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Dysnatremia in cardiac failure

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Abstract
Background: Heart failure is rapidly increasing problem worldwide. Despite recent advances, the development of symptomatic heart failure carries poor prognosis. The sodium concentration affects three dimensional structure of proteins and enzymesand thus play a critical role in maintaining electrical gradient across cellular membrane in muscular excitation. Small changes in sodium concentration may have deleterious effect on cardiac muscle function in patients with heart failure.
Aims: The aims of study were 1. To measure serum sodium level in patients with heart failure and to classify whether patient is having eunatremia or dysnatremia. 2. To correlate serum sodium level with left ventricular ejection fraction (LVEF), systolic blood pressure (SBP), blood urea and serum creatinine level.
Material and Methods: The study included 88 patients with heart failure of any cause admitted to SSG Hospital. And the study was cross sectional analytical.
Results: Out of 88 patients, 44 had eunatremia, 41 had hyponatremia and 3 had hypernatremia. The patients with eunatremia had higher LVEF and SBP than patients with dysnatremia. The patients with hyponatremia had higher S. creatinine level than patients with eunatremia or hyponatremia. The patients with hypernatremia had higher blood urea level than patients with eunatremia or hyponatremia.
Conclusion: Dysnatremia is a common occurrence in heart failure. The eunatremia is associated with higher LVEF, higher SBP, lower blood urea and lower S. creatine level. The hyponatremia is associated with lower LVEF, lower SBP, higher S. creatinine and higher blood urea level. The hypernatremia is associated with higher LVEF, lower SBP, higher blood urea and lower S. creatinine level.

Keywords: heart failure, dysnatremia, eunatremia, left ventricular ejection fraction

Introduction

The current American Heart Association guidelines define heart failure(HF) as a complex clinical syndrome that results from structural or functional impairment of ventricular filling or ejection of blood, which in turn leads to the cardinal clinical symptoms of dyspnea and fatigue and signs of HF, namely edema and rales. Because many patients present without signs or symptoms of volume overload, the term “heart failure” is preferred over the older term “congestive cardiac failure” [1].

Heart failure is a principle complication of virtually all forms of heart disease. It is important to recognise that heart failure is a clinical syndrome arising from diverse causes. Apart from poorly contracting ventricles and a low ejection fraction, many heart failure patients have uncorrected valvular heart disease or abnormal filling resulting in diastolic failure.

Heart failure is rapidly increasing problem worldwide, with more than 20 million people affected. The incidence is increasing, partly because of current therapies for cardiac disorders such as myocardial infarction (MI), valvular heart disease and arrhythmias, are allowing patients to survive longer and heart failure is disease of elderly. The most common causes are coronary artery disease (CAD) and hypertension. Rheumatic heart disease (RHD) is still a major cause of heart failure in Asia. Despite many recent advances in the evaluation and management of HF, the development of symptomatic heart failure still carries a poor prognosis. Community based studies indicate that 30-40 % of patients die within 1 year of symptomatic heart failure and 60-70 % die within 5 years mainly from worsening of heart failure.[1]

Sodium is the major extra cellular cation. Normal serum sodium level ranges from 135 to 145 mEq/L. The sodium concentration affects three dimensional conformation of proteins and enzymes and thus play critical role maintaining electrical gradient across cellular membrane and in muscular excitation [2]. Small changes in sodium concentration may have deleterious effect on cardiac muscle function in patients with heart failure. Several studies have indicated the relationship between admission serum sodium level and clinical outcome in patients with heart failure [3-18]. Both hyponatremia and hypernatremia indicate markedly compromised prognosis in heart failure compared with those having normal serum sodium level. It has been found that hyponatremia was independently associated with higher urea level, higher NYHA (New York Heart Association) class, lower systolic blood pressure and lower ejection fraction. Emergency admissions were also correlated with hypernatremia. Hyponatremia also predicts cardio renal syndrome which occurs in heart failure. Due to complex physiology of heart failure and effects of loop diuretics on serum sodium it can be difficult to accurately predict thus making frequent monitoring of serum sodium very important.

The present study was done to know prevalence of dysnatremia in heart failure and to find out correlation

between serum sodium level with other variables as mentioned in aims.

2. Aims of study

- To measure serum sodium level in heart failure patients to classify whether the patient is having eunatremia or dysnatremia (hyponatremia / hypernatremia).
- To correlate serum sodium level with LVEF as determined by two dimensional (2D) echocardiography in heart failure patients.
- To correlate serum sodium level with other variables such as systolic blood pressure, blood urea level, serum creatinine in heart failure patients.

3. Material and Methods

Data collected from patients fulfilling the inclusion and exclusion criteria attending either outpatient department or inpatient of S.S.G Hospital, Vadodara. Informed written consent was obtained from patient or a responsible attendant before including the patient in the study. In addition to Vadodara, a large section of population comes to SSGH from Central and North Gujarat as well as from the states of Rajasthan, Madhya Pradesh and Maharashtra.

Study design: Analytical cross sectional.

Sample size: The present study was conducted on 88 patients with heart failure out of which 44 patients had eunatremia and 44 patiens haddysnatremia.

Inclusion Criteria

1. Patients who have given informed written consent to participate in study.
2. The patients diagnosed with heart failure that are older than 12 years of age.

Exclusion Criteria

1. The patients with conditions causing hyponatremia like - Vomiting, diarrhea, salt-losing nephropathy, diabetic ketoacidosis, cirrhosis, nephrotic syndrome, syndrome of inappropriate antidiuretic hormone secretion, glucocorticoid deficiency.
2. The patients with conditions causing hypernatremia such as - Chronic kidney disease, diabetic insipidus, uncontrolled DM, insensible water loss from skin, diarrhea and excessive IV hypertonic saline.

All the patients were subjected to a detailed clinical history and examination using pretestproforma. Blood Urea, serum Creatinine and serum Sodium were estimated.Other relevant test like chest x- ray (PA view), electrocardiogram and echocardiography were also carried out. Various parameters of two groups were compared by using ANOVA test, Mann Whitney test and Logistic regression wherever applicable.

4. Results

In the present study, age distribution was between 13-90 years with majority cases were between age of 51 and 70 year. There were 56 males and 32 females. Out of 88 patients, 44 patients had eunatremia and 44 patients had dysnatremia. All patients belong to NYHA functional class 3 and 4. Patients with normal serum sodium level had high LVEF (42.63%) and SBP (126.31 mm Hg) than patients with hyponatremia (LVEF=38.63%, SBP=114.58 mm Hg) and hypernatremia (LVEF=42%, SBP=16.66mmHg). But on correlation statistically it was not significant (P>0.05). Patients with hypernatremia had lower S. creatinine (0.99 mg/dl) and higher B. urea (56.66 mg/dl) level than patients with normal S. sodium level (S. creatinine=1.14 mg/dl, B.urea=40.31 mg/dl) and hyponatremia (S. creatinine=1.15 mg/dl, b.urea=45.31 mg/dl).However, P value was more than 0.05 and there was no positive association.

Table 1: Comparison between serum sodium level and left ventricular ejection fraction.

Group of patient	Mean S. Sodium Level (SD)mEq/l	Mean Lvef %(SD)
Hyponatremia	131.24(+/- 3.24)	38.63(+/-3.24)
Eunatremia	138.31(+/-2.44)	42.63(+/-2.44)
Hypernatremia	146.66(+/-0.57)	42(+/-0.577)

Table 2: Relation of mean serum sodium level with serum creatinine, blood urea and systolic blood pressure(SBP).

Group of patient	Mean S. Sodium Level(SD)mEq/l	Mean S. creatinine (SD) mg/dl	Mean blood urea level mg/dl	Mean SBP(SD)mm Hg
Hyponatremia	131.24(+/-3.24)	1.15(+/-0.25)	45.31(+/-16.28)	114.58(+/-27.45)
Eunatremia	138.31(+/-2.44)	1.14(+/-0.39)	40.31(+/-15.42)	126.31(+/-32.01)
Hypernatrema	146.66(+/-0.57)	0.99(+/-0.11)	56.66(+/-13.65)	106.66(+/-15.27)

5. Discussion

Heart failure patients with hyponatremia seem to exhibit a pathophysiological profile that is different from heart failure patients without hyponatremia, as it reflects a greater activation of the renin-angiotensin aldosterone system, the arginine vasopressin system, and the sympathetic nervous system. Both hyponatremia and hypernatremia indicate a markedly compromised prognosis in heart failure regardless of LVEF.

The present study was done to determine the relation between serum sodium level and left ventricular ejection fraction determined by two dimensional echocardiography. The study included 88 patients, 44 had eunatremia and 44 haddysnatremia (hyponatremia or hypernatremia). Detail history, examinations and investigations were done for each patient.

In the present study age distribution was between 13 year to 90 year, with 77% of patients were between 41-80 years. Highest number of 38 patients were in age group of 41-60 years, followed by 30 patients in age group of 61-80 years. As major underlying disorder of HF e.g. IHD and hypertension are common in middle age and elderly.

Out of 88, 56 were males and 32 were females, because in

male gender non- modifiable risk factor for development of atherosclerosis and other modifiable risk factors e.g. cigarette smoking, alcohol intake are also common. All the patients with heart failure studied were NYHA class 3 (42 patients) and NYHA class 4 (46 patients). Out of 88, 44 patients with normal serum sodium level had mean serum sodium level of 138.31(+/- 2.44) mEq/l, 41 patients with hyponatremia had mean serum sodium level of 131.24(+/- 3.24) and 3 patients with hypernatremia had mean serum sodium level of 146.66(+/- 0.57). In patients with dysnatremia majority of patients had hyponatremia because patients with NYHA class 3 and 4 were included. Comparison between serum sodium level and left ventricular ejection fraction is as in table 1.

In comparison, mean LVEF was higher in patients with eunatremia than hypo- or hypernatremia (P=0.0783). However, in correlation it is statistically not significant. This indicates that prolong activation of renin angiotensin aldosterone system has detrimental effect in patients with HF.

We also studied relation of mean serum sodium level with serum creatinine, blood urea and systolic blood pressure (SBP), which is as in table 2.

In comparison, mean S. creatinine was higher in hyponatremia{1.15(+/-0.25)} patients compared to those with eunatremia{1.14(+/-0.39)} and hypernatremia patients{0.99(+/-0.11)} with HF (P=0.71).

Mean blood urea level was higher in hypernatremia patients {56.66(+/-13.65)} than hyponatremia {45.31(+/-16.28)} and eunatremia patients{40.31(+/-15.42)} with HF (P=0.11).

SBP was higher in eunatremia patients {126.31(+/-32.01)} than hyponatremia {114.58(+/-27.45)}and hypernatremia patients {106.66(+/-15.27)} with HF (P=0.143).

However, it is statistically not significant on ANOVA test.

Following are few studies which had comparable results.

In the previous study by Ganiger H *et al*. [4], the mean age of study population was 58.1 ± 13.6 years. In Deubner et al. study [19], median age was 73 years. Ganiger H *et al*. [4] study had 30 % prevalence of dysnatraemia; 24% had hyponatremia and 6% had hypernatremia. Deubner *et al*. [19] study had 17% prevalence of dysnatremia, 7.2% hyponatremia, and 9.8% hypernatremia. In the previous study patients with NYHA class 4 were enrolled, while in our study we enrolled NYHA class 3 and 4 patients. The studies which included patients with decompensated heart failure had a higher prevalence of hyponatremia. Outcomes of a Prospective Trial of Intravenous Milrinone for Exacerbations of Chronic Heart Failure (OPTIMECHF) trial [3] had 27% prevalence of hyponatremia. ESCAPE trial study [5] had 24% prevalence of hyponatremia. OPTIMIZE-HF registry had 26% prevalence of hyponatremia. Studies on prevalence of hypernatremia are not done, except for Deubner *et al*. [19]prevalence of hypernatremia in their study was more compared to our study; this is probably because in their study there were no exclusion criteria other than acute de novo heart failure. The increased prevalence of hypernatremia in their study was may be because of associated renal dysfunction.

In our study, mean LVEF was higher in patients with normal serum sodium level and hypernatremia than patients with hyponatremia. (P=0.0783){Table 1}

In previous study Ganiger H *et al*. [4] mean LVEF was higher in patients with hyponatremia than patients with normal serum sodium level and hypernatremia.

In our study, hyponatremia was associated with higher S. creatinine than patients with normal s. sodium level or hypernatremia (P=0.71) {table 2}. In Ganiger H *et al*. [4] hypernatremia was associated with higher S. creatinine.

In our study, b. urea was higher in patients with hypernatremia. In Ganiger H *et al*. [4] hypernatremia was associated with higher b.urea.

In a previous study by Deubner *et al*. [19] hyponatremia was associated with higher blood urea and serum creatinine levels with lower GFR.

In the previous study, Ganiger H *et al*. [4] hypernatremia was associated with lower SBP, in our study also hypernatremia was associated with lower SBP. {table 2.}

In the previous study of Balling *et al*. [21] hyponatremia was independently associated with lower SBP compared to patients with normal sodium values.

In our study also patients with hyponatremia had low SBP compared to patients having normal s.sodium level. {Table 2}

Table 3: Comparison of key parameters with other studies

Parameter	Group of patient	In our study	Ganiger H et al	Deubner et al
Mean LVEF %	Hyponatremia	38.63	47.25	38
	Eunatremia	42.63	39.82	40
	Hypernatremia	42	30.33	40
Mean S. creatinine (mg/dl)	Hyponatremia	1.15	1.01	1.3
	Eunatremia	1.14	1.08	1.1
	Hypernatremia	0.99	1.23	1.2
Mean B.Urea(mg/dl)	Hyponatremia	45.31	43.33	61
	Eunatremia	40.31	43.26	50
	Hypernatremia	56.66	45.67	65
Mean SBP(mm Hg)	Hyponatremia	114.58	129.2	113
	Eunatremia	126.31	129	130
	Hypernatremia	106.66	120	130

6. Conclusions

1. Out of 88 patients, 44 patients had eunatremia, 41patients had hyponatremia and 3patients had hypernatremia.
2. Heart failure patients with normal serum sodium level had higher mean LVEF on 2D-echo than patients with hyponatremia and hypernatremia. But on correlation it was not significant.
3. Mean serum creatinine was higher in patients with hyponatremia than patients with normal serum sodium level and hypernatremia, but there was no association.

4. Mean blood urea level was higher in patients with hypernatremia than patients with normal serum sodium level and hyponatremia, but there was no association.
5. Mean systolic blood pressure was higher in patients with normal serum sodium level than patients with hyponatremia and hypernatremia, but there was no association.

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