ISSN 2515-8260 Volume 10, Issue 01, 2023

ASSOCIATION OF SERUM ELECTROLYTE CHANGES WITH CLINICAL OUTCOMES IN ACUTE HEART FAILURE PATIENTS

First Author – Dr. Shaik Karishma, Final year junior resident,
Department of General Medicine, Aarupadai Veedu medical college
Vinayaka missions research foundation
Puducherry – 607403
Contact – 8317520503
Email – shaikk615@gmail.com
Second Author – Dr. R.N Sechassayana, MD Associate Professor
Department of General Medicine, Aarupadai Veedu medical college
Vinayaka missions research foundation
Puducherry – 607403
Contact – 9443141260
Email – sechassayananarayanassamy@avmc.edu.in
Third Author – Dr.G.Rengaraj, MD – General Medicine, DNB – Cardiology
Assistant Professor of Cardiology, Aarupadai Veedu medical college
Vinayaka missions research foundation
Puducherry – 607403
Contact – 9080818076
Email – rengarajgovind@gmail.com
Corresponding Author – Dr. Shanmukh T Kalsad MD
Professor and Head , Department of General Medicine
Aarupadai Veedu medical college,
Vinayaka missions research foundation , Puducherry – 607403
Contact – 9448111404
Email – shanmukh.tammanna@avmc.edu.in

INTRODUCTION: Since heart failure is a significant cause of mortality and morbidity Understanding the clinical profile, risk factors, and outcome predictors in patients with heart failure is crucial**.** Considered to be the main electrolytes linked to the electrical characteristics of the cardiac membrane are serum sodium, potassium, and calcium, which determine four phases of the action potential following an incident of acute myocardial infarction, serum electrolyte abnormalities are frequent whose clinical significance in both STEMI and NSTEMI has not yet been fully recognised yet. With the above available literature there still seems to be a lacuna especially with regard to Indian population, hence this study was taken up mainly to assess, measure and determine serum electrolytes and its association in acute heart failure patients based on the outcomes.

MATERIAL AND METHODS: This Cross-sectional study was conducted among patients attending Department of general medicine of Aarupadai Veedu Medical College Puducherry from December 2020 – November 2022 for 2 years . Inclusion Criteria were acute Heart Failure Patients above 18 years of both genders. Patients who are less than 18 years, who are Pregnant, diagnosed with sepsis and other malignancies were included. After obtaining

ISSN 2515-8260 Volume 10, Issue 01, 2023

approval from institutional ethical committee and informed & written consent from the patient. All patients were subjected to detailed history taking and clinical examination. The present study enrolled patients who were with acute heart failure confirmed by specific lab diagnosis and clinical examination. Laboratory tests like serum electrolytes, ECG, 2D ECHO, lipid profile, HbA1C, fasting blood glucose, post prandial blood glucose were done for all the patients.

STATISTICAL METHODS: The data collected was coded, entered into Microsoft excel work sheet and exported to SPSS. Data was analyzed using statistical package for social sciences (SPSS) version 21.Data is presented as percentage in categories and then presented as tables and diagrams. Chi-square test and independent T test was used for test of significance. A p- value of 0.05 was considered statistically significant for all statistical tests performed.

RESULTS:

Table 1 shows the socio demographic characteristics where the mean age in the present study was 58.5 ± 11.80 years with majority aged between 50 and 64 years (43.3%) followed by ≥ 65 (37.5%)& aged ≥ 50 years(80%) with 60.8% being males majority belonged to rural area (59.2% of the subjects), educated up to 12^{th} standard and below (40.8% of the subjects) and illiterate (30%).(70%) were married,(44.2%) had normal BMI & (37.5%) being obese, of which (22.5%) belonged to Class 1 obesity, with (31.7%) smokers&(41.7%) alcoholics. Regarding co-morbidities,(43.3%) had HTN followed by CAD, Hyperlipidemia and DM in (40%), (38.3%) and(37.5%) respectively. CKD, previous myocardial infarction and lung disease were present in 29.2%, 25.8% respectively.

Table 2 shows the clinical presentation where (51.7%) had Compensated HF with preserved ejection fraction (HFpEF) followed by Acute Decompensated HF with reduced left ventricular ejection fraction (HFrEF) (28.3%) and cardiogenic Shock(20%). According to NYHA Classification of severity of Heart Failure, (31.7%) of them were Class IV HF followed by Class I and II HF (27.5%) and (11.7%) of them had Class III HF.

In the current study, serum electrolyte levels ($S.Na^{+}$, $S.K^{+}$, $S.Ca^{2+}$ and $S.PO_4^{3-}$) were recorded on Day 1, 3, 7, 14 and 21.**Table 3** shows Hyponatremia (36.6%), hypo (40.8%) and hyperkalemia (12.5%), hypocalcemia (50%) and hyperphosphatemia (30%) were the most common electrolyte imbalances documented on the day 1 of hospitalization.

Table 4 shows the clinical outcomes accordingly, (20%) of the subjects died during their first hospitalization. During the clinical assessment after 1 month, (1.1%) of the subjects had mortality due to CVS cause& (5.2%) of lost to follow up , after 3 months, (3.4%) deaths due to CVS cause & (2.2%) all cause mortalities along with(2.2%) of lost to follow up & after 6 months (1.2%) death due to CVS cause and (4.8%) had all cause mortalities &(33.8%) of lost to follow up and after 1 year (4%) all cause mortalities & (42%) lost to follow up. The mean number of readmissions in 1 year was 2 ± 1.03 times among 56 patients. The mean duration of hospital stay was 6.9 ± 2.87 days ranging from 1 to 60 days.

Fig 1 shows The proportion of those with hyponatremia and hypokalemia among those who had mortality during 1st hospitalization was higher than those survived and this was found to be statistically significant with p values of 0.012 and < 0.001 respectively.$S.Ca^{2+}$and $S.PO_4^{3-}$ imbalances were not found to be significantly associated with

mortality during 1st hospitalization (p values > 0.05).The electrolyte imbalances on day 1 were found to be associated with prolonged duration of hospitalization among study subjects (p values < 0.05)

DISCUSSION: Acute congestive heart failure (CHF) has a pathophysiology that includes characteristics (such as stimulation of the renin-angiotensin-aldosterone pathway) that, when used in conjunction with CHF treatments, make individuals with this disease highly sensitive to electrolyte abnormalities. Hyponatremia and hypokalemia are the most frequent ones. These abnormalities are of great clinical significance because, in addition to posing a direct risk to CHF patients (such as dysrhythmias brought on by hypokalemia), they also signal underlying pathophysiologic events, an unfavourable clinical course, and occasionally an unfavourable therapeutic response. Recognizing and treating these electrolyte abnormalities are essential components of the best therapy for CHF patients. These electrolytes are crucial in modifying this myocardial infarction patients' prognosis. Investigations into the occurrence and significance of hypokalaemia in myocardial infarction have been on going for a very long time. Hypokalaemia is hypothesised to indicate greater in-hospital morbidity, notably arrhythmias and mortality, in patients with AMI. Hypokalaemia has been linked in several studies to an increased risk of cardiac arrhythmias in AMI patients. According to recent recommendations, even if K seems normal at admission, patients with heart failure and MI should have their K levels frequently checked and refilled. [10,11,12,13]

Hyperkalemia should be avoided as it is also linked to higher mortality. There are 3500 mmol of potassium in the body overall, 98% of which is found inside cells. Renal excretion and switching between intracellular and extracellular compartments serve as its primary regulators. The sodium potassium ATPase pump is primarily in charge of maintaining intracellular potassium levels. Aldosterone and vasopressin increase the luminal Na K ATPase pump and open the luminal Na and K channels to enhance potassium secretion.

The alteration in the environment at the level of the myocytes and purkinje fibres, which is primarily governed by electrolyte imbalances and autonomic nervous system activity, is what causes sudden cardiac death after MI (death within an hour).[15]Since calcium has a role in the control of numerous processes that result in coronary artery disease, such as coronary spasm, thrombus development, and atherosclerotic plaque disruption. Oedema is caused by calcium being redirected to the mitochondria during MI, which disrupts calcium handling between the sarcoplasmic reticulum and myofilaments. Both reversible and irreversible cardiac damage results from poor calcium management. Sarcoplasmic calcium content is typically low with a gradient between intracellular and extracellular compartments. When an action potential occurs, voltage-gated Na+ channels are opened, and inward Na+ current causes the sarcolemma to depolarize quickly, opening L type Ca++ channels. The Ryanodine (RYR) receptor opens in response to the Ca++ influx, releasing calcium into the cytosol and starting contraction. Accumulation of cytosolic calcium is a key factor in the start of programmed cell death. [16]

CONCLUSION

Hyponatremia, hypo and hyperkalemia, hypocalcemia and hyperphosphatemia were the most common electrolyte imbalances documented on the day 1 of hospitalization. Hyponatremia and hypokalemia were found to be associated with mortality during 1st hospitalization.

Electrolyte imbalances on day 1 were found to be associated with prolonged duration of hospitalization among study subjects.

REFERENCES:

1. Beusekamp, J. *Electrolyte disturbances in heart failure: focus on sodium and potassium*. University of Groningen. 2022; https://doi.org/10.33612/diss.196047233.
2. Renata R, Lika L, Alan H et al. Acute hemodynamic index predicts in hospital mortality in acute heart failure. Arg Bras Cardiol. 2021;116(1):77-86.
3. Kiran S, Rohan S and Shelley Z. Hyperkalemia in heart failure. Heart failure. 2020;35(2):150-155.
4. K. Kjeldsen. Hyokalemia and suddern cardiac death. Exp Clin Cardiol. 2019;15(4):e96-399.
5. Kantilal Meghwal. A study to evaluate the role of hypokalemia in acute myocardial infarction patients: A prospective hospital-based study. Asian Journal of Mediacal Research. 2019;8(2):1-3.
6. Cecilia L, Lei Q, Ameet B et al. Serum potassium and clinical outcomes in heart failure patients: results of the risk calculations in 21,334 patients in the UK. ESC Heart Failure. 2019;6:280-290.
7. Patrick R, Andrew C, Ovidiu C et al. Renal function, electrolytes and congestion monitoring in heart failure. European Heart Journal Supplements. 2019; M:M25-31.
8. Hariprasad S. and Basavaraj M. Electrolyte dysfunction in myocardial infarction patients. IJAM. 2018;5(5):1172-1176.
9. Shilpa P, Saurabh G, Piyush P et al. A study of electrolyte imbalance in acute myocardial infarction patients at a tertiary care hospital in Western Maharashtra. International Journal of contemporary Medical Research. 2016;3(12):3598-3571.
10. Fauci AS, Braunwald E, Isselbacker KJ, Wilson JD, Martin JB, Kasper DL, et al. ST elevation myocardian infraction. In Harrisons the principles of internal medicine, 17 ed. USA: McGraw Hill Companies, 2012;P1532.
11. Goyal A, Spertus J A, Gosch K, Venkitachalam L, Jones P G, Berghe G V D, et al. Serum potassium levels and mortality in acute myocardial infarction. JAMA. 2012;307:157-164.
12. Tada Y, Nakamura T, Funayama H, Sugawara Y, Ako J, Ishikawa S, Momomura S. Early development of hyponatremia implicates short and long term outcomes in ST elevation acute myocardial infarction. Circ J. 2011;75:1927-1933.
13. Tang Q, Hua Q. Relationship between hyponatremia and in hospital outcomes in Chinese patients with ST- elevation myocardial infarction. Intern med. 2011;50:969-974.
14. Xianghua F, Peng Q, Yanbo W, Shigiang L, Weize F, Yunfa J. The relationship between hypokalemia at the early stage of acute myocardial infarction and malignant ventricular arrhythmia. Heart. 2010;96:196.
15. Jeldsen K K. Hypokalemia and sudden cardiac death. Exp Clin Cardiol. 2010;15:96-99.
16. Alizadehasl A, Sepasi F, Azarfarin R, Ghaffari S. Hypokalemia, arrhythmias and early outcomes in acute myocardial infarction. Res J Bio Sci. 2008;3(9):1130-2.

17. K. Park. 19th Edition. 2007. Textbook of Preventive and Social Medicine; pp. 286–287.
18. Singla I, Zahid M, Good CB, Macioce A, Sonel AF. Effect of hyponatremia (<135mEq/L) on outcome in patients with non-ST-elevation acute coronary syndrome. Am J Cardiol. 2007;100(3):406-8.
19. Goldberg A, Hammerman H, Petcherski S, Zdorovyak A, Yalonetsky S, Kapeliovich M, et al. Prognostic importance of hyponatremia in acute ST elevation myocardial infarction. The Am J Med. 2004;117:242-248.
20. Mac Donald J E, Struthers A D. What is the optimal serum potassium level in cardiovascular patients. J Amc Cardio. 2004;43:155-161.
21. Cohn J N, Kowey PR, Whelton PK, Prisant L M. New Guidelines for Potassium replacement in Clinical Practice, A Contemporary Review by the National Council on Potassium in clinical practice. Arch Int Med. 2000;160:16.
22. Rimailho A, Bouchard P, Schaison G, Richard C, Auzepy P. Improvement of hypocalcemic cardiomyopathy by correction of serum calcium level. Am Heart J. 1985;109: 611–3.
23. Nordrehaug J E. Malignant arrhythmia in relation to serum potassium in acute myocardial infarction. Am J Cardio. 1985;56:20-23.
24. MP Oliver. Metabolic response during impending myocardial infarction, II Clinical implications. Circulation. 1972;45:491.
25. NJ Vetter, W Adams, RC Strange, MF Oliver. Initial metabolic and hormonal response to AMI. Lancet. 1974;I:284.

26. Table -1 socio demographic characteristics

Character	N(%)	Character	N(%)
Age	58.3+_11.8yrs	BMI - <18.5 18.5- 25 25- 30 >30	8(6.7%) 53(44.2%) 14(11.7%) 45(37.5%)
Gender - Male	73(60.8)	Smoking –yes no	44(30.4%) 74(61.6%)
Female	47(39.2)	Alcohol – yes no	50 (41.7%) 70 (58.3%)
Education –illeteracy High school College	36(30%) 49(40.8%) 35(29.2%)	Co-morbidities Hypertension(HTN) Coronary artery disease(CAD) Hyperlipidemia Chronic kidney Disease Previous MI	 62(43.3%) 48(40%) 46(38.3%) 35(29.2%) 31(25.8%)
Residence – Urban Rural	49(40.8%) 71(59.2%)		

Table - 2 clinical presentation

ISSN 2515-8260 Volume 10, Issue 01, 2023

PRECIPITATING FACTOR	N(%)	INVESTIGATIONS	N(%)
Acute coronary syndrome	53(44.2%)	ECG – NSTEMI/STEMI Atrial Fibrillation Old MI	46(38.3%) 18(15%) 17(14.2%)
Drug discontinuation	36(30%)	2D ECHO- IHD DCM Valvular Lesion	44(36.7%) 34(28.3%) 45(37.5%)
Atrial Fibrillation	26(21.7%)	CXR – Pulmonary congestion Cardiomegaly Pneumonia	 52(43.3%) 39(32.5%) 39(9.2%)
CLINICAL FINDINGS			
Acute pulmonary oedema-	Present Absent	47(39.2%) 73(60.8%)	
PND JVP Measurement	Present Absent <6cms 6- - 9cms	51(42.5%) 69(57.5%) 45(37.5%) 61(57.5%)	

Table – 3 Association between Serum Electrolyte Levels at Day 1 and mortality during 1st hospitalization among the subjects

Serum electrolyte	Mortality during 1st hospitalization	NO Mortality during 1st hospitalization	P Value
$S.Na^+$ - (x^2 value = 4.142)			
Normal Hyponatremia Severe hyponatremia	14(58.3%) 9(37.5%) 1(4.2%)	62(64.6%) 39(35.4%) 0(0%)	0.012

S. K^+ (x^2 value = 23.869)			
Normal Mild hypokalemia Moderate hypokalemia Severe hypokalemia Hyperkalemia Severe hyperkalemia	4(63.4%) 15(35.8%) 5(0.8%) 0(0%) 0(0%) 0(0%)	52(54.2%) 21(21.9%) 7(7.3%) 1(1%) 13(13.4%) 2(2.1%)	0.001
S.Ca^{+2} (x^2 value = 1.203)			
Normal Hypocalcemia Severe hypocalcemia	12(50%) 8(33.3%) 4(16.7%)	18(50%) 39(40.6%) 9(9.4%)	0.548
S.PO_4^{-3} (x^2 value = 6.011)			
Normal Mild hyperphosphatemia Moderate Hyperphosphatemia Severe hyperphosphatemia	 18(75%) 1(4.2%) 4(6.7%) 1(4.2%)	 66(68.8%) 15(15.6%) 15(15.6%) 0(0%)	0.111

Table – 4 Distribution of subjects according to Outcome

	OUTCOME	**N(%)**
1.	Mortality during 1st hospitalization	24(20%)
2	Clinical assessment after 1month -signs&symptoms improved -lost follow up -mortality due to cvs cause	 47(48.9%) 5(.2%) 1(1.1%)
3.	Clinical assessment after 3months -signs&symptoms improved -lost follow up -all cause mortality	 39(43.3%) 2(2.2%) 2(2.2%)

ISSN 2515-8260 Volume 10, Issue 01, 2023

	-mortality due to cvs cause	3(3.4%)
4.	Clinical assessment after 6 months -free of signs&symptoms -lost follow up -all cause mortality -mortality due to cvs cause	 37(44.6%) 28(33.8%) 4(4.8%) 1(1.2%)
5.	Clinical assessment after 1 year -free of signs&symptoms -lost follow up -mortality due to cvs cause	 22(44%) 21(42%) 2(4%)
6.	Mean readmission in an year = 2+-1.03	
7.	Mean duration of hospital stay=6.9+_2.87days	

Figure 1: Line graph showing comparison of mean duration of hospitalization to Serum Electrolyte Levels at Day 1 among study subjects