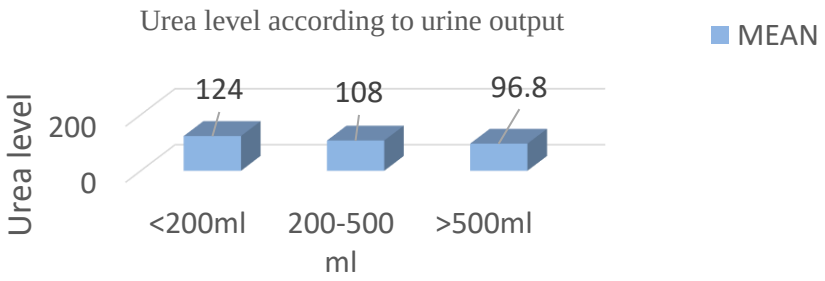
From the table no.7, it is observed that the mean serum calcium of patients with urine output >500ml/day have 9.32mg/dl, patients with urine output between 200-500ml have 8.24mg/dl while patients with urine output < 200ml/day have 7.87mg/dl. Thus from above table, it can be concluded that patient with greater urine output/day have serum calcium levels within normal range.

SERUM UREA BASED ON URINE OUTPUT

Table no.8: Serum Urea level according to urine output

URINE OUTPUT	NO. OF PATIENTS	MEAN ± SD	p value
Group1 (<200ml/day)	10	124± 3.36	<0.01
Group2 (200-500ml/day)	10	108.0± 0.5	
Group3 (>500ml/day)	10	96.8± 0.78	

Figure 8: Diagrammatic representation of Serum Urea based on Urine Output



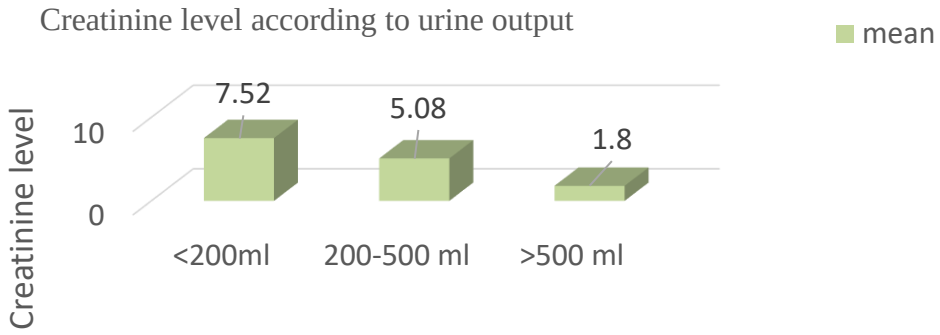
From the table no.8, it is observed that the mean serum urea of patients with urine output >500ml/day have 96.8mg/dl, patients with urine output between 200-500ml have 108mg/dl while patients with urine output <200ml/day have 124mg/dl. Thus from above table, it can be concluded that patient with greater urine output/day have better control on serum urea levels.

SERUM CREATININE BASED ON URINE OUTPUT

Table no.9: Serum Creatinine level according to urine output

URINE OUTPUT	NO. OF PATIENTS	MEAN ± SD	p value
Group1 (<200ml/day)	10	10.72± 0.1	<0.01
Group2 (200-500ml/day)	10	7.52± 0.6	
Group3 (>500ml/day)	10	5.08± 0.2	

Figure 9: Diagrammatic representation of Serum Creatinine based on Urine Output



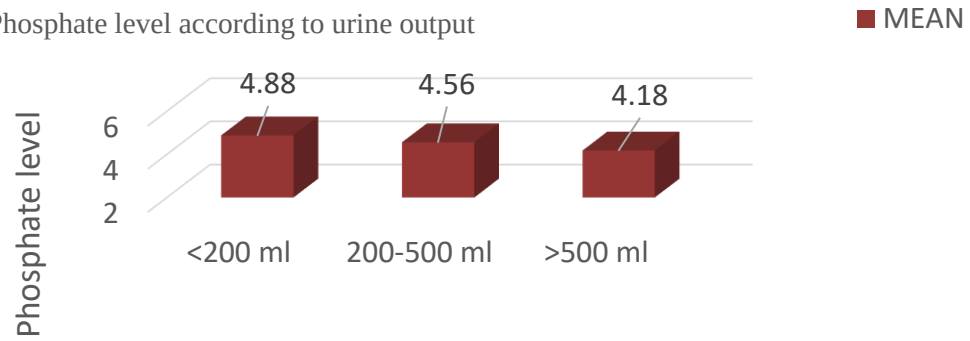
From the table no.9, it is observed that the mean serum creatinine of patients with urine output >500ml/day have 1.8mg/dl, patients with urine output between 200-500ml have 5.08mg/dl while patients with urine output <200ml/day have 7.52mg/dl. Thus from above table, it can be concluded that patient with greater urine output/day have better control on serum creatinine levels.

SERUM PHOSPHATE BASED ON URINE OUTPUT

Table no.10: Serum Phosphate level according to urine output

URINE OUTPUT	NO. OF PATIENTS	MEAN ± SD	p value
Group1 (<200ml/day)	10	4.88 ± 0.13	<0.01
Group2 (200-500ml/day)	10	4.56 ± 0.10	
Group3 (>500ml/day)	10	4.18 ± 0.20	

Figure 10: Diagrammatic representation of Serum Phosphate based on Urine Output



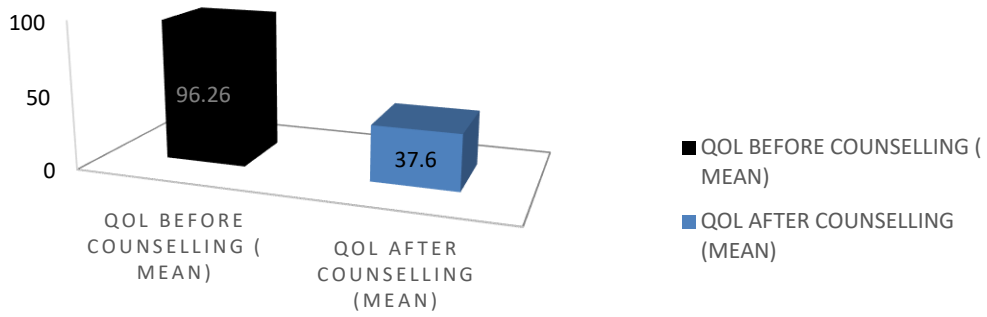
From the table no.10, it is observed that the mean serum phosphate of patients with urine output >500ml/day have 4.18mg/dl, patients with urine output between 200-500ml have 4.56mg/dl while patients with urine output < 200ml/day have 4.88mg/dl. Thus from above table, it can be concluded that patient with greater urine output/day have better control on serum phosphate levels.

IMPACT OF PATIENT COUNSELLING ON QUALITY OF LIFE IN HEMODIALYSIS PATIENTS USING KIDNEY DISEASE QUALITY OF LIFE 36 QUESTIONNAIRE FORM (VALIDATED)

Table no.11: Distribution based on QOL before and after patient counselling

NO. OF PATIENTS	QOL BEFORE COUNSELLING (MEAN ± SD)	QOL AFTER COUNSELLING (MEAN ± SD)	p value
30	96.26 ± 8.94	37.6 ± 3.51	<0.01

Figure 11: Diagrammatic Representation of QOL before and after counselling



From the table no.11, it was observed that the mean score of quality of life in hemodialysis patients before counselling is 96.26 ± 8.94 while the mean score after patient counselling is 37.6 ± 3.51. Thus, from above table it can be concluded that the quality of life of patients have been improved after the patient counselling as the mean score decreases after the counselling.

DISCUSSION

In chronic kidney disease and end stage renal failure condition, the kidneys get damaged and thereby accumulation of nitrogenous waste products and fluid occurs. Hemodialyis is one of the treatment option for chronic kidney disease and end stage renal failure, which helps to remove the fluid and waste products from the body. Kidney disease quality of life 36 questionnaire form (KDQOL-36) is designed to measure the impact on overall health dialysis patients[12].

This study aims to evaluate changes in serum electrolytes with varying urine outputs in chronic hemodialysis patients and assessing the impact of patient counselling on their quality of life. The 3 groups considered in this study was Group 1: urine output <200 ml/day, Group 2: urine output 200-500 ml/day, Group 3: urine output >500 ml/day. The electrolytes checked in the study were Sodium, Potassium, Bicarbonate, Calcium, Urea, Creatinine, and Phosphate. Kidney disease quality of life 36 questionnaire form were used to check the impact of patient counselling on hemodialysis patients.

In this study, the demographic data concludes that 49 male (81.6%) patients and 11 female (18.3%) total 60 patients were selected and dived equally into 3 groups according to urine output. Statistical analysis was performed using ANOVA test and a detailed analysis was performed.

Thus study demonstrate that there is increase in sodium, potassium, urea, creatinine, and phosphate in group 1as compared to group2 and group 3, And reduced value in bicarbonate and calcium in group 1 as compared to group 2 and group 3. The observation of our study was similar to the study conducted by ***Fernando Luiz et al***. In their study **'*Metabolic and Volume Status Evaluation If Hemodialysis Patients with or without Residual Renal Function in Long Interdialytic Interval'***. This cross sectional study describes patient without RRF had a higher increase in serum potassium, sodium, and phosphate and decreased calcium and bicarbonate level[6].

The study demonstrates that most of the patients undergoing hemodialysis are from elderly group and the mean age of the study population is found to be 59.4 ± 12.9. The result was similar to the study conducted by **Harin Rhee et al** on '***Significance of Residual Renal Function for Phosphate Control***

in Chronic Hemodialysis Patients'. This cross sectional study suggests that the mean patient age was 59.27±13.95 which shows most of the hemodialysis patients are from elderly group[7].

The study demonstrates that overall study population indicates male population over-rides female population with 81.6% dominance over 18.3%.The result was similar to the study conducted by **Ernest Kiswaya et al** on '***Factors Associated with Residual Urine Volume Preservation in Patients Undergoing Hemodialysis for End Stage Kidney Disease***'. The cohort study suggests that majority of the patients were male[5].

The observation was similar to the study conducted by '**Takeshi Suda et al** on '***The Contribution of Residual Renal Function to Overall Nutritional Status in Chronic Hemodialysis Patients'***. Comparative study concluded that, in patients without RRF there is greater rise in inorganic phosphate and potassium while there is decrease in level of bicarbonate[17].

The result concluded in this study is similar to the study done by **J.Winkler et al** on ***'Effect of Residual Renal Function in Hemodialysis Patients'***. A comparative study concluded that, serum potassium and phosphate are significantly lower in patients with RRF[5].

A study conducted by **Dena E. Cohen et al** on '***Use Of The KDQOL 36 For Assessment Of Health-Related Quality Of Life Among Dialysis Patients In The United States'*** showed similar improvement in the QOL of patients undergoing hemodialysis[4].

The 13 questions include the; Patient's health-related questions, limitations in daily activities, emotional status, pain during the therapy, effect of kidney disease in day-to-day life, sleep patterns, and education. For the better outcome of the result the intake of fluids and certain foods must be limited. The QOL of hemodialysis patients was first noticed at the time of admission and after patient counselling the second follow up was taken at the 1st month[12].

These outcomes were observed in a treatment duration of 6 months, through adequate follow-ups, Hence in our study we found the patients with greater urine output have better control on the serum electrolytes, and the patient counselling had greater impact on the patient QOL.

CONCLUSION

The present study demonstrates the variation in serum electrolytes according to varying urine output and the quality of life in hemodialysis patients. The primary objective of the study was to determine the changes in serum electrolytes on the basis of urine output per day. The study also involves the evaluation of quality of life of these patients before and after the patient counselling. The Kidney Disease Quality of Life-36 Questionnaire Form (Validated) was used to assess the quality of life.

In our study, demographic and socioeconomic data conclude that more males are undergoing hemodialysis as compared to female. According to age wise distribution obtained for our study, shows that age group above 60 accounts for a greater number of patients.

Significant variations are observed in serum electrolytes according to daily urine output of hemodialysis patients as the serum sodium, potassium, bicarbonate, calcium and phosphate are within the normal range in patients with greater urine output i.e. in group 2 and group 3. While the group 1 patients show highly imbalanced levels of these electrolytes. Comparing the serum creatinine and urea in different groups shows that the group 3 patients show better control on these parameters.

The quality of life of the patient assessed by the Kidney Disease Quality of Life-36 Questionnaire Form (Validated) showed steep improvement in the quality of life, which was assessed before and after the patient counselling.

The results assessed from the study clearly indicates that the patient undergoing long term hemodialysis with greater urine output (>500ml/day) have better control on serum electrolytes. The quality of life of these patients were also improved after the patient counselling.

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