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RESEARCH ARTICLE

Evaluation of Serum level of Sodium and Potassium in Patients with Congestive Heart Failure

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ABSTRACT

Millions of individuals worldwide suffer from heart failure, a chronic illness that has a high morbidity and death rate. The study found that the majority of patients were male and over the age of 60, with a significant proportion having comorbidities such as high blood pressure and diabetes. The mean serum sodium level was elevated, while the mean serum potassium level was within the normal range. However, a significant number of patients had abnormally high or low levels of both electrolytes, and hypernatremia and high serum potassium levels were prevalent in the patient population. This study was aimed to evaluate the serum sodium and potassium levels in 100 CHF patients and determine the range of their elevation. This study will provide important insights into the prevalence and severity of electrolyte imbalances in CHF patients and may help to inform clinical management strategies. The cross-sectional study included 100 samples patients infected with congestive heart failure (66 male, 34 female) with a match age ranged between (50-64) years. The investigation was carried out from Al-Hussein Teaching Hospital, Al-Hussein Medical City, Kerbala Health Directorate / Kerbala - Iraq during. The mean serum sodium level is slightly higher in smokers than in non-smokers, with a difference of 0.1 mEq/L, which is statistically significant ($P < 0.0001$). Similarly, the mean serum sodium level in diabetics is noticeably higher than in people without it ($P < 0.0001$), hypertensives compared to non-hypertensives ($P < 0.0001$), and so on, the same pattern can be observed for mean serum potassium levels. Overall of these results illustrate the significance monitoring serum electrolyte levels in heart failure patients, particularly for hypernatremia and high serum potassium levels.

INTRODUCTION

Congestive heart failure (CHF) is a chronic, progressive, and life-threatening condition that has an impact on millions of people globally. It contributes significantly to morbidity and death, with a 5-

year survival rate of only 50% for patients with advanced heart failure (1). The defining feature of congestive heart failure (CHF) is the heart's incapacity to efficiently pump blood, resulting in fluid accumulation in the lungs and other body regions (2) (3). Impaired left ventricular myocardial function is the cause of symptoms in the majority of heart failure patients. Patients typically exhibit fluid retention, manifested as pulmonary and peripheral edema, tiredness, deficient exercise tolerance, and dyspnea (4) (5) Left ventricular ejection fraction (LVEF) is used to characterize heart failure resulting from left ventricular dysfunction. Heart failure with reduced ejection fraction (HFrEF) is described as LVEF 40% or below, whereas heart failure with preserved ejection fraction (HFpEF) is considered as LVEF greater than 40%(6) (7).

People with diabetes have an increased incidence of CHF than people without diabetes, and diabetes is a risk factor for CHF on its own. (8)

Serum sodium and potassium are crucial electrolytes that play a vital role in maintaining normal bodily functions. Sodium is the most abundant extracellular cation and is responsible for maintaining fluid balance, cell membrane potential, and acid-base balance (1). The critical role of sodium is maintaining acid-base balance and preserving standard membrane potentials and normal cardiac function (9). Potassium is the most abundant intracellular cation and is involved in regulating cellular excitability, muscle function, and acid-base balance (10). Since the cardiovascular and neurological systems are primarily affected by changes in extracellular potassium, serious abnormalities in potassium levels may cause deadly arrhythmias or paralysis of the muscles prior to the onset of central nervous system symptoms (11). Changes in serum sodium and potassium levels can have significant clinical implications, including the development of cardiac arrhythmias, renal dysfunction, and neurological symptoms (1). In particular, the renin-angiotensin-aldosterone system (RAAS) and the sympathetic nervous system (SNS) play important roles in regulating electrolyte balance in CHF. Activation of the RAAS and the SNS can lead to increased sodium and water retention, which can result in hypernatremia and hypokalemia Several studies have reported that CHF patients often have electrolyte imbalances, including changes in serum sodium and potassium levels. These imbalances are thought to be due to various factors, including diuretic therapy, renal dysfunction, and neurohormonal activation (12). The impact of sodium and potassium imbalances on other outcomes in CHF patients has also been investigated.

RESEARCH METHODOLOGY

This study will involve analysis (cross sectional study) of medical records from 100 CHF patients (66 male, 34 female) who were tested in 2023. The inclusion criteria for this study are: (1) confirmed diagnosis of CHF based on the Framingham criteria(1), (2) age above 18 years, (3) availability of serum sodium and potassium levels on admission, and (4) no history of end-stage renal disease or liver disease. Each patient's age, sex, smoking status, history of hypertension, and history of diabetes mellitus will be taken from their medical records. ELISA, an immunosorbent test, and spectrophotometric technique were used to measure serum potassium and sodium levels. The hospital ethics committee approved the study plan, and all patients or their families were informed of this before taking blood.

Statistical Analysis

Statistical analysis of data was conducted using the statistical program GenStat, version 12, where the design two-way Analysis of Variance (ANOVA) was used to test the general significant difference between the coefficients under study. the probability level of 0.05 to test the significance difference between the pairwise of the studied traits and determine which of the studied coefficients is more influential. The mean and standard deviation were used for data that were normally distributed.

DATA ANALYSIS

Table 1 shows a summary of the demographic features of the 100 CHF patients included in the study, including their age, gender, smoking habits, and other conditions such diabetes mellitus and hypertension. The data suggests that men constitute most of the patients and between the age of 50-64, and that a significant proportion had hypertension and diabetes.

Table 1: Demographic Characteristics of CHF Patients

Characteristic	Number of Patients	Percentage
Age (years)		
<50	45	45%
50-64	50	50%
>65	5	5%
Sex		
Male	66	66%
Female	34	34%
Smoker	63	63%
Hypertension	84	84%
Diabetes	83	83%

Table 2 presents the mean serum sodium and potassium levels of the CHF patients, along with the range of values and standard deviation. The data indicates that the mean serum sodium level was elevated, while the mean serum potassium level was within the normal range. However, a significant number of patients had abnormally high or low levels of both electrolytes.

Table 2: Serum Electrolyte Levels in CHF Patients

Serum Electrolyte	Mean ± SD	Normal Range
Sodium	152.44± 9.9 mEq/L	135-145 mEq/L
Potassium	5.5 ± 0.7 mEq/L	3.5-5.0 mEq/L

The table 3 presents the prevalence of serum sodium and potassium imbalances among CHF (Congestive Heart Failure) patients. Each row displays a different electrolyte imbalance, and the column next to it shows the percentage of patients with that imbalance.

Table 3: Prevalence of Serum Sodium and Potassium Imbalances in CHF Patients

Electrolyte Imbalance	Prevalence
Low serum potassium	20%
High serum potassium	80%
Hyponatremia	23%
Hypernatremia	77%

Note: The normal ranges for serum sodium and potassium levels are based on laboratory reference values.

There is a statistically significant difference in mean serum sodium and potassium levels between each pair of patient groups (non-smokers vs smokers, non-diabetics vs diabetics, hypertensives vs non-hypertensives, etc.). The mean serum sodium level is slightly higher in smokers than in non-smokers, with a difference of 0.1 mEq/L, which is statistically significant ($P < 0.0001$). Similarly, the mean serum sodium level in diabetics is noticeably higher than in non-diabetics. ($P < 0.0001$), hypertensives compared to non-hypertensives ($P < 0.0001$), and so on. The same pattern can be observed for mean serum potassium levels. (TABLE4)

Table 4: Comparing the Serum Potassium and Sodium levels in Patients having CHF

	Mean Sodium Level (mEq/L)	Mean Potassium Level (mEq/L)	P-value
Non-Smokers	153 ± 12.4	5.5 ± 0.9	P < 0.0001
Smokers	153.1 ± 10.9	5.4 ± 0.8	P < 0.0001
Non-Diabetics	147.5 ± 10.4	4.9 ± 0.6	P < 0.0001
Diabetics	153.8 ± 12.2	5.5 ± 0.9	P < 0.0001
Hypertensives	153.7 ± 12.2	5.5 ± 0.9	P < 0.0001
Non-Hypertensives	150.1 ± 9.7	5.1 ± 0.9	P < 0.0001

DISCUSSION

These results are consistent with previous studies on CHF patients, which have also reported a high prevalence of comorbidities such as hypertension and diabetes. For instance, a study by (2) found that 74% of CHF patients had hypertension, and 32% had diabetes. Furthermore, a study by (3) that found CHF patients had a higher mean serum sodium level than healthy people confirm our conclusion that these patients had an elevated mean serum sodium level. Similarly, our finding of a high prevalence of hypernatremia in CHF patients is consistent with a study by(4), which found that hypernatremia was present in 23% of hospitalized CHF patients.

On the other hand, the finding of a normal mean serum potassium level in our study is somewhat contradictory to previous studies, which have reported that CHF patients often have low serum potassium levels due to the use of diuretics(5). However, it should be noted that our study found a significant number of CHF patients with abnormally high or low levels of serum potassium, which is consistent with the results of further studies. The rise in sodium and potassium levels in heart failure patients can be attributed to several physiological mechanisms. Here are some explanations from a physiological perspective(6).

Renin-Angiotensin-Aldosterone System (RAAS) Activation: Heart failure leads to a reduction in cardiac output, which triggers the activation of the RAAS. This activation enables the hormone aldosterone to be released, which enhances the kidneys' ability to reabsorb sodium and encourages the outflow of potassium(6). As a result, sodium levels increase, and potassium levels decrease. Moreover, medications that disrupt the RAAS, such as angiotensin receptor blockers or ACE inhibitors, or potassium-sparing diuretics (ARBs), can cause hyperkalemia by reducing potassium excretion(7).

Neurohormonal Dysregulation: Heart failure is typified by neurohormonal imbalance, which includes heightened activity of the sympathetic nervous system and cytokine activation(6). These imbalances can disrupt the normal regulation of electrolyte homeostasis, leading to alterations in sodium and

potassium levels. It is important to note that the specific changes in sodium and potassium levels can vary among heart failure patients and depend on factors such as disease severity, comorbidities, and medication regimens(5). Regular monitoring and appropriate management of electrolyte imbalances are crucial in optimizing heart failure treatment and patient outcomes (3).

Similarly, a study by (8) reported that hypokalemia had been related to an elevated likelihood of death in CHF patients. A study by (9) reported that hyponatremia was associated with an increased risk of hospitalization for heart failure and worsening renal function in CHF patients. Similarly, a study by (9)found that hypokalemia had been associated to a greater risk of heart failure admission and adverse cardiovascular events in CHF patients. Smoking is a proven contributory factor for cardiovascular diseases, including CHF. Cigarette smoking causes endothelial dysfunction, oxidative stress, inflammation, and atherosclerosis, all of these promote expansion and progression of CHF(10). People with diabetes have a greater incidence of CHF than people without the disease, and diabetes is an independent predictor of CHF (22-24).

CONCLUSION

The study highlights the importance of monitoring serum sodium and potassium levels in CHF patients, given the high prevalence of electrolyte imbalances in this population. Close attention should also be paid to patients with comorbidities such as hypertension and diabetes, as they may be at higher risk for developing electrolyte imbalances. Healthcare providers should be vigilant in monitoring and managing electrolyte imbalances in CHF patients to prevent adverse outcomes.

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