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Original Article

Characteristics of Electrolyte Imbalance in Patients with Chronic Kidney Disease Stage 4-5

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Abstract

Background: *Chronic Kidney Disease (CKD) is characterized by the presence of kidney damage or an estimated glomerular filtration rate (eGFR) of less than 60 mL/min/1.73 m² and persisting these conditions for 3 months or more. In case of CKD progressive loss of kidney function occurs. The kidneys play a vital role in the regulation of electrolyte and acid-base balance. With progressive loss of kidney function, derangements in electrolytes and acid-base occur which contribute to poor patient outcomes. The objective of this study was exploring the characteristics of electrolyte imbalance in patients with chronic kidney disease stage 4-5.*

Materials and methods: *A cross-sectional study was conducted at East West Medical College, from July to December 2023. A total of 100 respondents were included in this study where data were collected through structured interviews and medical record reviews.*

Results: *The prevalence of CKD by the gender group where 46% were male and 54% were female. According to aged group 42% were from 51-60 years of age and 23%, 14% and 10%, 11% were from 41-50 years, 31-40 years, 21-30 years and >60 years accordingly. At the level of educational status 33% completed secondary level, 21% completed primary, 20% completed higher secondary level and 15%, 12%, and 4% completed Graduation, able to read and write and illiterate accordingly. Among all respondents 52% were employed and 48% were unemployed. According to economic status 44% belongs to low economic status, 40% from middle income and 16% from high income status. Majority 63% were overweight, 26% and 11% were from Normal weight and underweight accordingly. Family history of CKD 62% had positive family history and 38% had negative history. According to personal habit of excess salt intake 65% had this habit and 35% did not take excess salt. Among all respondents most of the patients had DM which was 51%, HTN were 42%, hypothyroidism and hyperthyroidism were 24% and 06% accordingly. The prevalence of electrolyte imbalance in patients with CKD where mild hyponatraemia were 32%, moderate and severe hyponatraemmia were 16% and 4% were accordingly. Hypernatraemia and hypokalaemia were 18% and 21%. The stages of hyperkalaemia were mild, moderate and severe and prevalence were 19%, 09% and 3% accordingly. Majority 65% were metabolic acidosis and 11% were metabolic alkalosis. Among all respondent's hyperphosphatemia, hyperparathyroidism, hypoparathyroidism, hypocalcemia, hypercalcaemia, hypomagnesemia and hypermagnesemia deficiency were 71%, 79%, 21% 61%, 17%, 21% and 8% accordingly.*

Conclusion: *If we maintain the screening process at early of life for case detection of CKD and established early treatment of all cases, electrolytes related complication can reduce which improve health outcome of these patients.*

Key words: Anemia; CKD; Electrolyte imbalance; GFR; Metabolic alkalosis; Metabolic acidosis.

INTRODUCTION

Chronic Kidney Disease (CKD) is a condition that is advancing across the globe. In this condition, the kidneys do not function properly and steadily lose their ability to filter waste products and the body's fluids. Therefore, it leads to the build-up of fluids and waste products in the body which induce various health issues. It is characterized as a slow and permanent decrease in kidney function, typically occurring over several months.[1] As kidney disease advances, it can ultimately lead to kidney failure, which either requires dialysis or a kidney graft to sustain life. The KDIGO work group characterizes CKD as the existence of a significant indicator of kidney damage, such as albuminuria or a Glomerular Filtration Rate (GFR) below sixty millilitres/min/1.73 m² persisting for at least three months.[2] The estimated occurrence of CKD worldwide ranges from eight percent to sixteen percent. Globally, the estimated occurrence of CKD is 13.4%, with approximately 4.902M to 7.083M individuals requiring kidney replacement therapy for end-stage renal disease.[3]

Sleep disorders are a group of conditions that disturb or mediate with a person's normal sleep patterns.[4] These disorders can affect the attribute, period and timing of sleep, leading to difficulties in dropping asleep, residing asleep, or experiencing compensatory sleep. Sleep apnea, insomnia, restless leg syndrome, excessive daytime somnolence, and parasomnia are common sleep disorders in CKD.[5] Even though it is commonly accredited that patients with CKD encounter poor sleep quality, not much is known about the physiological mechanisms underlying this prodigy. According to Hildreth, the patients with CKD, experience poor sleep quality which is related with sympathovagal imbalance, disturbed blood pressure control and modifications in the renin-angiotensin -aldosterone system during sleep. This imbalance leads to increased sympathetic nervous system activity, decreased parasympathetic activity and a lack of normal nocturnal blood pressure dipping. These factors lead to sleep disturbances and may impact kidney function. Interpreting such processes can assist develop targeted measures to improve sleep quality in addition to blood pressure control, perhaps slowing CKD advancement and developing overall kidney health. Moreover, study is needed to research these mechanisms and amplify adequate therapeutic policies for managing sleep disorders in CKD patients.[6]

Although it is commonly accepted that patients with CKD experience poor sleep quality, not much is known about the physiological mechanisms underlying this phenomenon. According to Hildreth, in the patients with CKD, poor sleep quality is associated with sympatho-vagal imbalance, disrupted blood pressure regulation and alterations in the renin-angiotensin-aldosterone system during sleep. This imbalance leads to increased sympathetic nervous system activity, reduced parasympathetic activity and a lack of normal nocturnal blood pressure dipping. These factors contribute to sleep disturbances and may impact kidney function. Understanding these mechanisms can help develop targeted interventions to improve sleep quality and blood pressure control, potentially slowing CKD progression and enhancing overall kidney health. Further research is needed to explore these mechanisms and develop effective therapeutic strategies for managing sleep disturbances in CKD patients.[6]

Pittsburgh Sleep Quality Index (PSQI) is a broadly used and verified questionnaire to evaluate sleep quality in citizens. The survey using PSQI contains a stream of questions contrived to assess different features of sleep, involving sleep period, sleep disturbances, sleep latency (Time taken to fall asleep) daytime dysfunction, sleep efficiency and overall sleep quality.[7]

Homeostasis of electrolytes is important for the proper functioning of numerous metabolic activities and various organ functions in the human body. Kidneys play an analytical role in the maintenance and regulation of this homeostasis. Kidney diseases and dysfunction may disrupt the regulatory functions, resulting in electrolyte alterations which can lead to potentially fatal.

This study aims was to explore the characteristics of electrolyte imbalance in patients with chronic kidney disease stage 4-5.

MATERIALS AND METHODS

A cross-sectional study was conducted at East West Medical College Dhaka from July to December 2023. A total of 100 respondents were included in this study where data were collected through structured interviews and medical record reviews. As 100 patients were suffering from CKD the objective of this study was assessment of electrolyte imbalance in these patients in a tertiary care hospital. Data were collected for socio-demographic, socio-economic purposes, family history, personal habits and from medical reviews. After data collection SPSS 24 version was used for data analysis.

RESULTS

Table 1 Sociodemographic Characteristics

Variable	Frequency (n)	Percentage (%)
Total respondent	**100**	
Gender		
Male	46	46%
Female	54	54%
Age Group		
21-30 years	10	10%
31- 40 years	14	14%
41-50 years	23	23%
51 – 60 years	42	42%
>60 years	11	11%
Education		
Illiterate	4	4%
Able to read and write	12	12%
Primary	21	21%
Secondary	33	33%
Higher Secondary	20	20%

Variable	Frequency (n)	Percentage (%)
Graduate	15	15%
Occupation		
Employed	52	52%
Unemployed	48	48%
Socio-Economic Status		
Low	44	44%
Middle	40	40%
High	16	16%
Nutritional Status (BMI)		
Underweight (BMI < 18.5)	11	11%
Normal weight (BMI 18.5-24.9)	26	26%
Overweight/Obese (BMI ≥ 25)	63	63%
Family History		
Present	62	62%
Absent	38	38%
Excess salt intake history		
Yes	65	65%
No	35	35%

Table I describes the prevalence of CKD by the gender group where 46% were male and 54% were female. According to aged group 42% were from 51-60 years of age and 23%, 14% and 10%, 11% were from 41-50 years, 31-40 years, 21-30 years and >60 years accordingly. At the level of educational status 33% completed secondary level, 21% completed primary, 20% completed higher secondary level and 15%, 12% and 4% completed Graduation, able to read and write and illiterate accordingly. Among all respondents 52% were employed and 48% were unemployed. According to economic status 44% belongs to low economic status, 40% from middle income and 16% from high income status. Majority 63% were overweight, 26% and 11% were from Normal weight and underweight accordingly. Family history of CKD 62% had positive family history and 38% had negative history. According to personal habit of excess salt intake 65% had this habit and 35% did not take excess salt.

Table II Presence of Comorbidities

Comorbidities	Present (n)	Percentage (%)
DM	51	51%
HTN	42	42%
Hypothyroidism	24	24%
Hyperthyroidism	6	6%

Table II represent that among all respondents most of the patients had DM which was 51%, HTN were 42%, hypothyroidism and hyperthyroidism were 24% and 06% accordingly.

Table III Laboratory findings of electrolyte imbalance

Electrolyte	Ref. Value	Present Frequency	Percentage %
Mild hyponatraemia	<130-135mmol/L	32	32%
Moderate	<125-130 mmol/L	16	16%
Severe	<125 mmol/L	4	4%
Hypernatraemia	>145mmol/L	18	18%
Normal	130- 145mmol/L	30	30%
Hypokalaemia	<5.6mmol/L	21	21%
Mild hyperkalaemia	5.6 - < 6mmol/L	19	19%
Moderate	6 - < 7mmol/L	9	9%
Severe	>7mmol/L	3	3%
Normal	3.7-5.2mmol/l	48	48%
Metabolic Acidosis	Serum Bicarbonate < 22meq/l	65	65%
Metabolic Alkalosis	>35meq/l	11	11%
Normal	22-29 meq/l	24	24%
Hyperphosphatemia	>1.45 mmol/L	71	71%
Normal	0.81- 1.45 mmol/L	29	29%
Hyperparathyroidism	>65 pg/ml	79	79%
Hypoparathyroidism	<10 pg/ml	21	21%
Hypocalcaemia	<8.5mg/dl	61	61%
Hypercalcaemia	>10 mg/dl	17	17%
Normal	8.5-10.2 mg/dl	22	22%
Hypomagnesemia	<1.46 mg/dl	21	21%
Hypermagnesemia	>2.6mg/dl	8	8%
Normal	1.7- 2.2mg/dl	71	71%

Table III describe the prevalence ofelectrolyte imbalance in patients with CKD where mild hyponatraemia were 32%, moderate and severe hyponatraemmia were 16% and 4% were accordingly. Hypernatraemia and hypokalaemia were 18% and 21%. The stagesof hyperkalaemia were mild, moderate and severe and prevalence were 19%, 09% and 3% accordingly. Majority 65% were metabolic acidosis and 11% were metabolic alkalosis. Among allrespondent's hyperphosphatemia, hyperparathyroidism, hypoparathyroidism, hypocalcemia, hypercalcaemia, hypomagnesemiaand hypermagnesemia deficiency were 71%, 79%, 21% 61%, 17%, 21% and 8% accordingly.

DISCUSSION

The prevalence of CKD by the gender group where 46% were male and 54% were female. Using the 2021 CKD-EPI formula, the respective CKD prevalence was 12.3% among women and 6.1% among men. In 2019, 45% of all outpatients at 6 participating nephrology departments were women.[8] According to aged group 53% were from 51-60 years of age and 23%, 14% and 10%, 11% were from 41-50 years, 31-40 years, 21-30 years and >60 years accordingly. About 1 in 10 people have some degree of CKD. It can develop at any age and various conditions can lead to CKD. However, CKD becomes more common with increasing age. After the age of 40, kidney filtration begins to fall by approximately 1% per year.[9] At the level of educational status 33% completed secondary level,

21% completed primary, 20% completed higher secondary level and 15%, 12% and 4% completed Graduation, able to read and write and illiterate accordingly. Among all respondents 52% were employed and 48% were unemployed. According to economic status 44% belongs to low economic status, 40% from middle income and 16% from high income status. CKD prevalence was associated with several indicators of SES, particularly lower income (OR 1.34, 95% CI (1.18 to 1.53), p<0.001, I^2=73.0%, p=0.05), lower education (OR 1.21, 95% CI (1.11 to 1.32), p<0.001, I^2=45.20%, p=0.034) and lower combined SES (OR 2.18, 95% CI (1.64 to 2.89) p<0.001, I^2=0.0%, p=0.326). Lower levels of income, occupation and combined SES were also significantly associated with progression to end-stage renal disease (Risk Ratio (RR) 1.24, 95% CI (1.12 to 1.37), p<0.001, I^2=66.6%, p=0.006, RR 1.05, 95% CI (1.01 to 1.09), p=0.012, I^2=0.0%, p=0.796 and RR 1.39, 95% CI (1.09 to 1.79), p=0.009, I^2=74.2%, p=0.009).[10] Majority 63% were overweight, 26% and 11% were from Normal weight and underweight accordingly. Many studies have demonstrated that obesity is an important risk factor for incident CKD.[11-15] and increased risk of ESRD.[16-20] Paradoxically, obesity itself in CKD and ESRD has been found to be associated with more favorable outcomes.[21-22] A reverse obesity–mortality association has been consistently observed in patients with ESRD.[23-25] Family history of CKD 62% had positive family history and 38% had negative history. Another study represents that the presence of any affected family member with CKD was associated with a significantly higher risk of CKD with adjusted ORs (95% CI) of 1.42 (1.38–1.45) 1.50 (1.46–1.55) 1.70 (1.64–1.77) and 1.30 (1.27–1.33) for individuals with affected parents, offspring, siblings and spouses, respectively.[26] According to personal habit of excess salt intake 65% had this habit and 35% did not take excess salt. Among all respondents according to presence of comorbidities most of the patients had DM which was 51%, HTN were 42%, hypothyroidism and hyperthyroidism were 24% and 06% accordingly. The prevalence of electrolyte imbalance in patients with CKD where mild hyponatraemia were 32%, moderate and severe hyponatraemmia were 16% and 4% were accordingly. Hypernatraemia and hypokalaemia were 18% and 21%. In a large cohort of 655,000 veterans with a mean eGFR of 50 ml/min/1.73 m^2, hyponatremia was seen in 13.5% and hypernatremia in 2%.[26] The stages of hyperkalaemia were mild, moderate and severe and prevalence were 19%, 09% and 3% accordingly. Hyperkalemia is one of the most common and life-threatening electrolyte disorders in CKD and ESRD.[27] It becomes increasingly prevalent as CKD advances. Hyperkalemia has been classified somewhat arbitrarily into mild (5.1-<6 mmol/l), moderate (6-<7 mmol/l) and severe (≥7 mmol/l).[27] Majority 65% were metabolic acidosis and 11% were metabolic alkalosis. Clinically, metabolic acidosis is considered to be present when serum bicarbonate levels fall below the level 22 mmol/l. In a cross-sectional analysis of the baseline data in the Chronic Renal Insufficiency Cohort study of patients with CKD stages 2-4 (n = 3,900), prevalence of serum bicarbonate <22 mmol/l was 17.3% for overall, 7, 13 and 33% for CKD stages 2, 3 and 4, respectively.[27] Among all respondent's hyperphosphatemia, hyperparathyroidism, hypoparathyroidism, hypocalcemia, hypercalcemia, hypomagnesemia and hypermagnesemia deficiency were 71%, 79%, 21% 61%, 17%, 21% and 8% accordingly.

CONCLUSION

Chronic kidney disease represents an especially large burden in low- and middle-income countries, which are least equipped to deal with its consequences. Chronic kidney disease has emerged as one of the leading causes of mortality worldwide, and it is one of a small number of non-communicable diseases that have shown an increase in associated deaths over the past 2 decades. The high number of affected individuals and the significant adverse impact of chronic kidney disease should prompt enhanced efforts for better prevention and treatment.

DISCLOSURE

All the authors declared no competing interest.

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