

ELECTROLYTE DISORDERS AND RENAL DYSFUNCTION IN PATIENTS WITH CHRONIC HEART FAILURE

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Contribution

All the authors contributed significantly to the research that resulted in the submitted manuscript.

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ABSTRACT

Objectives:The objective of this study is to determine the frequency of electrolyte disorders and renal dysfunction in patients with chronic heart failure.

Methodology:This was a prospective cross-sectional study. Patients admitted to cardiology department Lady Reading Hospital, Peshawar with acute decompensation of chronic heart failure from September 2010 to October 2011 were included in the study. Blood samples were collected for serum electrolytes and creatinine and results were recorded on a pre-specified proforma. Data was stored and analyzed via SPSS version 16.

Results:Total of 227 patients were included in the study. Mean age was 58.48 ± 12.5 years (range 16-90). Male were 130 (57.3%). Of these 27.3% (62) were ≤ 50 year, while 72.7% (165) were >50 years old. Patients having renal dysfunction (Serum Creatinine >1.5 mg/dl) were 37.4% (85). Renal dysfunction was more common in elderly (40% vs 30.6%, p value=0.220)

Hyponatremia (S. Na+ <135 mmol/dl) was noted in 32.1% patients. Hypokalemia (S. K+ <3.6 mmol/dl) was noted in 18.1% patients and hyperkalemia (S. K+ >5.5 mmol/dl) was noted in 16.7% patients. In addition hyperkalemia was more common in patients with renal dysfunction (24.7% vs 12% P value= 0.017), while hypokalemia was less frequent in patients with renal dysfunction (14.1% vs 20.4% p value= 0.286).

Conclusion:Electrolyte disorders and renal dysfunction are frequent in patients with chronic heart failure. Electrolyte disturbances are more frequent in patients with underlying renal dysfunction.

Key Words:Electrolyte Disorders, Renal Dysfunction, Chronic Heart Failure

INTRODUCTION

Heart failure (HF) is a complex syndrome, resulting from structural or functional cardiac disorders that impair the ability of the cardiac pump to support a physiological circulation.¹ Congestive heart failure affects about 2% of the western population, with prevalence increasing sharply from 1% in 40 years old to 10% above age 75 and it is the most common cause of hospitalization in patients over 65 years of age.²

Renal dysfunction is extremely common in patients with CHF and it is strongly related not only to increased mortality and morbidity but to a significant decrease in exercise tolerance, as well.³ Electrolyte disorders i.e hypokalemia, hyperkalemia and hyponatremia are common among patients with congestive heart failure (CHF) and may be caused by the disease itself or its treatment.⁴ All patients with evidence of volume overload or a history of fluid retention should be treated with diuretics.⁵ The minimum required dose should be used because over-diuresis exacerbates the activation of the Renin Angiotensin System and may result in electrolyte abnormalities.^{6,7} Hypokalemia makes ventricular myocardium more susceptible to potentially lethal arrhythmias. In the absence of formal guidelines with respect to the level of maintenance of serum K⁺ levels in heart failure patients, many experienced heart failure clinicians advocate that the serum K⁺ level should be maintained between 4.0 and 5.0 mEq/liter because heart failure patients are often treated with pharmacological agents likely to provoke proarrhythmic effects in the presence of hypokalemia (e.g., digoxin, type III antiarrhythmics, beta agonists, phosphodiesterase inhibitors).⁵ A study conducted recently has shown that 22% patients with congestive heart failure develop hypokalemia.⁸ Hyponatremia in patients with CHF signifies poor prognosis.⁹ Hyponatremia in CHF is associated with significantly higher rates of in-hospital and follow-up mortality and longer hospital stays.¹⁰ An incremental increase in the risk of in-hospital death, follow up mortality and rehospitalization was reported in one study for each 3 mmol/L decrease in admission serum sodium below 140 mmol/L.¹⁰ It has been shown that 24% patients with CHF develop hyponatremia.¹¹

Electrolyte disorders including hypokalemia and hyponatremia are frequently overlooked in heart failure patients. The objective of this study was to determine the frequency electrolyte disorders and renal dysfunction in patients with chronic heart failure.

METHODOLOGY

It was a Descriptive Cross Sectional Study at Department of Cardiology, Post Graduate Medical Institute Govt. Lady Reading Hospital Peshawar. Study was carried out from

September 2010 to October 2011. Sampling Technique was Non-probability consecutive sampling

Both male and female patients aged 14 years and above with congestive heart failure of ≥ 6 months duration were included in the study. All Patients were on heart failure treatment including diuretics.

Chronic liver disease diabetic nephropathy history of vomiting, diarrhea during last one week of enrollment, hypothyroidism as per medical record and nephrotic syndrome were excluded from the study. All the above-mentioned conditions were excluded from the sample as they could act as effect modifiers, thus might have introduced bias in the study results.

The study was conducted after approval from hospitals ethical and research committee. All admitted patients meeting the inclusion criteria were included in the study. Complete history and physical examination was carried out. The diagnosis of congestive cardiac failure was based upon any two of the following features i.e. orthopnea, exertional dyspnea, paroxysmal nocturnal dyspnea, raised jugular venous pressure, bilateral ankle edema and lung crepitations. The purpose and benefits of the study were explained to the patients and a written informed consent was obtained. All patients were subjected to detailed history and clinical examination. From all patients 5cc of blood was taken under strict aseptic technique and sent to hospital laboratory to detect hyponatremia.

Congestive heart failure was defined as two or more of the following clinical features: Orthopnea, Exertional dyspnea, Paroxysmal nocturnal dyspnea, Raised jugular venous pressure, Ankle edema and Lung crepitation Hyponatremia was defined as admission serum sodium < 135 mg/dl. Hypokalemia was defined as serum potassium of ≤ 3.5 mg/dl and Hyperkalemia was defined as serum potassium of > 5.5 mg/dl. Renal dysfunction was defined as serum creatinine of > 1.5 mg/dl.

All the above mentioned information including name, age, gender, and address were recorded in a pre-designed proforma. Strict exclusion criteria were followed to control confounders and bias in the study results.

All data was stored and analyzed in SPSS version 16.0. Mean + SD was calculated for continuous variables. Frequencies and percentages were calculated for categorical variables like gender, renal dysfunction, hyponatremia hypokalemia and hyperkalemia. Renal dysfunction, hyponatremia, hypokalemia and hyperkalemia were stratified among age and gender to see the effect modifications. All results were arranged and presented in the form of tables and graphs.

RESULTS

Total number of the study population was 227. Mean age in years was 58.48 ± 12.5 (range 16-90). The number of male patients was 130 (57.3%) while 97 (42.7%) patients were females. Based upon age Patients were subdivided into two groups, Group I included patients 50 years and below while Group II included patients more than 50 years of age. Of total Group I included 27.3% (62), while Group II included 72.7% (165) patients. Majority of the patients were in NYHA class IV (71%).(Table 1)

The most common cause of CHF was coronary artery disease 57.7% (131). Cardiomyopathy and valvular heart disease was the cause of CHF in 32.2% (73) and 10.1% (23) patients respectively. (Table. 2) CAD was more common in male patients (61.5% vs 52.6%) while cardiomyopathy and valvular heart disease was common in female patients (38.1% vs 27.7%) and (9.3% vs 10.8%) respectively. CAD was more common in group II (61.2% vs 48. %) while cardiomyopathy and valvular heart disease was more frequent in group I (40.3.7% vs 29.1%) and (11.3% vs 9.7%) respectively. (Table . 3, 4)

Patients having renal dysfunction (Serum Creatinine >1.5 mg/dl) were 37.4% (85). Renal dysfunction was more common in elderly (40% vs 30.6%, p value=0.020). Hyponatremia (S. Na+ <135 mmol/dl) was noted in 32.1% patients. Hypokalemia (S. K+ <3.6 mmol/dl) was noted in 18.1% (41) patients while hyperkalemia (S. K+ >5.5 mmol/dl) was noted in 16.7% (38) patients. In addition hyperkalemia was more common in patients with renal dysfunction (24.7% vs 12% p value=

0.017), while hypokalemia was less frequent in patients with renal dysfunction (14.1% vs 20.4% p value= 0.286).

DISCUSSION

Renal dysfunction is extremely common in patients with CHF and it is strongly related not only to increased mortality and morbidity but to a significant decrease in exercise tolerance, as well.³ heart failure is characterized by neurohormonal activation of multiple systems that leads to clinical deterioration and significant morbidity and mortality.¹² Hyponatremia is the most common electrolyte abnormality in hospitalized patients with a prevalence of 1–45% depending on the clinical setting, patient population, and the serum value used to define it.¹³

In this regard, hyponatremia is due to inappropriate and continued vasopressin activity despite hypo osmolality and volume overload. Diuretic used to manage volume overload also leads to hyponatremia and hypokalemia. Hyponatremia in this setting is a marker of heart failure severity.¹² Also in heart failure, hyponatremia has been associated with increased risk of haemodynamic deterioration, longer hospital stay, and higher rehospitalization and higher mortality.^{13,14} The risk of hyperkalemia in patients with heart failure has increased in the past few years together with the evolution of pharmacological treatment for these patients. This significant change has been associated with the introduction of angiotensin converting enzyme (ACE) inhibitors, angiotensin II receptor blockers (ARBs), and aldosterone antagonists.¹⁵

Table 1: Baseline Characteristics and Demographic Data

Variables	OVERALL n=227
GROUP I (≤ 50 years)	27.3% (62)
GROUP II (>50 years)	72.7% (165)
NYHA Class III	71% (161)
NYHA Class IV	29% (66)
ACE-Inhibitor and/or ARBs at admission n (%)	70% (159)
BB at admission (n %)	32% (72)
Aldosteron antagonists at admission (n %)	54% (123)
Digoxin at admission (n %)	41% (93)
Loop Diuretics	82%(186)

**Table 2: Gender Distribution of Heart Failure Causes
Sex of Patient * Etiology Crosstabulation**

Sex of patient	Etiology			Total
	CAD	CARDIOMYOPATHY	VALVULAR	
Male% (N)	61.5 (80)	27.7 (36)	10.8 (14)	57.3 (130)
Female% (N)	52.6 (51)	38.1 (37)	9.3 (9)	42.7 (97)
Total% (N)	57.7 (131)	32.2 (73)	10.1 (23)	227

**Table 3: Age wise Distribution of Heart Failure Causes
Age of Patient * Etiology Crosstabulation**

Age group	Etiology			Total
	CAD	CARDIOMYOPATHY	VALVULAR	
Group I% (N)	48.4 (30)	40.3 (25)	11.3 (7)	23.3 (62)
Group II% (N)	61.2 (101)	29.1 (48)	9.7 (16)	72.7 (165)
Total % (N)	57.7 (131)	32.2 (73)	10.1 (23)	227

Table 4: Frequency of Electrolyte Disorders and Renal Dysfunction

Variables	% (n)
Renal dysfunction	37.4% (85)
Hyponatremia	32.1% (73)
Hypokalemia	18.1% (41)
Hyperkalemia	16.7% (38)

In this study renal dysfunction was recorded in 37.4% patients with heart failure. It was even higher in those who were elderly. Another study has also reported similar rate of renal dysfunction (32.2%) in heart failure patients, but GFR instead of serum creatinine was used as tool to measure renal dysfunction. Secondly majority of the patients were elderly male.³ Another report showed that about 60% of patients admitted to Internal Medicine with HF have impaired renal function. Most of these patients were having HFNEF and were elderly and their findings were again based on GFR < 60.¹⁶ Another study showed that the incidence of Worsening Renal Function (a rise in s. creatinine > .5mg/dl) was 22%.¹⁷

In my study hyponatremia was recorded in 35.3% of patients with chronic heart failure. Earlier studies conducted in acutely destabilized heart failure patients have reported hyponatremia in 23-27% patients.^{11,18,19}

The reason for a higher frequency of hyponatremia in this study is because most of the study population was in NYHA class IV heart failure and peripheral edema was quite frequent. In this study 18.1% patients were noted to have a

lower serum potassium. Hypokalemia was less frequent in patients with renal dysfunction (14.1% vs 20.4% P value= 0.286). A study conducted has shown that 22% patients with congestive heart failure develop hypokalemia.⁸ The Digoxin Investigation Group (DIG) trial of the 2793 patients with HF and CKD (eGFR < 60 ml/min/1.73 m²), 527 (19%) had hypokalemia, however their definition for hypokalemia included patients with S. potassium < 4 mEq/L.²⁰

Overall hyperkalemia was quite common in our study (16.7%) and in patients with renal dysfunction it was significantly higher as compared to those with normal renal function (24.7% vs 12% P value= 0.017). A similar rate of hyperkalemia (13.4%) was reported in a group of heart failure patients who were followed for 18 months and they also showed that in addition to other factors increasing baseline serum creatinine is an independent predictor of hyperkalemia.²¹ In a review of 39 studies, assessing the effects on serum potassium levels of angiotensin-converting enzyme inhibitors, angiotensin receptor blockers, aldosterone receptor antagonists, and direct renin inhibitors, alone and in combination, in patients with

hypertension, heart failure (HF), or chronic kidney disease (CKD); it was found that in patients with hypertension without risk factors for hyperkalemia, the incidence of hyperkalemia with RAAS inhibitor monotherapy is low (< or =2%), whereas rates are higher with dual RAAS inhibition (approximately 5%) and the incidence of hyperkalemia is increased in patients with HF or CKD (5% to 10%).²² Another study showed that the incidence of hyperkalemia was 10.7% in decompensated heart failure patients taking spironolactone as compared to 5.4% in those who were not taking spironolactone.²³

CONCLUSION

Electrolyte disorders and renal dysfunction are frequent in patients with chronic heart failure. Electrolyte disturbances are more frequent in patients with underlying renal dysfunction.

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