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Original Research Article

PROSPECTIVE OBSERVATIONAL STUDY OF DYSNATREMIA IN CARDIAC FAILURE

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ABSTRACT

INTRODUCTION

Dysnatremia, including both hyponatremia and hypernatremia, is a frequent electrolyte imbalance in heart failure patients, often associated with poor clinical outcomes. Heart failure, driven by structural or functional impairments, leads to altered sodium levels due to factors such as neurohormonal activation, renal dysfunction, and medication use. This study examines the prevalence of dysnatremia in heart failure and its association with key clinical parameters.

OBJECTIVES

To assess serum sodium levels at admission, determine the prevalence of dysnatremia in heart failure patients, and analyze the correlation between sodium levels and left ventricular ejection fraction (LVEF), systolic blood pressure (SBP), serum urea, and creatinine.

MATERIALS AND METHODS

This prospective observational study was conducted at Dr. B. R. Ambedkar Medical College and Hospital, Bengaluru, India, between August 2020 and June 2022. A total of 50 patients with heart failure, aged 18 years and above, were included. Data collection involved sociodemographic information, clinical history, and comprehensive lab investigations.

RESULTS

Hyponatremia was present in 66% of patients, 20% had normal sodium levels, and 14% showed hypernatremia. The mean serum sodium level was 138 ± 7.48 mEq/L, and the mean ejection

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fraction was 43.06 ± 7.02%. A positive correlation was observed between serum sodium levels and LVEF, SBP, serum urea, and creatinine.

CONCLUSION

Dysnatremia, particularly hyponatremia, is highly prevalent in heart failure patients. The positive correlation between sodium levels and key clinical variables highlights the importance of monitoring and managing electrolyte imbalances to improve patient outcomes.

INTRODUCTION

Dysnatremia, which includes both hyponatremia and hypernatremia, is a critical electrolyte imbalance commonly observed in individuals with heart failure. Heart failure is a multifaceted clinical condition that arises from any structural or functional disruption in the heart's ability to fill with or eject blood effectively. The relationship between heart failure and dysnatremia is complex, driven by factors such as neurohormonal activation, kidney dysfunction, and the impact of various medications employed in the treatment of heart failure[1,2]

Hyponatremia, defined as a serum sodium level below 135 mmol/L, is the most prevalent electrolyte disturbance in heart failure patients. This condition often results from the non-osmotic release of arginine vasopressin (AVP), which leads to water retention and dilutional hyponatremia. Hyponatremia is not only indicative of more severe disease but also serves as an independent predictor of worse outcomes in heart failure patients. Several studies have linked hyponatremia with increased mortality, prolonged hospitalizations, and higher rates of readmission in these patients.[3]

Conversely, hypernatremia, defined as a serum sodium level exceeding 145 mmol/L, is less common in heart failure but is associated with even poorer outcomes. It typically indicates severe dehydration or advanced renal impairment, both of which are critical in the context of heart failure. The underlying causes of hypernatremia in heart failure are not as well understood, but they may include a reduced thirst response, overuse of diuretics, or insufficient water intake.[4]

The study aims to assess serum sodium levels at admission and determine the prevalence of dysnatremia in heart failure patients, as well as to examine the relationship between these sodium levels and variables such as left ventricular ejection fraction (LVEF), systolic blood pressure (SBP), blood urea, and serum creatinine levels during the hospital stay.

MATERIALS AND METHODS

The study was carried out among patients attending the Departments of General Medicine, Cardiology, and Emergency Medicine at Dr. B. R. Ambedkar Medical College and Hospital, Bengaluru, India. Designed as a prospective observational study, the research spanned from August 2020 to June 2022, with prior approval obtained from the institutional ethical committee.

The study population included individuals of both sexes aged 18 years and above, who presented with chest pain, discomfort, tightness, and electrocardiogram (ECG) findings suggestive of cardiac changes, and who provided informed consent. Exclusion criteria were set to exclude those under 18 years of age, individuals with conditions that could cause hyponatremia (such as vomiting, diarrhea, salt-losing nephropathy, diabetic ketoacidosis,

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cirrhosis, nephrotic syndrome, syndrome of inappropriate antidiuretic hormone secretion, or glucocorticoid deficiency), and conditions leading to hypernatremia (such as chronic kidney disease and diabetes insipidus). Additionally, subjects who were unwilling or did not provide consent were excluded from the study.

The sample size was calculated based on a 1% prevalence of heart failure in India, as reported by Vivek C et al[5]. Using this prevalence as a reference, the sample size was determined using the formula N=Z2p(1-p)/d2, where p represents the prevalence (0.01), q is 1 minus the prevalence (0.99), and L is the allowable error (3%, or 0.3). This calculation yielded a minimum required sample size of 42 participants; however, a total of 50 subjects were ultimately included in the study as it progressed.

Data collection was facilitated using a pre-designed, pre-tested questionnaire. Subjects who consented to participate had their sociodemographic details recorded, followed by a detailed clinical history collection from both patients and their attendants. This history focused on the sudden onset of chest pain, sweating, palpitations, altered behavior or consciousness, and any associated symptoms. Additionally, a comprehensive past medical history was obtained, including the presence or absence of diabetes and hypertension, their duration, and other known clinical conditions such as rheumatic heart disease (RHD), coronary artery disease (CAD), chronic kidney disease (CKD), decompensated liver disease (DCLD), pulmonary tuberculosis, bronchial asthma, and chronic obstructive pulmonary disease (COPD). Personal history concerning addictive habits, sleep patterns, diet, alcohol consumption, smoking, and narcotic use was also documented. Each patient underwent a thorough physical examination, systemic evaluation, and anthropometric measurements.

Routine investigations were conducted for all patients, including complete blood counts, erythrocyte sedimentation rate (ESR), routine urine examination, renal function tests, liver function tests, serum electrolytes, thyroid profile, urine and blood culture and sensitivity, ECG, 2D echocardiography, chest X-ray, and ultrasound of the abdomen.

The collected data was coded and entered into a Microsoft Excel worksheet before being exported to the Statistical Package for Social Sciences (SPSS) version 21 for analysis. Statistical significance was assessed using the Chi-square test, Independent T-test, and Pearson's correlation test, with a p-value of 0.05 considered statistically significant for all tests conducted.

RESULTS

Of the 50 patients in the study, the maximum number (54%) fell within the 41-60 years age group, followed by 24% who were over 60 years old. The mean age of the participants was 49.94 ± 13.97 years, with a male-to-female ratio of 1.6:1. The study population had a mean height of 154.38 ± 9.57 cm and a mean weight of 55.5 ± 9.86 kg. Among them, 36% were classified as overweight, and 16% were considered obese. The average systolic blood pressure was 155 ± 29.01 mmHg, while the mean diastolic blood pressure was 111.9 ± 11.73 mmHg. (Table 1)

SNO.	BASELINE CHARACTERISTICS	NO. OF PATIENTS	PERCENTAGE
	AGE DISTRIBUTION		
1	21 – 40 Years	11	22%
2	41 – 60 Years	27	54%
3	> 60 Years	12	24%

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	GENDER		
1	Male	31	62%
2	Female	19	38%
	COMORBIDITIES		
1	Anaemia	18	36%
2	Diabetes Mellitus	28	56%
3	Hypertension	26	52%
4	Coronary Artery Disease	22	44%
5	Valvular Heart Disease	10	20%
6	Dilated Cardiomyopathy	13	26%
7	Myocarditis	2	4%
8	Arrhythmia	9	18%
	BMI		
1	<18.5 Kg/m2	4	8%
2	18.5 – 24.99 Kg/m2	20	48%
3	25 – 29.99 Kg/m2	18	36%
4	>30 Kg/m2	8	16%

Table 1: Baseline characteristics of the study population

The mean serum creatinine level in the study population was 2.86 ± 0.42 mg/dl, while the mean urea level was 9.84 ± 1.32 mmol/L. Hyponatremia was observed in 66% of participants, 20% had normal sodium levels (eunatremia), and 14% exhibited hypernatremia. The average serum sodium level was 138 ± 7.48 mEq/L. The mean ejection fraction (EF) was 43.06 ± 7.02, with the majority (96%) of the participants having an EF below 50%. (Table 2)

SNO.	LABORATORY FINDINGS	NO. OF PATIENTS	PERCENTAGE
	Serum Creatinine		
1	<1.4 g/dl	0	0%
2	>1.4 g/dl	50	100%
	Blood Urea		
1	2.1 – 8.5 mmol/L	11	22%
2	>8.5 mmol/L	39	78%
	Serum Sodium		
1	<135 mEq/L	33	66%
2	135 – 145 mEq/L	10	20%
3	>145 mEq/L	7	14%
	Ejection Fraction		
1	50 – 75%	2	4%
2	<50%	48	96%

Table 2: Laboratory and Echocardiographic findings in the study population

A positive correlation was observed between serum sodium levels and ejection fraction, systolic blood pressure, serum urea and serum creatinine in the present study. (Table 3)

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SNO.	CORRELATION OF SERUM SODIUM WITH CERTAIN VARIABLES	R VALUE	P VALUE
1	Ejection Fraction	0.52	< 0.0001*
2	Systolic Blood Pressure	0.128	< 0.0001*
3	Serum Urea	0.753	< 0.0001*
4	Serum Creatinine	0.68	< 0.0001*

Table 3: Correlation between serum sodium levels with ejection fraction and other selected variables

Line diagram showing correlation between serum sodium and ejection fraction, systolic blood pressure, serum urea and serum creatinine

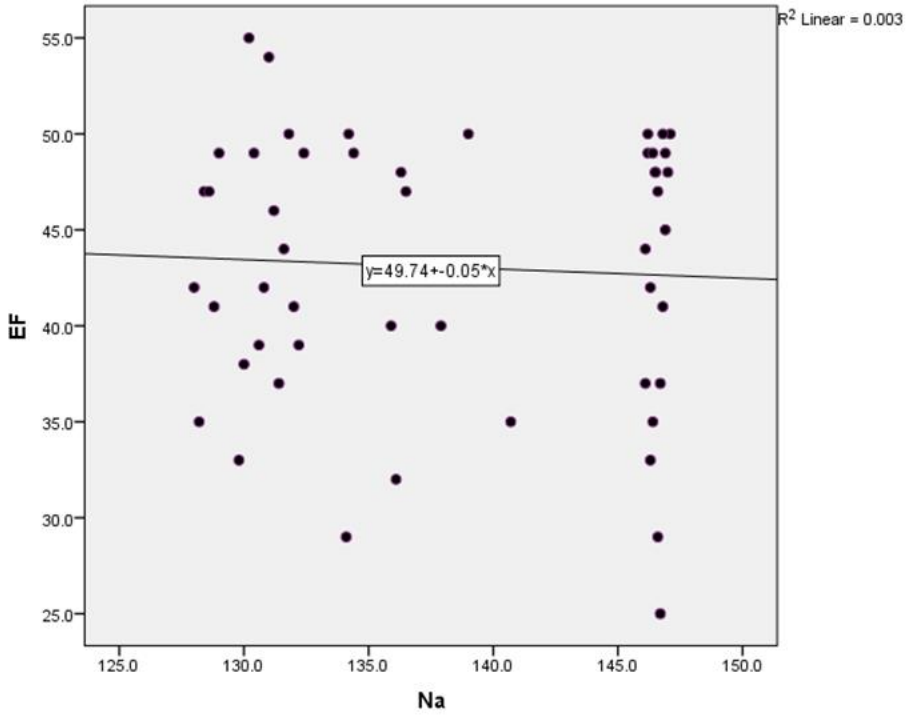

Figure 1: Correlation between Serum sodium and Ejection fraction

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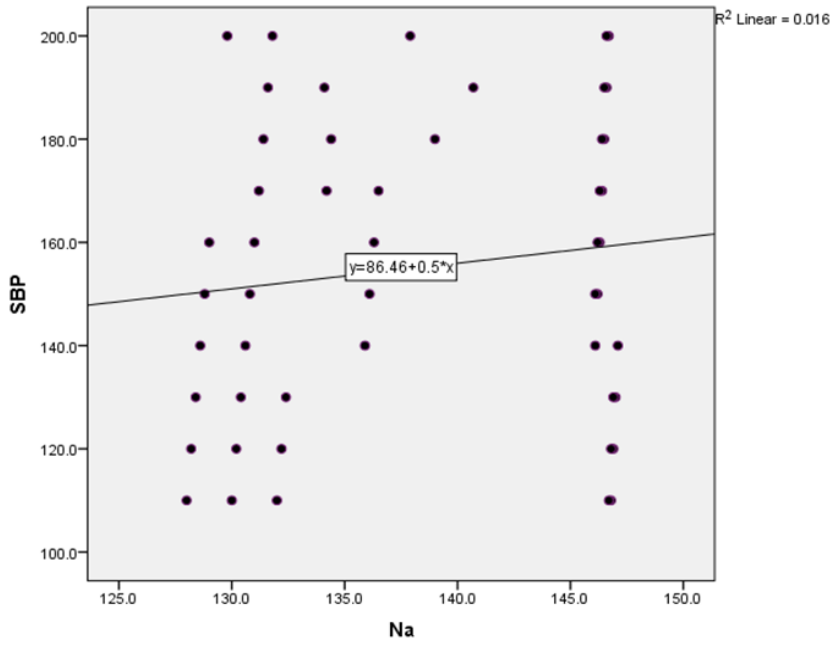

Figure 2: Correlation between Serum Sodium and Systolic Blood Pressure

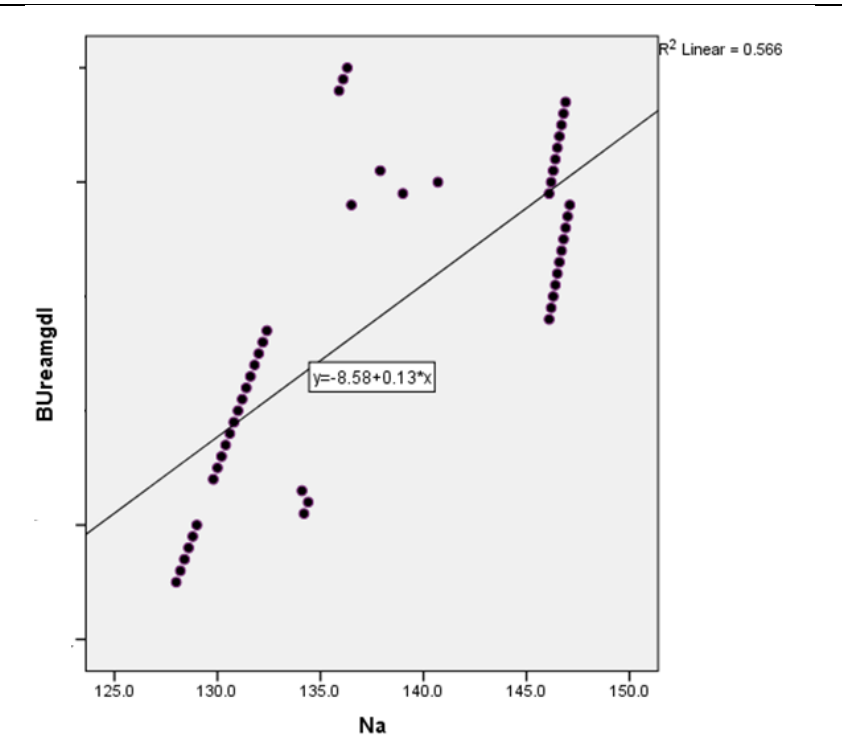

Figure 3: Correlation between Serum Sodium and Blood Urea

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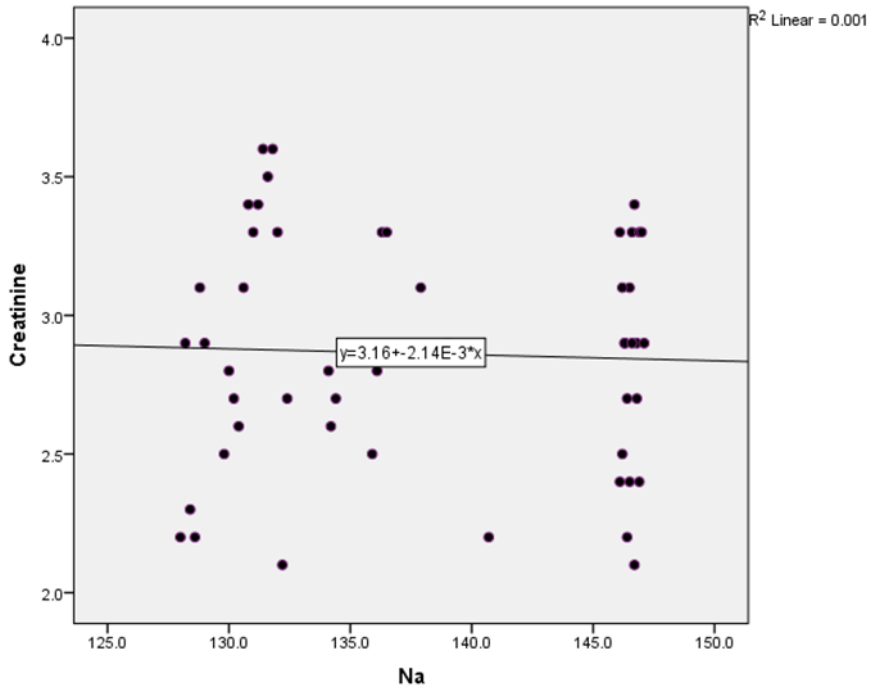

Figure 4: Correlation between Serum Sodium and Serum Creatinine

DISCUSSION

Dysnatremia, a common electrolyte disturbance in cardiac failure, significantly impacts morbidity and mortality. In our study, hyponatremia was observed in 66% of the participants, with 20% showing normal sodium levels and 14% displaying hypernatremia. These findings are consistent with the established prevalence of dysnatremia in patients with heart failure, where hyponatremia is often seen as a marker of disease severity and poor prognosis.[6]

The mean serum sodium level in our population was 138 ± 7.48 mEq/L, which, though close to normal, hides the fact that a majority of participants exhibited significant variations from normal sodium values. This supports the growing evidence that dysnatremia, particularly hyponatremia, is common in heart failure patients and may be associated with fluid overload, neurohormonal activation, and diuretic therapy.[7]

A striking finding in our study was the positive correlation between serum sodium levels and ejection fraction (EF). The majority (96%) of our participants had an EF below 50%, and the mean EF was 43.06 ± 7.02. The relationship between low EF and dysnatremia, particularly hyponatremia, is well-documented. Hyponatremia in heart failure results from the activation of the renin-angiotensin-aldosterone system (RAAS) and vasopressin, leading to water retention and dilutional sodium imbalance.[8] As heart function declines, increased RAAS activity and non-osmotic vasopressin release further exacerbate fluid retention, contributing to both hyponatremia and worsening heart failure.[9]

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Our study also revealed significant associations between serum sodium levels and systolic blood pressure, serum urea, and serum creatinine. These findings reflect the interconnected nature of renal function and heart failure, where declining renal function, indicated by elevated creatinine and urea levels, exacerbates fluid and electrolyte imbalances.[10] This is consistent with prior studies showing that renal impairment in heart failure is closely related to the development of dysnatremia.[11]

The mean serum creatinine in our population was 2.86 ± 0.42 mg/dl, indicating a substantial degree of renal dysfunction, which is a known contributor to the high prevalence of dysnatremia in heart failure patients.[12] Similarly, the mean urea level was 9.84 ± 1.32 mmol/L, further supporting the role of impaired renal function in the pathophysiology of dysnatremia. This aligns with the findings of previous studies that have highlighted the contribution of renal dysfunction to electrolyte disturbances in heart failure patients.[13]

Additionally, the high prevalence of hypertension in our study population (mean systolic blood pressure of 155 ± 29.01 mmHg and mean diastolic pressure of 111.9 ± 11.73 mmHg) reflects the contribution of uncontrolled hypertension to the progression of cardiac failure and electrolyte disturbances. Hypertension is a major contributor to the worsening of cardiac function and is associated with both hyponatremia and hypernatremia.[14]

In terms of demographics, the majority of our participants fell within the 41-60 years age group, which is consistent with the typical age range of patients presenting with heart failure. The male predominance (male-to-female ratio of 1.6:1) seen in our study mirrors global trends in heart failure, where men are more commonly affected than women.[15] Furthermore, the high percentage of overweight (36%) and obese (16%) participants indicates a significant prevalence of obesity, which is a known risk factor for both heart failure and dysnatremia.[16]

CONCLUSION

In conclusion, our study underscores the high prevalence of dysnatremia, particularly hyponatremia, in patients with cardiac failure. The positive correlations observed between serum sodium levels and parameters like EF, systolic blood pressure, serum urea, and creatinine highlight the multifaceted pathophysiology underlying dysnatremia in heart failure. These findings reinforce the need for regular monitoring and management of electrolyte imbalances in this population to optimize patient outcomes[17].

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