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Serum Sodium Concentration as a Predictor of Outcome in Acute Decompensated Heart Failure

[1]Dr. Vishwakiran Jhawar, M.D., General Medicine, Department of General Medicine, Government Medical College, Surat, Gujarat, India.

[2]Dr Mahesh G. Solu, Additional Professor, Department of General Medicine, Government Medical College, Surat, Gujarat, India.

[1]Dr. Sumer Sharad Ramawat, M.D. , General Medicine, Department of General Medicine, Government Medical College, Surat, Gujarat, India.

[3]Dr. Arpit Vasantbhai Patel, Senior Resident, Department of General Medicine, Government Medical College, Surat, Gujarat, India.

[4]Dr. Meet Kishorkumar Thakkar, 2nd year Resident, Department of General Medicine, Government Medical College, Surat, Gujarat, India.

[4]Dr. Roshani Bharatbhai Savaliya, 2nd year Resident, Department of General Medicine, Government Medical College, Surat, Gujarat, India.

[4]Dr. Zinal Rajeshkumar Dave, 2nd year Resident, Department of General Medicine, Government Medical College, Surat, Gujarat, India.

Corresponding Author: Dr. Vishwakiran Jhawar, M.D., General Medicine, Department of General Medicine, Government Medical College, Surat, Gujarat, India.

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Abstract:

Introduction: Heart failure is one of the leading cardiac disorders, and is considered as very critical clinical condition representing an important health care problem. Low levels of sodium in serum refers to sodium concentration of <135 m.eq./L and is one of the most common biochemical conditions seen in subjects with heart failure.

Materials and Methods: 146 indoor patients of heart failure (acute or chronic) that were admitted in new civil hospital, Surat, Gujarat and those who satisfied the inclusion and exclusion criteria were included in this study. History, systemic examination and blood sample

to measure sodium levels were collected at the time of hospital admission. Direct Ion Selective Electrode (Direct ISE) method was employed to measure sodium levels.

Results: Mean, standard deviation as well as level of significance were measured for different parameters under study as well as for each type of anti-hypertensive medications that were regularly taken by patients. A statistical significant difference was seen in the medication profile as well as laboratory results among hyponatremia and normonatremia patients, in particular, the use of diuretics.

Conclusion: Hyponatremia is one of the key factors, along with other factors like medications and systemic conditions, for determining the prognosis of heart failure patients. Further study on larger sample size is required for evaluating in detail, the effects of hyponatremia in heart failure patients.

Keywords: Heart failure, Hyponatremia, serum sodium level, antihypertensive drugs

Introduction

Heart failure (HF), regarded as one of the foremost cardiovascular disorder, remains a critical clinical condition notwithstanding any progression in medical care, representative of a significant health care problem and overall health expenditure.[1]

Low serum sodium level, also known as hyponatremia, is characteristically defined as a serum sodium concentration of <135 m.eq./L and is one of the most common biochemical disorders featured in heart failure patients, with a prevalence close to 25%.[2-4] HF affects cardiac output by either decreasing heart rate or reducing the stroke volume. The reduction of cardiac output subsequently causes arterial under–filling, which triggers the renin angiotensin aldosterone system (RAAS). Angiotensin II, the final product of the RAAS, activates aldosterone from the adrenal cortex, which results in the reabsorption of water and salt into the blood. The expansion of extracellular fluid ultimately results in hyponatremia.[5-7]

Several observational studies and clinical trials have been conducted to assess the prognostic impact of serum sodium levels at -admission and during hospitalization of HF patients. The current study was conducted with the aim of assessing the prevalence of hyponatremia in patients hospitalized with a diagnosis of heart failure and comparing baseline clinical characteristics of heart failure patients based on sodium level. Further survival progress between patients with hyponatremia and normonatremia was assessed and clinical prognostic markers of overall mortality in heart failure patients were monitored.

Materials and Methods

This study was conducted in 146 indoor patients of heart failure (acute or chronic) that were admitted in new civil hospital, Surat, Gujarat.

Inclusion criteria

Individuals diagnosed as heart failure patients (irrespective of aetiology), who were willing to participate in the study and give consent, having age more than 18 years were included in the study.

Exclusion criteria

Patients with conditions causing hyponatremia like vomiting, diarrhoea, diabetic ketoacidosis, cirrhosis, nephritic syndrome, salt losing nephropathy, Syndrome of inappropriate antidiuretic hormone secretion (SIADH), glucocorticoid deficiency were excluded from the study. Also, patients with conditions causing hypernatremia such as chronic kidney disease and diabetes insipidus were excluded from the study.

Moreover, patients taking leave against medical advice or discharge against medical advice were not included in this study.

Detailed history of the patient was taken and complete systemic examination was performed followed by blood sample collection to measure sodium levels at the time of admission. Direct Ion Selective Electrode (Direct ISE) method was employed to measure sodium levels.

A pretested semi structured questionnaire was used for data collection. Follow up of the patient was done till the discharge of the patient and the response outcome was noted as improvement or deterioration of the patient condition as well as outcome was measured in terms of discharge / death of the patient at the end of the hospital stay.

Data collected was entered in to Statistical Package for the Social Sciences (SPSS) software and Microsoft excel for carrying out statistical analysis.

Results

Out of 146 patients included in this study, 65 were males and 81 were females. The mean, standard deviation and the maximum minimum values were calculated for age, heart rate, systolic and diastolic blood pressure and are enumerated in Table 1.

	Age	Heart Rate (HR)	Diastolic blood pressure (DBP)	Systolic blood pressure (SBP)
Mean	58.68	107.26	79.78	125.96
Std.deviation	18.46	26.05	10.96	23.38
Minimum	40.22	80.51	68.82	102.58
Maximum	77.14	133.61	90.74	149.34

Table 1: Mean standard deviation and range (minimum-maximum) for patient's age, heart rate and diastolic – systolic blood pressure findings.

Out of 146 subjects, a little more than 50% (74 patients = 50.7%) had dyspnea at rest, whereas 66 patients (45.2%) had complaint of chronic fatigue.

Parameter	Frequency	
	YES (%)	NO (%)
Hypertension (HTN)	81 (55.5%)	65 (43.5%)
Diabetes Mellitus (DM)	72 (49.3%)	74 (50.7%)
Dyslipidemia	82 (56.2%)	64 (43.8%)
History of Smoking	47 (32.2%)	99 (67.8%)
Atrial Fibrillation (AF)	26 (17.8%)	120 (82.2%)

Table 2: The frequency distribution of patients as per the presence of hypertension, diabetes, dyslipidemia, history of smoking and atrial fibrillation.

Parameter	Frequency	
	YES (%)	NO (%)
Ischemic heart disease (IHD)	58 (39.7%)	88 (60.3%)
Valvular heart diease (VHD)	31 (21.2%)	115 (78.8%)
Dilated cardiomyopathy (DCM)	67 (45.9%)	79 (54.1%)
Prior hospitalization	78 (53.4%)	68 (46.6%)
Presence of oedema	115 (78.8%)	31 (21.2%)
Lung congestion	115 (78.8%)	31 (21.2%)
Pleural effusion	24 (16.4%)	122 (83.6%)

Table 3: The frequency distribution of patients as per the presence of ischemic heart disease, valvular heart disease, dilated cardiomyopathy, prior hospitalization, presence of edema, lung congestion and pleural effusion.

Medications (drugs)	Frequency	
	YES (%)	NO (%)
Angiotensin Converting Enzyme (ACE) inhibitors	69 (47.3%)	77 (52.7%)
Angiotensin II Receptor Blockers (ARB)	75 (51.4%)	71 (48.6%)
Beta blockers	83 (43.2%)	63 (56.8%)
Diuretics	84 (57.5%)	62 (42.5%)
Calcium Channel Blockers	65 (44.5%)	81 (55.5%)

(CCB)		
Statin	115 (78.8%)	31 (21.2%)

Table 4: The frequency distribution of patients as per the history of taking different medication (drugs).

The overall outcome of 146 cases under study revealed a discharge percentage of 72.6% (106 patients) as against the mortality percentage of 27.4% (40 patients).

	Frequency	
	Discharge (%)	Expired (%)
Outcome	106 (72.6%)	40 (27.4%)

Table 5: The frequency distribution of outcomes noticed in patients.

Discussion

Hyponatremia is a typical finding in heart failure patients. A strong association is established between the mortality of HF patients and low serum sodium status at admission.[8-10] This association is attributed to cardiorenal insufficiency and the related decrease in water elimination but there is no current evidence on the prognostic impact of changes in serum sodium concentrations on patients' overall prognosis.

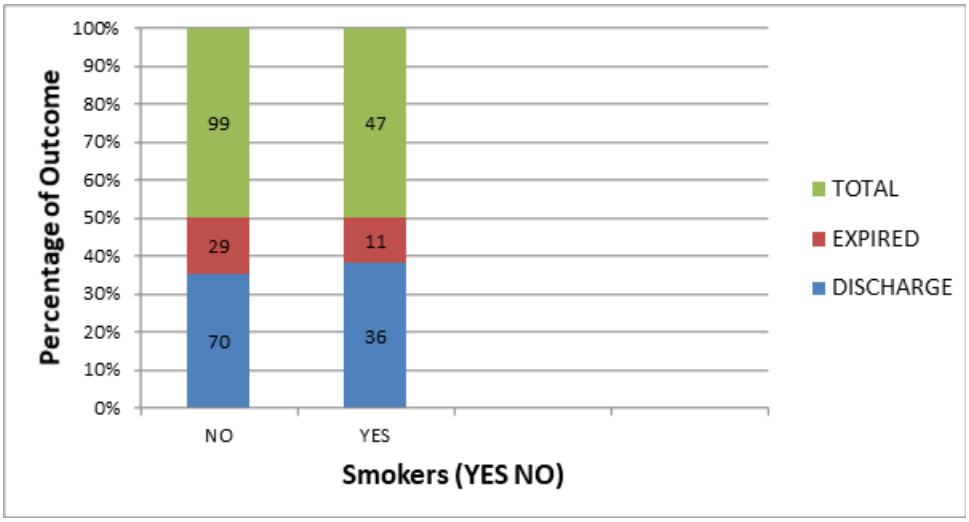
Several observational studies reported similar findings, suggesting hyponatremia as a marker of a more severe clinical condition, but not a target for treatment or intervention.[11-12] The clinical significance of hyponatremia acquired during hospitalization was highlighted by Goldsmith, as a predictive factor for increased mortality and readmission in patients with HF.[13]

In the current study, a significant difference was seen in the medication profile and laboratory results among hyponatremia and normonatremia patients, in particular, the use of diuretics. Similar findings were reported by Dai-Yin Lu et al. and J.C Arevalo Lorido et al[14], where most of the patients with hyponatremia were found to be treated with diuretics.

Valvular heart disease was an important etiology which was more pronounced in patients with normonatremia. The etiological significance of VHD for the development of heart failure is further supported by the Valirie N. Agbor et al. study (a meta-analysis and systematic review of heart failure etiologies in sub-Saharan Africa) where VHD (14.1%) was the leading cause of HF.[15] Tefera et al. further showed the valvular implication of VHD with findings of mitral regurgitation and mitral stenosis as the most common valvular involvement in Ethiopian HF cohorts.[16]

The pathogenesis of hyponatremia in HF is considered to be multidimensional and correlated to disease severity. In most HF patients' cases, hypervolemic-hyponatremia is the common denominator or nexus. The interlinking of increased secretion of arginine vasopressin (AVP) - enhanced activity of the sympathetic nervous system and the renin-angiotensin system plays a paramount factor in the development of hyponatremia.[17-18]

In our study, independent prognostic markers of all-cause mortality among study participants were hyponatremia ($p = 0.001$), advanced age ($p = 0.003$), and prescription of medications like, ACEI ($p = 0.015$), arb ($p = 0.344$), diuretics ($p = 0.009$), ccb ($p = 0.943$), beta blocker ($p = 0.637$). These findings were on par with studies conducted in Ethiopia,[19] Poland,[20] Spain,[21-22], UK,[23] and the US[24] that showed an unfavorable prognosis in HF cohorts, who were at advanced ages and had lower levels of sodium.



Graph 1: Graph shows outcome percentage in patients who were smokers (YES) and non-smokers (NO). The correlation obtained was found to be non-significant with p-value = 0.456

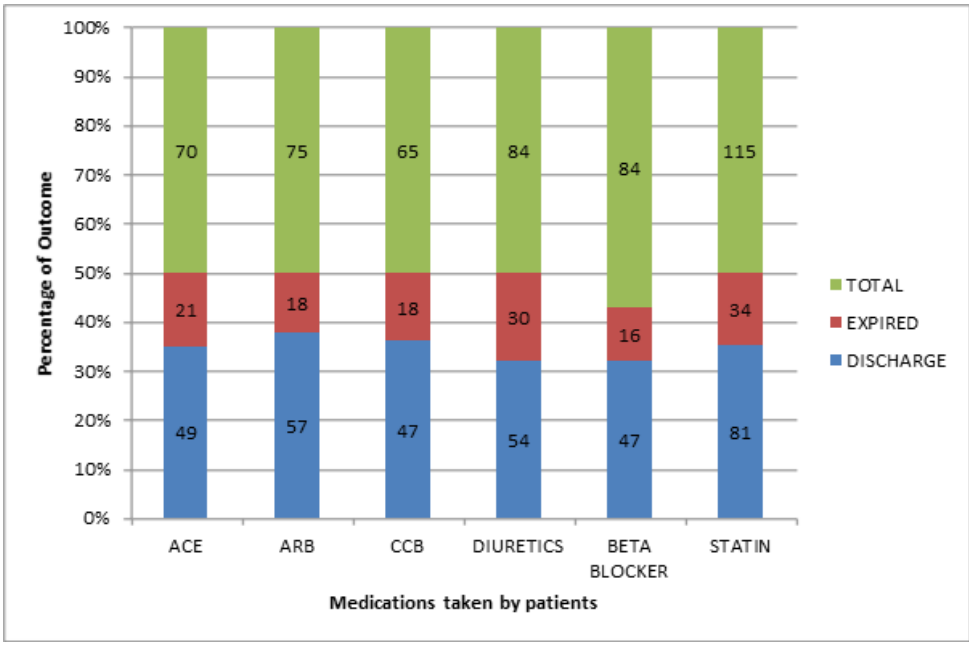
Parameter		Outcome		Total	p value
		Discharge	Expired		
Sodium	<135 (Low)	58	38	96	<0.005
	>135 (Normal)	48	2	50	
Sex	Female	53	28	81	0.03
	Male	53	12	65	
Dyspnea	Female	49	25	74	0.079
	Male	57	15	72	
Fatigue	Female	59	21	80	0.732

Table 6: Independent analysis of outcome in patients under different conditions

Parameter		Outcome		Total	P value
		Discharge	Expired		
Hypertension	NO	49	16	65	0.682
	YES	57	24	81	
Diabetes Mellitus	NO	57	17	74	0.224
	YES	49	23	72	
Dyslipidemia	NO	47	17	64	0.842
	YES	59	23	82	
Atrial Fibrillation	NO	88	32	120	0.671
	YES	18	8	26	
Ischemic Heart Disease	NO	62	26	88	0.473
	YES	44	14	58	

Valvular Heart Disease	NO	82	33	115	0.498
	YES	24	7	31	
Dilated Cardiomyopathy	NO	57	22	79	0.894
	YES	49	18	67	
Pleural Effusion	NO	89	33	122	0.832
	YES	17	7	24	
Lung Congestion	NO	23	8	31	0.832
	YES	83	32	115	
Prior Hospitalization	NO	51	17	68	0.544
	YES	55	23	78	
Presence of pedal edema	NO	21	10	31	0.494

Table 7: Independent analysis of outcome in patients with different systemic conditions.



Graph 2: Independent analysis of outcome in patients taking different medications.

Conclusion

In conclusion, hyponatremia is one of the crucial factors in the clinical prognosis of heart failure patients. However, as other prognostic factors (i.e., medication, age etc) also played vital roles in overall survival, well-controlled clinical trials (complete with medication dosing, laboratory outputs and long-term prospective follow up) are required to further study the impact of hyponatremia in HF patient's prognosis.

References

1. Bui AL, Horwich TB, Fonarow GC. Epidemiology and risk profile of heart failure. Nature Reviews Cardiology.2011;8(1):30–41. 10.1038/nrcardio.2010.165

2. Mohan S, Gu S, Parikh A, Radhakrishnan J. Prevalence of hyponatremia and association with

mortality: results from NHANES. The American journal of medicine. 2013;126(12):1127–37.e1.

3. Rossi J, Bayram M, Udelson JE, Lloyd-Jones D, Adams KF, Oconnor CM, et al. Improvement in hyponatremia during hospitalization for worsening heart failure is associated with improved outcomes: insights from the Acute and Chronic Therapeutic Impact of a Vasopressin Antagonist in Chronic Heart Failure (ACTIV in CHF) trial. Acute cardiac care. 2007;9(2):82–6.

4. Gheorghiade M, Abraham WT, Albert NM, Gattis Stough W, Greenberg BH, O'Connor CM, et al. Relationship between admission serum sodium concentration and clinical outcomes in patients hospitalized for heart failure: an analysis from the OPTIMIZE-HF registry. European heart journal. 2007;28(8):980–8.

5. Oren RM. Hyponatremia in congestive heart failure. The American journal of cardiology. 2005;95(9):2–7.

6. Sica DA. Hyponatremia and heart failure—pathophysiology and implications. Congestive Heart Failure. 2005;11(5):274–7.

7. Bettari L, Fiuzat M, Felker GM, O'Connor CM. Significance of hyponatremia in heart failure. Heart failure reviews. 2012;17(1):17–26. 10.1007/s10741-010-9193-3.

8. Lee DS, Austin PC, Rouleau JL, Liu PP, Naimark D, Tu JV. Predicting mortality among patients hospitalized for heart failure: derivation and validation of a clinical model. Jama. 2003;290(19):2581–7. Epub 2003/11/20. 10.1001/jama.290.19.2581.

9. Rusinaru D, Tribouilloy C, Berry C, Richards AM, Whalley GA, Earle N, et al. Relationship of serum sodium concentration to mortality in a wide spectrum of heart failure patients with preserved and with reduced ejection fraction: an individual patient data meta-analysis(dagger): Meta-Analysis Global Group in Chronic heart failure (MAGGIC). European journal of heart failure. 2012;14(10):1139–46.

10. Klein L, O'Connor CM, Leimberger JD, Gattis-Stough W, Pina IL, Felker GM, et al. Lower serum sodium is associated with increased short-term mortality in hospitalized patients with worsening heart failure: results from the Outcomes of a Prospective Trial of Intravenous Milrinone for Exacerbations of Chronic Heart Failure (OPTIME-CHF) study. Circulation. 2005;111(19):2454–60.

11. Lee SE, Choi DJ, Yoon CH, Oh IY, Jeon ES, Kim JJ, et al. Improvement of hyponatraemia during hospitalisation for acute heart failure is not associated with improvement of prognosis: an analysis from the Korean Heart Failure (KorHF) registry. Heart (British Cardiac Society). 2012;98(24):1798–804.

12. Madan VD, Novak E, Rich MW. Impact of change in serum sodium concentration on mortality in patients hospitalized with heart failure and hyponatremia. Circulation Heart failure. 2011;4(5):637–43.

13. Goldsmith SR. Hyponatremia in Heart Failure: Time for a Trial. Journal of cardiac failure. 19(6):398–400.

14. Lu DY, Cheng HM, Cheng YL, Hsu PF, Huang WM, Guo CY, et al. Hyponatremia and Worsening Sodium Levels Are Associated With Long-Term Outcome in Patients Hospitalized for Acute Heart Failure. Journal of the American Heart Association. 2016;5(3):e002668

15. Agbor VN, Essouma M, Ntusi NAB, Nyaga UF, Bigna JJ, Noubiap JJ. Heart failure in sub-Saharan

Africa: A contemporaneous systematic review and meta-analysis. International journal of cardiology. 2018;257:207–15.

16. Tefera YG, Abegaz TM, Abebe TB, Mekuria AB. The changing trend of cardiovascular disease and its clinical characteristics in Ethiopia: hospital-based observational study. Vascular health and risk management. 2017;13:143

17. Lilly LS, Dzau VJ, Williams GH, Rydstedt L, Hollenberg NK. Hyponatremia in congestive heart failure: implications for neurohumoral activation and responses to orthostasis. The Journal of clinical endocrinology and metabolism. 1984;59(5):924–30.

18. Packer M, Lee WH, Kessler PD, Gottlieb SS, Bernstein JL, Kukin ML. Role of neurohormonal mechanisms in determining survival in patients with severe chronic heart failure. Circulation. 1987;75(5 Pt 2):Iv80–92.

19. Abebe TB, Gebreyohannes EA, Tefera YG, Abegaz TM. Patients with HFpEF and HFrEF have different clinical characteristics but similar prognosis: a retrospective cohort study. BMC cardiovascular disorders. 2016;16(1):232

20. Tyminska A, Kaplon-Cieslicka A, Ozieranski K, Peller M, Balsam P, Marchel M, et al. Anemia at Hospital Admission and Its Relation to Outcomes in Patients With Heart Failure (from the Polish Cohort of 2 European Society of Cardiology Heart Failure Registries). The American journal of cardiology. 2017.

21. Macin SM, Perna ER, Cimbaro Canella JP, Alvarenga P, Pantich R, Rios N, et al. [Differences in clinical profile and outcome in patients with decompensated heart failure and systolic dysfunction or preserved systolic function]. Revista espanola de cardiologia. 2004;57(1):45–52. Epub 2004/01/30.

22. Ojeda S, Anguita M, Munoz JF, Rodriguez MT, Mesa D, Franco M, et al. [Clinical characteristics and medium-term prognosis of patients with heart failure and preserved systolic function. Do they differ in systolic dysfunction?]. Revista espanola de cardiologia. 2003;56(11):1050–6. Epub 2003/11/19.

23. Kearney MT, Fox KA, Lee AJ, Brooksby WP, Shah AM, Flapan A, et al. Predicting sudden death in patients with mild to moderate chronic heart failure. Heart (British Cardiac Society). 2004;90(10):1137–43.

24. Owan TE, Hodge DO, Herges RM, Jacobsen SJ, Roger VL, Redfield MM. Trends in prevalence and outcome of heart failure with preserved ejection fraction. The New England journal of medicine. 2006;355(3):251–9.