Hyponatremia in Patients with Congestive Heart Failure

MARWAN MOHAMMED FAISAL RAAD

SIXTH GRADE STUDENT

SUPERVISED BY:

Dr. ZAID MOHAMMED SAEED WAHEED

Lecturer of Internal Medicine
Department of Internal Medicine
Al-Nahrain College of Medicine

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MARWAN MOHAMMED FAISAL

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Dedication

To my dear professors……..

To my dear family……..

To my dear patients… … …

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List of Abbreviations

HF	**Heart failure**
EF	**Ejection fraction**
NYHA	**New York Heart Association**
AVP	**arginine vasopressin**
RAAS	**renin-angiotensin-aldosterone system**
TSH	**Thyroid stimulating hormone**
NA	**Sodium**
SIADH	**syndrome of inappropriate antidiuretic hormone**

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Abstract

Background: Hyponatremia is a common electrolyte abnormality in patients with heart failure (HF). It is independently associated with increased short-term and long-term morbidity and mortality.

Aim of the study: To assess the frequency of hyponatremia in patients with congestive heart failure.

Patients and methods : This is a hospital based cross sectional study to patients with HF admitted to Al - Imamain Al-Kadhimain Medical City in Baghdad ; conducted over the period of five months from 1st October 2018 till 1st of March 2019 . Both male and female patients admitted with heart failure fulfilling the inclusion criteria, were included in the study. Patients were subjected to detailed history and clinical examination. Admission Serum sodium was measured in all patients. A preformed Questionnaire was used to get information from studied population.

Results: Of 30 patients admitted with HF, 7 patients (23%) had hyponatremia, which is defined as serum sodium level <135 mmol/L. of those patients with hyponatremia there were 4 male patients (57%) and 3 female patients (43%), 3 patients with EF 40 - 50 % and NYHA classification I-II, 4 patients with EF below 40 % and NYHA classification III-IV .

Conclusion: Hyponatremia is fairly common in patients hospitalized with heart failure and its prevalence increases with the severity of heart failure.

Introduction

Hyponatremia is the most common electrolyte disorder and is frequently encountered in patients with advanced heart failure. [1, 2]

Sodium balance is the result of sodium intake, extra-renal sodium loss, and renal sodium excretion. Renal sodium excretion is the primary determinant of sodium homeostasis. [3]

Hyponatremia can be caused by either an excessive loss of sodium, known as depletional hyponatremia, or excessive retention of water, called dilutional hyponatremia. [4, 5]

Depletional hyponatremia is caused by certain disorders or drugs (like diuretics) that produce a decrease in extracellular fluid, leading to an excessive loss of renal salts. [6]

Dilutional hyponatremia has two primary classifications: normal extracellular volume (euvolemic) or elevated extracellular volume (hypervolemic). Euvolemic hyponatremia is defined by a low serum osmolarity and a low urine osmolarity. It is most commonly a syndrome of inappropriate antidiuretic hormone (SIADH) and is associated with elevated arginine vasopressin (AVP) release. Hypervolemic hyponatremia is generally the result of fluid overload associated with raised AVP secretion, examples include: advanced liver cirrhosis, renal disease, or congestive heart failure. In these instances, total body sodium is elevated but total body water is increased disproportionately, causing hyponatremia and edema. [6]

In case of heart failure, low cardiac output and blood pressure trigger a compensatory response by the body that activates several neurohormonal systems designed to preserve arterial blood volume and pressure. These neurohormonal systems changes include increased activity of arginine vasopressin (AVP) and activation of the renin-angiotensin-aldosterone (RAAS) system. [7]

The AVP receptors V2 on the collecting tubules, when stimulated, activate the adenylate cyclase and cyclic AMP, increasing the number of aquaporin-2 water channels in the apical membrane of the collective tubules, leading to increased water reabsorption responsible for hyponatremia .[8]

RAAS plays a crucial role in the progression of heart failure. The RAAS is stimulated by a decrease in renal blood flow and by low blood salt concentration. [8]

RAAS is also stimulated by the increase in sympathetic tone that results from the decrease in arterial baroceptor stretch in heart failure. [8]

Increase in aldosterone concentration causes water and sodium reabsorption at the level of the collecting duct which further exacerbates hyponatremia. [8]

Another factor that may contribute to the development of hyponatremia in CHF is insufficient tubular flow through diluting segments of the distal nephron which impairs the urine diluting ability of the kidney (free water excretion), and subsequent hyponatremia. [6]

Hyponatremia may also evolve from the renal effects of HF therapies. Diuretic-induced hyponatremia is common among patients with HF, with the elderly being at particular risk. [9] Although thiazide diuretics are most often

implicated in this process, loop and collecting duct agents such as furosemide and spironolactone have been also linked with the development of hyponatremia. (9)

The combination of very low dietary sodium intake in HF and exaggerated losses due to diuretic therapy might lead to progressive depletion of whole-body sodium. (9)

	Mechanism of Action
Dilutional hyponatremia	
Increased sensitivity of osmotic AVP release → Lower osmo-checkpoint*	Baroreceptor activation/angiotensin II
Increased nonosmotic AVP release	Baroreceptor activation/angiotensin II
Impaired AVP degradation	Liver and/or kidney dysfunction
Increased thirst	Baroreceptor activation/angiotensin II
Decreased distal nephron flow	Impaired glomerular filtration/Increased proximal tubular reabsorption
Depletional hyponatremia	
Low sodium intake	Salt-restricted diet
Exaggerated nonurinary sodium losses	Diarrhea, ascites
Exaggerated natriuresis	Diuretics, osmotic diuresis
Sodium shift toward the intracellular compartment	Potassium and/or magnesium deficiency

Table (1) summarizes the mechanisms of hyponatremia in CHF. (6)

Hyponatremia has been identified as a risk factor for increased morbidity and mortality in patients with congestive heart failure (CHF) and other edematous disorders and can lead to severe neurologic derangements as a result of brain edema. (7)

The aim of the study:

To assess the frequency of hyponatremia in patients with congestive heart failure.

Patients and Methods

1) Study setting and design: A hospital based cross sectional study was conducted over the period of five months from 1st October 2018 till 1st of March 2019. We conducted the study in the internal medicine ward in Al - Imamain Al-Kadhimain Medical City in Baghdad.

2) Selection of the study sample:

The serum sodium level was measured from 50 patients with congestive heart failure in the internal medicine ward in Al-Imamain Al-Kadhimain Medical City in Baghdad from both sexes.

Inclusion criteria: all patients with ejection fraction < 50%

Exclusion criteria: patients with following medical conditions:

Renal insufficiency, liver cirrhosis, chronic vomiting, diarrhea patients, adrenal insufficiency, hypothyroidism.

3) Baseline Assessment:

The patients had full history and clinical examination and were diagnosed to have heart failure based on echocardiography.

Complete blood count, basic biochemical investigations including serum electrolytes, blood urea and serum creatinine, liver function test and TSH were assessed in all patients.

Laboratory analyses performed at Laboratory Department of Al-Imamain Al-Kadhimain Medical City

4) Data collection:

A preformed Questionnaire was used to get information from studied population, which included general information from the patients and duration of heart failure.

A venous blood sample of 2 ml obtained without tourniquet (plain tube) and serum sodium was measured with an auto-analyzer. Normal range of serum sodium in both sexes is 135 - 150 mmol/L

5) Statistical analysis:

The collected data was organized, and statistically analyzed using Microsoft excel worksheet 2016 and the results were expressed as percentages.

Results

Over 30 case included by this study there is 7 cases with hyponatremia i.e. the frequency of hyponatremia in heart failure in this study was 23 %.

As shown by the following figure:

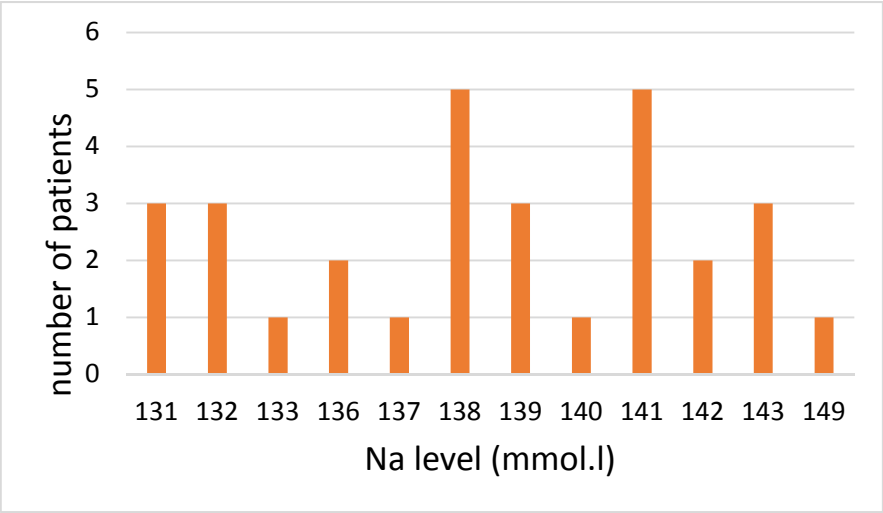

Figure 1: sodium level distribution in patients with heart failure

Age: among the hyponatremic patients our results show that hyponatremia increases in the older age groups

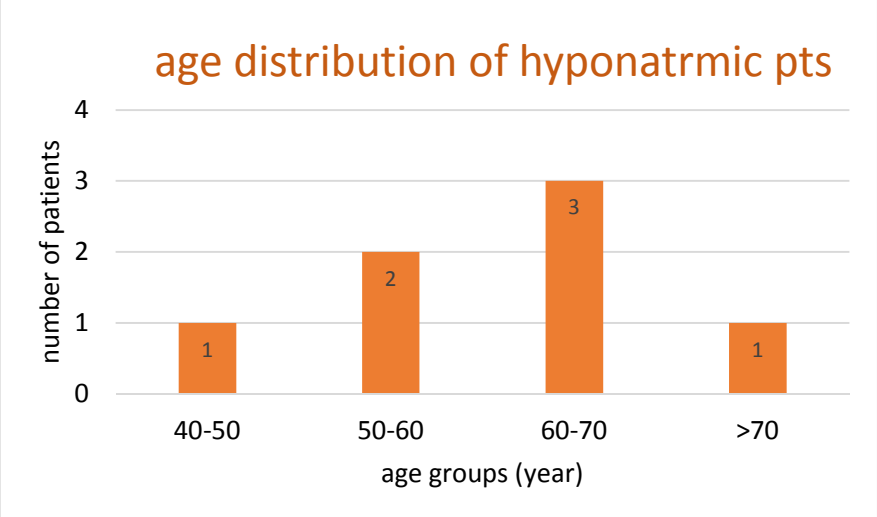

Figure 2: age distribution in hyponatremic patients

Gender: Our results show that the frequency of hyponatremia is almost equal in male and female patients. (4 male patients and 3 female patients)

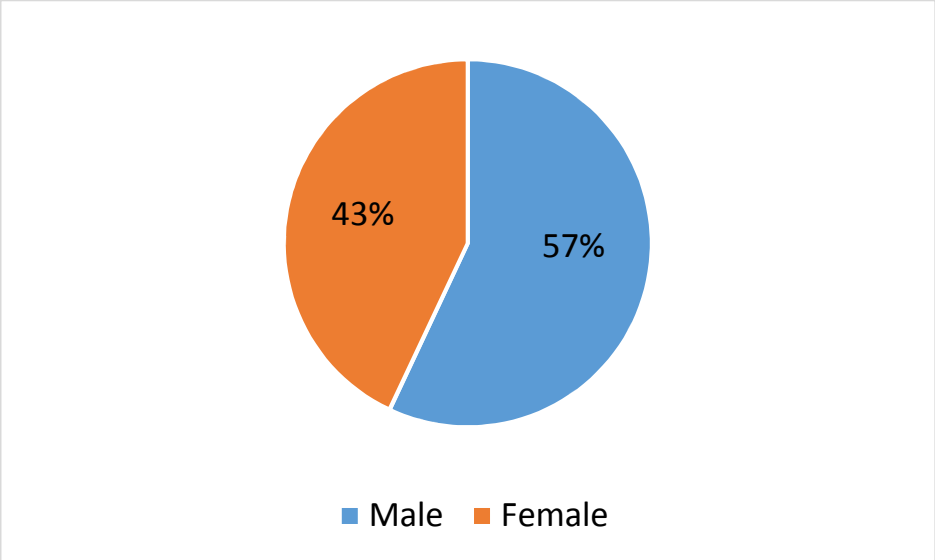

Figure 3: gender distribution in hyponatremic patients

Ejection fraction: in heart failure patients with hyponatremia 3 patients (43%) had ejection fraction 40-50% and 4 patients (57%) had ejection fraction 30-40%.

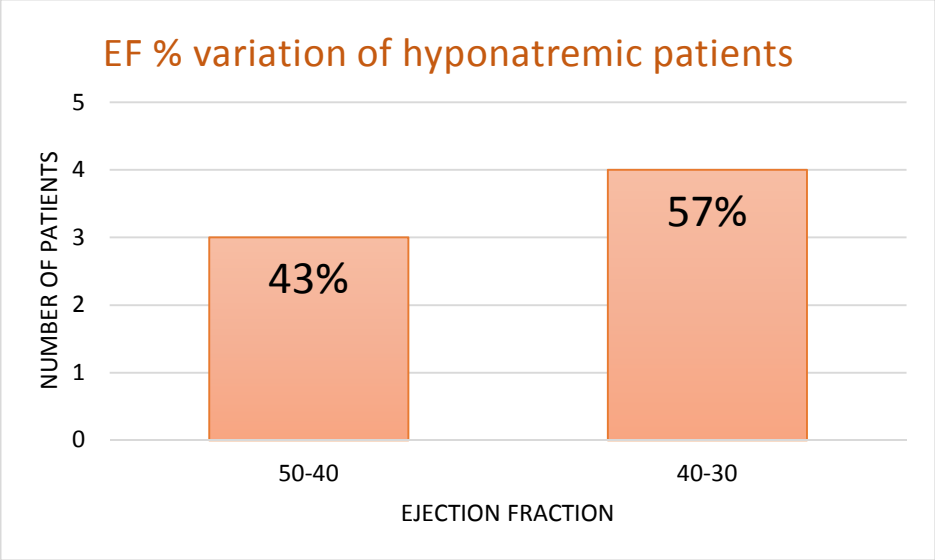

Figure 4: ejection fraction in heart failure patients with hyponatremia

NYHA classification: in heart failure patients with hyponatremia 3 patients (43%) had NYHA class I-II and 4 patients (57%) had NYHA class III-IV.

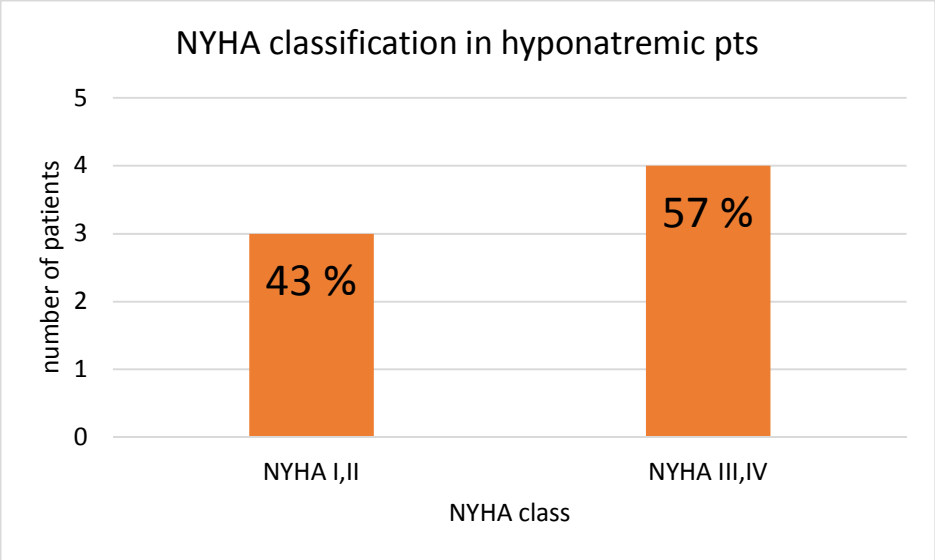

Figure (5): NYHA classification in heart failure patients with hyponatremia.

Discussion

The findings of this study demonstrated that hyponatremia was present in 23% of patients hospitalized with HF.

The prevalence of hyponatremia in patients hospitalized with HF in this study is in the range reported in most of other studies like: 27% in Outcomes of a Prospective Trial of Intravenous Milrinone for exacerbations of Chronic Heart Failure (OPTIME-CHF) [10] and 23.8% in the Evaluation Study of Congestive Heart Failure and Pulmonary Artery Catheter Effectiveness (ESCAPE). [11]

However, it is higher than findings from Organized Program to Initiate Lifesaving Treatment in Hospitalized Patients with Heart Failure (OPTIMIZE-HF) [12] with 19.7%, the Korean heart failure Registry (KorHF) with 19.1%, [13] and Japanese ATTEND registry with 11.6%.[14]

The reason for a higher frequency of hyponatremia in this study could be due to most of hospitalized patients enrolled in our study were in NYHA class IV heart failure and peripheral edema was quite frequent.

The age and gender distribution of hyponatremic patients showing that prevalence of hyponatremia increases with age and it was distributed almost equally among male and female patients. This was similar to age and gender distribution obtained by Khalid Ali and his coworkers [15] and also by other studies like study done by Farooq Ahmed and his coworkers. [16]

With regard to relation between sodium level and severity of heart failure we found that hyponatremia was more prevalent in patients with more severe heart failure as indicated by lower ejection fraction and higher NYHA class.

This is expected result due to the higher neurohormonal activation in more severe heart failure, and also more aggressive diuretic therapy in this group of patients.

This was similar to results obtained by Ahmed et al [16] who found that 71% of hyponatremic patients were in NYHA class IV, and results obtained by Juan et al [17] found that most of the hyponatremic patients were in class III-IV.

Limitations of study:

- Small sample size restricted to one hospital
- Serum sodium was assessed only by single reading during hospital stay, and this level could get lower with more prolonged hospital stay with more aggressive diuretic therapy.

Conclusion

Hyponatremia is fairly common in patients hospitalized with congestive heart failure and its prevalence increases with the severity of heart failure.

Recommendations

- To check serum sodium level in all patients hospitalized with heart failure as hyponatremia has a significant prognostic importance and also to correct it when present.
- To monitor serum sodium level during hospital stay as it may develop later on during hospital stay.

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