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ELECTROLYTES DISTURBANCE IN HEART FAILURE

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ABSTRACT

Electrolyte disturbances are a severe and potentially risky complication in heart failure patients. This could be due to metabolic disorders in the heart failure state that trigger neuro-humoral disruption (renin–angiotensin–aldosterone system stimulation, sympathoadrenergic stimulation), or it could be a side - effects of diuretics, cardiac glycosides, and ACE inhibitors. Patients with heart failure may have low sodium levels, magnesium deficiencies, and potassium deficiencies; the latter two are essential for the production of cardiac arrhythmias. Early detection of these abnormalities, as well as understanding of the metabolic pathways, is critical for managing these patients.

INTRODUCTION

Heart failure has been one of the leading causes of cardiovascular mortality and morbidity, accounting for millions of hospital admissions worldwide each year, and it is the most common hospital discharge condition for people over the age of 65 (1). Patients with heart failure (HF) also have acid–base and electrolyte imbalances, which are caused by the activation of many neurohumoral pathways as well as the side effects of medications used to treat this disease, such as diuretics(2). These hazardous disorders indicate the severity of HF and lead to functional dysfunction and poor long-term prognosis (3).

Hyponatremia, hypokalemia, and hypomagnesemia are the most common electrolyte disorders associated with heart failure. Several pathways work together to create the changes observed in the heart failure condition. Decreased cardiac output volume causes a decrease in renal blood flow, resulting in the absence of the renal function system in the excretion of water and electrolytes, as well as the activation of many neurohormonal responses that influence both cardiovascular homeostasis and electrolyte balance(4). The treatment of HF patients involves the identification and management of electrolyte defects that contribute to the production of ventricular arrhythmias. There was no association between intracellular electrolyte

content and plasma electrolyte levels in mononuclear cells, erythrocytes, or myocardial and skeletal muscle. Nevertheless, loop diuretics (e.g., furosemide) are estimated to involve significant magnesium and potassium loss in the plasma and intracellular space. Amiloride and Triamterene, both potassium-sparing diuretics, have been stated to have magnesium-sparing effects. ACE inhibitors have recently been shown to have significant magnesium-conserving effects, likely through their effect on glomerular filtration rate. Hyperkalemia is also well known as a side effect of ACE inhibitors in patients with heart failure. Digoxin works directly on the restriction of renal tubular re - absorption of magnesium, increasing magnesium excretion in the urine. A decrease in magnesium and potassium ratios can increase the toxicity of cardiac glycosides. Increased magnesium levels, on the other hand, reduce the vulnerability of human myocardium to the anti-arrhythmogenic effects of cardiac glycosides without affecting maximally established stress. Furthermore, magnesium enhances the ability of cardiac glycosides to bind to the receptor (5). The antiarrhythmic activity of magnesium is thought to be mediated by a decreased sensitivity to electrophysiological changes caused by Ca2+, suggesting magnesium's Ca2+ antagonistic properties. Magnesium deficiency has also been linked to sudden death, especially in patients suffering from congestive heart failure. As a result, when managing heart failure, one must understand how to avoid electrolyte loss or how to replenish potassium and magnesium deficiency states.

Hyponatremia

Low sodium levels in the blood are one of the most common electrolyte abnormalities found in elderly patients with heart failure]. Mild-to-moderate hyponatremia (Mild: 130-134 mmol/L. Moderate: 125-129 mmol/L (6)(7). It is reported to occur in 10% of heart failure cases; however, this prevalence appears to be higher in various studies. In the OPTIME-CHF experiment, for example, 27 percent of candidates had serum sodium concentrations between 132 and 135 mEq/L, while in the ESCAPE trial, 18 percent of participants had uncontrolled hyponatremia during their hospital stay, with serum sodium below 134 mEq/L (8).

The atrial-renal reflexes, the RAAS, and the sympathetic nervous system are in charge of keeping total body salt and fluid levels within normal limits (SNS)(9). Any rise in atrial pressure in a normal heart inhibits the release of antidiuretic hormone, reduces the tone of the SNS in the kidneys, and increases the release of the atrial natriuretic peptide. [10](11) The latter increases sodium and water secretions at the distal nephron, enhance GFR, induce vasodilation, and decreases antidiuretic hormone release. These mechanisms are disrupted in HF, resulting in sodium and water retention amid elevated atrial pressures.

On the other hand, amongst the most common reasons of drug-induced hyponatremia is diuretics. Although thiazide diuretics are most commonly associated with hyponatremia [12], non-thiazide agents such as furosemide, spironolactone, and indapamide have also been reported to cause hyponatremia. Many drug trials have shown that hyponatremia is associated with a poor prognosis and decreased survival in people with heart failure [13]. Serum sodium concentration at admission or discharge predicts in-hospital short-term and long-term mortality in subjects hospitalized for heart failure. A serum sodium concentration of 130 mEq/L was correlated with a higher in-hospital death rate in a survey of 355 patients admitted for HF [14]. Subjects with serum sodium levels of 135 mEq/L had longer hospital stays and a doubling of in-hospital and 60-day mortality in the OPTIME-CHF study [8].

Hypokalemia or hyperkalemia

The amount of K+ in the body and how it is distributed depends on a complex interaction of many influences, including renal and gastrointestinal function; diet, drugs, and supplements; neurohormonal status; and acid-base balance. With normal circumstances, the kidneys are responsible for up to 90-95 percent of K+ removal, with the colon handling the remainder. Colonic K+ excretion can triple in the presence of chronic renal impairment. Hypokalemia prolongs the electrical impulses and increases QT dispersion because cardiac repolarization is dependent on K+ influx (15)(16)(17). Hyperkalemia causes a shortening of the repolarization cycle, which may result in a shortening of the

QT interval. Both hypo- and hyperkalemia can be fatal, raising the risk of ventricular arrhythmia and sudden cardiac death. Clinically significant hypokalemia (3.5 mmol/L) is uncommon, although it is associated with an elevated case rate. Aldosterone antagonists decrease the incidence of hypokalemia, which may explain a portion of their therapeutic impact. The fact that hypokalemia is associated with mortality even after comprehensive adjustment and that the risk is reduced when hypokalemia is present (18)(19). The assumption that hypokalemia is associated with mortality even after substantial modification, and that risk is reduced when hypokalemia is corrected, indicates that hypokalemia is a causative factor rather than a risk factor. A serum K+ level of 3.5 to 4.0 mmol/L can indicate a similar risk of death as a K+ level of >5.5 to 6.0 mmol/L. According to current objective evidence, it seems prudent to keep serum K+ concentrations between 4.0 and 5.0 mmol/L(20).

Hypomagnesemia

Magnesium contributes in numerous transcriptional regulations and is an essential component of molecular structure and function; it regulates cellular potassium absorption and controls calcium uptake and delivery (21)(22)(23). While hypomagnesemia (serum magnesium 1.5 mg/dL) is not uncommon in HF patients, its etiology has received less attention than that of other electrolytes abnormalities. There is data; however, that effective monitoring of magnesium abnormalities can alleviate potentially harmful arrhythmogenic impact. There is also evidence that successful magnesium disruption correction is beneficial in CH patients (24).

Hypocalcemia and hypophosphatemia

Hypocalcemia (total serum calcium concentration 8.6 mg/dL or ionized calcium concentration 1.1 mmol/L) and hypophosphatemia (serum phosphorus level 2.7 mg/dL) are less reported in HF patients, despite the fact that they are not irrelevant. Despite the critical function of calcium ions in cardiac muscle contraction (25), few cases of hypocalcemia in HF have been recorded, and these are frequently associated with hypomagnesemia [4]. Hypocalcemia may occur in the presence of hypoparathyroidism, end-stage

kidney disease, and respiratory alkalosis (19); additionally, loop diuretics block calcium collecting duct in the loop of Henle and can serve a role in the development of hypocalcemia. It has been demonstrated that correcting the calcium disorder will benefit HF (20).Hypophosphatemia in HF patients is usually caused by phosphate deficiency caused by respiratory alkalosis, hypomagnesemia, and the phosphaturic effects of diuretics (21). Phosphorus deficiency has been linked to reverse myocardial function.

Even though the existence of these relationships is unclear, some studies have found a correlation between increased levels of inorganic phosphate and HF hospital admission (22); an explanation can be found in features of myocardiocyte metabolism. Recently, it has been hypothesized that inorganic phosphate is both the primary feedback signal for inducing oxidative phosphorylation and the most important result of ATP hydrolysis in limiting the heart's ability to hydrolyze ATP (23).

DISCUSSION

The findings which was noticed in globalized studies study were, of the 2793 patients with HF and CKD
(GFR 60 mL/min per 1.73 m2), 527 (19%) had hypokalemia, because hypokalemia was mild (3.5 to 3.9 mEq/L) in 87% of the 527 patients with hypokalemia. As showed in the table below

	Events (%); Rate per 10 000 Person-Years				
Outcomes	Serum Potassium 4 to 4.9 mEq/L (n=65)	Serum Potassium <3.5 mEq/L (n=65)	Absolute Rate Difference* (per 10 000 Person-Years)	HR (95% CI)	*P*
Mortality					
All-cause	25 (38); 1276	36 (55); 2236	+961	2.07 (1.12 to 3.83)	0.021
Cardiovascular	19 (29); 969	27 (42); 1677	+708	2.09 (1.02 to 4.29)	0.044
Progressive HF	9 (14); 459	20 (31); 1242	+783	2.83 (1.12 to 7.19)	0.028
Hospitalization					
All-cause	52 (80); 5714	55 (85); 8209	+2495	1.18 (0.71 to 1.95)	0.523
Cardiovascular	44 (68); 3894	44 (68); 5116	+1222	1.29 (0.76 to 2.20)	0.347
Worsening HF	30 (46); 1974	33 (51); 2821	+847	1.24 (0.65 to 2.34)	0.517

*Absolute differences in rates of events per 10 000 person-years of follow-up were calculated by subtracting the event rates in the serum potassium 4 to 4.9 mEq/L group from the event rates in the serum potassium <3.5 mEq/L group.

The outcome of the study was how far would increase the mortality level among these patients who diagnosed with heart failure. The outcomes were significantly affected by how low level of potassium during their diseased stage.

Other very important readings in the study are the serum calcium concentration which noticed that half of our selected cases had significant hypocalcemia, and Researchers from a Chinese study presented similar results for patients with established heart failure. The quartile of patients with the lowest serum calcium levels had the highest risk of long-term mortality (median follow-up: 4.9 years). Higher serum calcium levels did not correlate with higher mortality. Another study from 2012 examined associations between baseline calcium levels and risk of cardiovascular and all-cause mortality in a population with stable heart failure patients. 1206 patients were followed up for 8 years. More than half of these patients had low calcium level while followed up during eight years, and the outcome of the study, patients revealed that 62% of them had hypocalcemia.. The presence of hypocalcemia was also associated with a higher in-hospital-mortality compared to heart failure patients without any electrolyte disorders.

hyponatremia is associated with an increased rate of re-hospitalization and major complications , as well as a longer hospital stay in hospitalized HF subjects . In a study of 355 subjects admitted for heart failure, a serum sodium concentration was <130 mEq/L and this were associated with a higher in-hospital death rate. In the OPTIME-CHF study, subjects with serum sodium <135 mEq/L had longer lengths of hospital stay and a doubling of in-hospital as well as 60-day mortality. Finally, serum sodium levels also predict mortality in outpatients with chronic heart failure

CONCLUSION

Most patients admitted to the hospital with establish diagnosis of heart failure and other co morbidity diseases, had significant imbalance of the electrolytes. These abnormalities had a significant effect on the rate of morbidity and mortality in the cases which have discussed. The amount of electrolytes loses in patients with heart failure could affect by several factors including side effect of drugs or renal function impairment. For that reason, patients who are admitted with heart failure need carful laboratory assessments of their electrolytes imbalance. ; another point is to focus on patients associated disease such as renal impairment, diabetes and hypertension, and the adverse effect of the prescribed medication.

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