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Original Research Article

Assessing the electrolyte imbalances, predisposing factors and their impact on sleep quality in chronic kidney disease patients: a hospital-based study

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ABSTRACT

Background: Chronic kidney disease (CKD) poses a significant burden on patients' health and quality of life, often accompanied by various risk factors, electrolyte disturbances and disturbances in sleep patterns.
Methods: A prospective observational study was conducted in a tertiary care hospital inpatient general medicine department over a period of six months and recorded 120 cases. Pittsburgh sleep quality index (PSQI) was used to assess the quality of sleep and chi square test was performed as a statistical significance for the risk factors and complications and obtained the results.
Results: Out of 120 cases, 68 were males and 52 were females; patients with an age group greater than 65 years are more prone to CKD (p value <0.05, i.e., 0.048). Hypertension was the major risk factor, followed by diabetes, among these patients (p value <0.05). Anemia, sepsis, and edema are the most common complications among CKD patients. This study confirms that the majority of the patients have long-term sleep disturbances followed by poor sleep quality. Significant decrease in glomerular filtration rate, albumin levels, serum sodium, serum calcium levels, and an increase in serum creatinine levels, blood urea nitrogen, bilirubin levels, serum potassium, serum chloride and serum phosphate levels were observed in these CKD patients.
Conclusions: Study concluded that assessing sleep quality, monitoring electrolyte levels were essential for comprehensive care in CKD patients. Addressing sleep problems and managing risk factors can improve well-being, while maintaining electrolyte balance helps manage complications and prevent disease progression.

Keywords: CKD, Sleep disorders, Somnolence, Electrolytes, Hypertension, Glomerular filtration rate

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.[1] 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.[2]

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.[6] 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.[5]

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 to investigate the risk factors and electrolyte disturbances associated with CKD and their impact on sleep quality among affected individuals. The objective is to estimate the sleep quality over one-month time interval in CKD patients by using self-rated questionnaire-PSQI, to evaluate the predisposing factors linked with CKD patients, to assess the electrolyte imbalances in CKD patients, to determine the relationship of quality of sleep with risk factors and electrolyte imbalances individually.

METHODS

An observational prospective cross-sectional study was conducted in the department of nephrology and general medicine, Gandhi Hospital, Secunderabad, from August 2023 to January 2024 after the approval from Institutional Ethics Committee (CMR College of Pharmacy). A total of 120 subjects suffering from CKD were included in the study after taking informed consent individually. The criteria for inclusion were: CKD subjects greater than or equal to 25 years of age of either sex, inpatient department patients with complete information till discharge. Exclusion criteria were subjects with less than 25 years of age, pediatric patients, pregnant and lactating women, subjects who left against medical advice and outpatient department patients. In this study, we considered the subject's laboratory findings like GFR, creatinine, blood urea nitrogen, albumin, bilirubin, serum electrolyte levels such as sodium, potassium, calcium, chloride, phosphate. We also considered the subjects risk factors like age, hypertension, diabetes mellitus, cardiovascular diseases, and smoking. We conducted a survey to assess the quality of sleep by using a standard questionnaire PSQI in these subjects.

Instrument for assessment of quality of sleep

PSQI is a broadly used and verified questionnaire to evaluate sleep quality in citizens. The survey using PSQI can contain 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. Subjects are ordinarily asked to rate their sleep regimens over a specific period, generally the past month.

It includes questions such as "During the past month, how often have you had trouble sleeping because you cannot get to sleep within 30 minutes?" Or "During the past month, how often have you had trouble staying awake while driving, eating meals or engaging in social activity? Each question in the PSQI has an identical scale to rate their sleep experiences, frequently ranging from "Not during the past month" to "Three or more times a week." PSQI contains 24 questions and seven components (first component: subjective sleep quality, second component:

sleep latency, third component: sleep duration, fourth component: habitual sleep efficiency, fifth component: sleep disturbances, sixth component: use of sleeping medication, and seventh component: daytime dysfunction).[7]

Scoring the PSQI

The survey was conducted and the PSQI score was calculated. The ratings for each section of the PSQI were incorporated to propagate a total score ranging between 0 to 21. Supernal scores imply poorer sleep quality, while lower scores imply better sleep quality. In every aspect of the scale, scoring was performed within a range of 0-3. The sum of the scores of these seven components constitutes the total index score. In this scale, the total value can be between 0 and 21 (interpretation: 0-5=healthy sleep; 6-10=poor sleep quality, and >10=long-term sleep disturbance). A high score indicates that the sleep quality is impaired. Poor sleep quality is defined as a PSQI score >5.[7]

Statistical analysis

Statistical analysis was performed using statistical package for the social sciences (SPSS) software version 29.0.1.0. The parameters were assessed using Pearson chi-square test between age, gender, hypertension, diabetes, CVD, smoking with PSQI rate. The p value was found to be <0.01 for HTN, DM, smoking risk factors with PSQI rate where these parameters were found to be statistically significant.

RESULTS

A total of 120 subjects were included in the study. The subjects with age greater than 65 years of age were more prone to CKD and 46.9% were experiencing poor sleep quality followed by 31.2% of the patients were experiencing long term sleep disturbances and 21.9% experienced good sleep quality. Majority of the female patients experienced long term sleep disturbances compared to males. Hypertension was observed as a major risk factor with 83.3% followed by diabetes mellitus with 78.3%. The majority of the patients were having PSQI score 11-21 (57.5%) and 6-10 (35.8%) and a few patients scored between 0-5 (6.6%). This study confirms that the majority of the CKD patients have decreased sodium level (hyponatremia) with 90% and 6.6% patients have normal values followed by increased levels of sodium with 3.3% of the patients. So, majority of the patients suffered from poor sleep quality.

The majority of the CKD patients have increased potassium level with 82.5% (hyperkalemia) followed by 10% of patients having normal levels of potassium then decreased levels of potassium with 7.5% of the patients. So, majority of the patients suffered from long term sleep disturbances.

The majority of the CKD patients have decreased calcium level with 85.8% of patients (hypocalcemia) followed by normal levels of calcium with 9.1% then increased levels of calcium with 5% of the patients. Thus, majority of the patients suffered from long term sleep disturbances followed by poor sleep quality.

Most of the subjects have increased chloride level with 74.1% of the patients (hyperchloremia), followed by normal levels with 15% of the patients then decreased levels of chloride with 10.8% of the patients. Thus, the majority of the patients suffered from long term sleep disturbances.

83.33% of the patients have increased phosphate level (hyperphosphatemia) followed by decreased levels of phosphate with 8.3% of the patients. Majority of the patients suffered from long term sleep disturbances.

The chi square analysis was performed and statistical significance was found between hypertension, DM, smoking with PSQI Rate (p value=0.000, 0.000, 0.000 respectively which was less than 0.005) and there was no statistical significance between the age, gender, CVD with PSQI rate (p=0.059, 0.504, 0.554, respectively which was greater than 0.005) as shown in Table 3.

Table 1: Distribution according to age, gender, risk factors, complications, PSQI score, sodium levels, potassium levels, calcium levels, chloride levels, phosphate levels.

Variables	Number of patients (n=120)	Percentage (%)	PSQI rate		
			Long term (%)	Poor (%)	Good (%)
Age (years)					
25-34	7	5.8	28.5	28.5	42.8
35-44	26	21.6	50	34.6	3.3
45-54	29	24.1	55.2	17.2	27.6
55-64	26	21.6	19.2	57.7	23.1
>65	32	26.6	31.2	46.9	21.9
Gender					
Male	68	56.6	35.8	42.6	20.6
Female	52	43.3	40.4	32.7	27
Risk factors					

Continued.

Variables	Number of patients (n=120)	Percentage (%)	PSQI rate		
			Long term (%)	Poor (%)	Good (%)
Hypertension	100	83.3	42	42	16
Diabetes mellitus	94	78.3	42.5	42.5	14.9
Cardiovascular diseases	78	65.0	41	38.5	20.5
Age above 65 years	32	26.6	31.2	46.9	21.9
Smoking	42	35	56	26	18
Complications					
Sepsis	31	25.8	32.2	29	38.7
Anemia	32	26.6	56.2	21.9	21.9
Edema	25	20.8	56	32	12
Sepsis + anemia	9	7.5	33.3	33.3	33.3
Sepsis + edema	3	2.5	66.6	33.3	0
Anemia + edema	11	9.1	72.2	9.1	18.2
Sepsis + anemia + edema	2	1.6	100	0	0
None	53	44.1	28.3	50.1	20.7
PSQI score					
0–5	8	6.6	-	-	-
6–10	43	35.8	-	-	-
11–21	69	57.5	-	-	-
Sodium levels					
Increased	4	3.3	75	0	25
Decreased	108	90	37	40.7	22.2
Normal	8	6.6	25	37.5	37.5
Potassium levels					
Increased	99	82.5	40.4	35.3	24.2
Decreased	9	7.5	33.3	44.4	22.2
Normal	12	10	25	58.3	16.7
Calcium levels					
Increased	6	5	50	16.7	33.3
Decreased	103	85.8	37.8	37.9	24.3
Normal	11	9.1	36.4	54.5	9.1
Chloride levels					
Increased	89	74.1	41.6	33.7	24.7
Decreased	13	10.8	46.1	38.5	15.4
Normal	18	15	16.7	61.1	22.2
Phosphate levels					
Increased	100	83.3	37	40	23
Decreased	10	8.3	50	30	20
Normal	10	8.3	40	30	30

Table 2: Distribution according to laboratory findings.

Laboratory findings	Increased	Decreased	Normal	Interpretation
Glomerular filtration rate	0	104	16	Majority of the patients (104) had decreased GFR and very few patients (16) had a normal GFR rate
Creatinine	110	9	1	Majority of the patients (110) had increased creatinine levels and 9 had a decreased creatinine levels
Blood urea nitrogen	92	19	9	Majority of the patients (92) had increased BUN and few patients had decreased BUN
Albumin	21	88	11	88 out of 120 patients had decreased albumin levels and 21 had increased whereas very few had normal albumin levels.
Bilirubin	49	45	26	49 out of 120 patients had increased bilirubin levels, 45 had decreased levels, 26 had normal levels.

Table 3: Chi-square analysis between age, gender, HTN, DM, CVD, smoking and PSQI rate.

Variables	Value	Degrees of freedom	Asymptotic significance (2-sided)
Chi-square analysis between age and PSQI rate			
Pearson chi-square	15.023[a]	8	0.059
Likelihood ratio	15.657	8	0.048
Number of valid cases	120		
Chi-square analysis between gender and PSQI rate			
Pearson chi-square	1.369[a]	2	0.504
Likelihood ratio	1.376	2	0.503
Number of valid cases	120		
Chi-square analysis between HTN and PSQI rate			
Pearson chi-square	18.037[a]	2	0.000
Likelihood ratio	15.531	2	0.000
Number of valid cases	120		
Chi-square analysis between DM and PSQI rate			
Pearson chi-square	17.275[a]	2	0.000
Likelihood ratio	15.374	2	0.000
Number of valid cases	120		
Chi-square analysis between CVD and PSQI rate			
Pearson chi-square	1.182[a]	2	0.554
Likelihood ratio	1.170	2	0.557
Number of valid cases	120		
Chi-square analysis between smoking and PSQI rate			
Pearson chi-square	18.037[a]	2	0.000
Likelihood ratio	15.374	2	0.000
No of valid cases	120		

Table 4: List of abbreviations.

S. no.	Abbreviation	Meaning
01	CKD	Chronic kidney disease
02	PSQI	Pittsburgh sleep quality index
03	KDIGO	Kidney disease: improving global outcomes
04	GFR	Glomerular filtration rate
05	WHO	World Health Organisation
06	ESRD	End-stage renal disease
07	HTN	Hypertension
08	DM	Diabetes mellitus
09	CVD	Cardiovascular disease
10	BUN	Blood urea nitrogen

DISCUSSION

The study findings highlight the intricate interplay between various predisposing factors, electrolyte imbalances, and sleep quality in CKD patients.[1] It was confirmed that the greater proportion of the population belonged to those above 65 years of age (26.6%). The high prevalence of comorbidities such as hypertension (83.3%), diabetes mellitus (78.3%), and cardiovascular disease (65%) among the study participants underscores the complex nature of CKD and its associated risk factors.[2]

Notably, the study revealed a substantial proportion of patients experiencing poor sleep quality and long-term sleep disturbances, which were closely linked to the presence of these comorbidities. This observation aligns with previous research suggesting that chronic conditions and their associated physiological alterations can significantly impact sleep quality and sleep patterns.[4]

The electrolyte imbalances observed in the study cohort, including hyponatremia (90%), hyperkalemia (82.5%), hypocalcemia (85.8%), hyperchloremia (74.1%), and hyperphosphatemia (83.3%), further compound the challenges faced by CKD patients. These imbalances can potentially contribute to various physiological disturbances, thereby exacerbating sleep issues and potentially contributing to the observed sleep disturbances.[8-12]

Interestingly, the study identified differences in the distribution of sleep quality categories among patients with specific comorbidities and electrolyte imbalances. For instance, patients with hypertension and diabetes mellitus exhibited a higher prevalence of long-term sleep disturbances and poor sleep quality compared to those with good sleep quality. This finding underscores the need for targeted interventions and management strategies to address sleep disturbances in CKD patients with specific comorbidities and electrolyte imbalances.[3,5,28]

CONCLUSION

The study provides valuable insights into the complex interrelationships between predisposing factors, electrolyte imbalances, and sleep quality in CKD patients. The high prevalence of comorbidities and electrolyte imbalances, coupled with their association with poor sleep quality and long-term sleep disturbances, highlights the need for a comprehensive and multidisciplinary approach to managing CKD patients.

Addressing sleep disturbances in CKD patient populations should be a priority, as poor sleep quality can further exacerbate existing conditions and negatively impact overall health outcomes. Targeted interventions, such as lifestyle modifications, pharmacological interventions, and sleep hygiene education, may be beneficial in improving sleep quality and mitigating the effects of comorbidities and electrolyte imbalances. Furthermore, regular monitoring and management of electrolyte levels, as well as effective control of comorbidities like hypertension, diabetes, and cardiovascular disease, are crucial in maintaining overall well-being and potentially improving sleep quality in CKD patients.

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