

Analysis of Arterial Blood Gas (ABG) Profile in Patients with Acute Heart Failure in Tertiary Care Centre at ACS Medical College

Kathiravan S*, Prabha K, Krishnaswamy B

Department of Pharmacology, Dr. M.G.R. Educational and Research Institute University, Maduravoyal, Chennai, Tamil Nadu, India

ABSTRACT

OBJECTIVE

To study the profile of arterial blood gas in patients admitted with acute heart failure and to find out various pattern of ABG results in heart failure patients admitted in tertiary care centre.

METHODS

This is a single centre, cross sectional, analytical study conducted during the period September 2021 to February 2022. 100 patients aged more than 18 years admitted in our centre for acute heart failure were included in our study. A detailed history taking, clinical examination were done. Blood sample were collected for Arterial blood gas analysis immediately at the time of admission followed by 2d echo to asses left ventricular function.

RESULTS

Out of 100 sample study 43 % were male and 57 % were females. The mean age of the study population is 58 years. 50 % of the patient admitted with heart failure has normal ABG. 29 % had acidosis and 21 % had alkalosis. Among 29 % of sample study population admitted with acidosis most common is metabolic acidosis which is present in 24 patients (83 %). 5 patients has respiratory acidosis (17 %). Among 21 % of patient with alkalosis 20 patient (95 %) has respiratory alkalosis and 1 patient (5 %) has metabolic alkalosis. 12 patients were expired. All expired patient has abnormal ABG. 10 patient had respiratory alkalosis and 2 had metabolic acidosis.

CONCLUSION

Heart failure patients develop different acid base disturbance due to several pathophysiologic mechanism. In half of the patient with acute decompensated heart failure ABG is normal in our study. The most common abnormality seen in our study is metabolic acidosis followed by respiratory alkalosis. Metabolic alkalosis and respiratory acidosis is rare ABG abnormality in patients with heart failure. All expired patient has abnormal ABG. So abnormal ABG in heart failure in particular respiratory alkalosis may indicate poor outcome as this seen in 83 percent of expired patient

KEYWORDS

Heart failure, Arterial blood gas analysis, Metabolic acidosis, Respiratory alkalosis

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Corresponding Author:
Kathiravan S, Department of
Pharmacology, Dr. M.G.R. Educational
and Research Institute University,
Maduravoyal, Chennai, Tamil Nadu.
E-mail: kathirasm@gmail.com

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INTRODUCTION

Heart failure is a common cardiovascular condition with increasing incidence and prevalence. Hospitalized Acute Heart Failure (AHF) patients have a poor prognosis. In AHF patients with cardiogenic pulmonary edema, the cardiac congestion leads to pulmonary edema with impaired gas exchange (hypoxaemia, hypercapnia) and the low cardiac output to a decreased tissue perfusion leading to metabolic acidosis. Arterial Blood Gas (ABG) may be used as a comprehensive marker for backward and forward failure, and acid-base balance may be used to assess the general status of heart function in high risk AHF patients. Complex patho physiologic mechanism in heart failure leads to different and mixed pattern in ABG. We sought to find the common pattern in ABG in heart failure. It is studied extensively in cop. Not many studies have been done in heart failure.¹

MATERIALS AND METHODS

This is a single center, cross sectional, analytical study conducted during the period September 2021 to February 2022 this study was approved by the institutional ethical committee of ACS medical college Chennai. 100 patients aged more than 18 years admitted in our center for acute heart failure were included in our study. Written informed consent is obtained from all patient a detailed history taking, clinical examination were done. Blood sample were collected for Arterial blood gas analysis immediately at the time of admission followed by ECG and 2d echo to asses left ventricular function. ABG is taken and analyzed in all patients with heart failure according to Framingham criteria aged more than 18 years admitted in medical ICU. Expected proportion 0.01. Precision % 2 desired confidence level (1-alpha) % 95. Required sample size 95. Rounded off to 100.²

Inclusion Criteria

All patients with heart failure according to Framingham criteria aged more than 18 years admitted in medical ICU. Major criteria include an enlarged heart on a chest X - ray, an S₃ gallop, pulmonary edema, episodes of waking up from sleep gasping for air, crackles on lung auscultation, central venous pressure more than 16 cm H₂O at the right atrium, jugular vein distension, positive abdominojugular test, and weight loss more than 4.5 kg in 5 days in response to treatment (sometimes classified as a minor criterion) minor criteria include an abnormally fast heart rate more than 120 beats per minute, nocturnal cough, difficulty breathing with physical activity, pleural effusion, a decrease in the vital capacity by one - third from maximum recorded, liver enlargement, and bilateral ankle edema. After obtaining proper informed consent, patients were selected according to inclusion/exclusion criteria. For diagnosis of heart failure presence of either 2 major or 1 major and 2 minor is essential. Patients with associated COPD, CKD and DKA are excluded from our study after the clinical history and thorough clinical examination, they are subjected to undergo ABG, chest x ray and routine blood investigations ECG and 2D echo. The results are arranged in the master chart and Data analyzed using SPSS version 20.^{3,4}

ABG Analysis

The ABG analysis was performed at room air in an emergency setting within 30 min of the patients' admission after the initial assessment. The analysis included measurement of pH, the partial pressure of arterial Carbon Dioxide (PaCO₂), and the partial pressure of arterial Oxygen (PaO₂). Standard Bicarbonate (HCO₃) was calculated from the observation parameters pH and PaCO₂. Acidosis was defined as pH < 7.36, and alkalosis as pH > 7.44. Hypoxaemia, hypercapnia, and low bicarbonate were defined as PaO₂ < 60 mmHg, PaO₂ > 44 mmHg, and HCO₃ < 21 mg / dL, respectively. These are the thresholds for abnormal ABG values.⁵

RESULTS AND DISCUSSION

Out of 100 sample study 43 % were male and 57 % were females. The mean age of the study population is 58 years 50 % of the patient admitted with heart failure has normal ABG. 29 % had acidosis and 21 % had alkalosis. Mean ph is 7.3 ± 0.7 Mean PO₂ is 73 ± 10 mmhg Mean PCO₂ is 38 ± 5 mmhg mean bicarbonate is 21 ± 3.7 mg / dl among 29 % of sample study population admitted with acidosis most common is metabolic acidosis which is present in 24 patients (83 %). 5 patients has respiratory acidosis (17 %). Among 21 % of patient with alkalosis 20 patients (95 %) has respiratory alkalosis and 1 patient (5 %) has metabolic alkalosis. 12 patients were expired. All expired patient has abnormal ABG. 10 patients had respiratory alkalosis and 2 had metabolic acidosis. Out of 100 patients in the study group prolonged stay for more than 5 days in ICU is seen in 20 patients. 11 patient (55 %) in this group has normal ABG. 5 patient (25 %) had metabolic acidosis and 3 (15 %) had respiratory alkalosis. 1 patient (5 %) had metabolic alkalosis.⁶

Clinical Profile of the Study Group

Mean age of the study group was 58.47 ± 10.7 years. Among the total study participants 43 % were males and 57 % were females. Mean pH was 7.3 ± 0.07, mean PO₂, PCO₂ and HCO₃ were 73 ± 10, 38.6 ± 5.2, 21.4 ± 3.7 respectively. Out of total 100 study participants 29 % had acidosis, pH was normal among 50 % and 21 % had alkalosis. Mean systolic BP was 127.5 ± 24.6 mmhg and mean diastolic BP was 80.1 ± 13.5 mmhg. Acute pulmonary edema and recurrent acute pulmonary edema was present among 96 % and 1 %. 53 % and 65 % were known diabetics and coronary artery disease. 47 % were known hypertensives, 12 % had accelerated hypertension. 4 % and 5 % had moderate and severe LVD respectively (Table 1).

	Acidosis	Normal	Alkalosis	P value
Age (Mean ± SD)	57.21 ± 10.641	57.46 ± 10.256	62.62 ± 11.382	0.136
Gender				
Males	44.80 %	40.00 %	47.60 %	
Females	55.20 %	60.00 %	52.40 %	0.816
Acute pulmonary edema	96.60 %	98.00 %	95.20 %	0.812
CAD	55.20 %	64.00 %	81.00 %	0.165
SHT	51.70 %	58 %	71.40 %	0.369
DM	44.80 %	60.00 %	47.60 %	0.367
LVD	10.30 %	6.00 %	14.30 %	0.514
Outcome				
Expired	8.30 %	8.30 %	83.30 %	< 0.001
Transferred to ward / Discharged	31.80 %	55.70 %	12.50 %	
Systolic BP	130.82 ± 24.67	132.12 ± 22.74	111.90 ± 23.47	0.004
Diastolic BP	82.82 ± 13.61	81.60 ± 14.04	72.42 ± 9.39	0.018
Pulse rate	86.55 ± 5.94	88.26 ± 5.34	91.0 ± 13.32	0.145
Respiratory rate	20.96 ± 1.65	20.28 ± 0.70	21.14 ± 1.49	0.009
SPO ₂	96.72 ± 1.81	97.56 ± 67	94.90 ± 3.75	< 0.001
Ejection fraction	57.24 ± 6.58	57.02 ± 6.25	38.95 ± 13.13	< 0.001

Table 1. Factors associated with ABG analysis.

Mean age was high among individuals with alkalosis. However it was not statistically significant. Alkalosis was common among females, while majority of males had normal pH. Alkalosis was found be common among individuals those who expired and it was statistically significant with p value of 0.000. Though not statistically significant, pulse rate was found be high among patients with alkalosis. Mean pulse rate was significantly high with p value of 0.009 among patients whose pH was in alkalosis range. SPO₂ was significantly low in patients with alkalosis when compared to patients with acidosis and normal pH where the p value was 0.000. Patients with significantly low ejection fraction tend to have alkalosis and the mean ejection fraction was almost similar among patients with normal pH and acidosis (Figure 1).

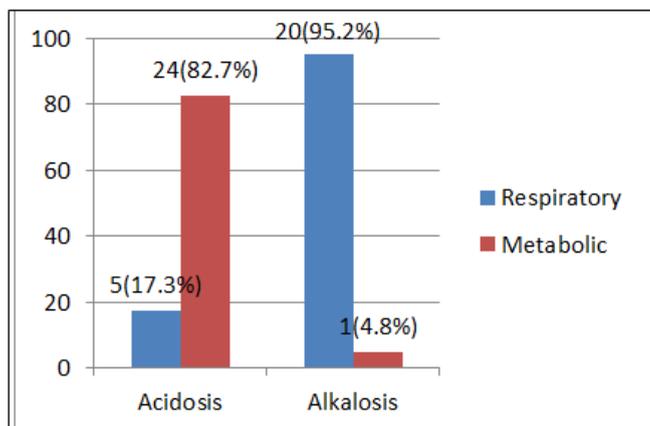


Figure 1. Bar Chart Showing Proportion of Patients with Respiratory and Metabolic Acidosis and Alkalosis.

Acidosis (29) – 29 % of the study group had acidosis. Among them 82.7 % had metabolic acidosis and 17.3 % had

respiratory acidosis respiratory acidosis: 5 patients (17.3 %) metabolic acidosis: 24 patients (82.7 %) alkalosis (21) – 21 % of the study group had alkalosis. Among them 95.2 % had respiratory alkalosis and 4.8 % had metabolic alkalosis Respiratory alkalosis: 20 patients (95.2 %) metabolic alkalosis: 1 patient (4.8 %). So in our study 50 percent has abnormal ABG and 50 percentage of patients with heart failure has normal ABG. In all expired patient ABG is abnormal. The most common abnormality seen in expired patient is respiratory alkalosis (83 %) and 17 percent has metabolic acidosis. respiratory alkalosis in pulmonary edema is explained by, according to Starling’s law, the acute elevation in left ventricular filling pressure in failing heart leads to increase in hydrostatic pressure in pulmonary capillaries and this leads to fluid accumulation in the lungs which stimulate juxta pulmonary capillary receptors J receptor which cause tachypnea and Co₂ washout. So abnormal ABG in heart failure may indicate poor outcome. The most common abnormality seen in our study is metabolic acidosis in 24 percentage of patient and 20 percentage had respiratory alkalosis. The mechanism of metabolic acidosis is tissue hypo perfusion due to hypotension leading to lactic acidosis which is buffered by bicarbonate and this leads to metabolic acidosis. And the other mechanism which cause metabolic acidosis is progressive reduction in renal blood flow which leads to reduced capacity of the kidney to excrete net acid which can leads to metabolic acidosis. In our study group blood pressure is normal and no difference is observed among patient with metabolic acidosis and respiratory acidosis. So the metabolic acidosis may be due to later mechanism. Thus, metabolic acidosis in acute heart failure may be a marker for inappropriate tissue perfusion caused by low cardiac output. Indeed, patients with acidosis were at an increased risk for short, mid, and long - term mortality. Out of 100 patient in the study group prolonged stay for more than 5 days in ice is seen in 20 patient. 55 % in this group has normal ABG. 25 % had metabolic acidosis and 15 % had respiratory alkalosis. 5 % had metabolic alkalosis. This shows no major abg difference in patient with prolonged ICU stay and patient with short ICU stay (less than 5 days)

LIMITATIONS

This study is just observational study analyzing the arterial blood gas value in patient with acute heart failure. We do not have follow up data and no prognostic value has been inferred from this study^{7,8}

CONCLUSION

Heart failure patients develop different acid base disturbance due to several pathophysiologic mechanism. In half of the patient with acute decompensated heart failure ABG is normal in our study. Various abnormality in BG like Metabolic acidosis, respiratory alkalosis, metabolic alkalosis and Respiratory acidosis can be seen in acute heart failure. The most common abnormality seen in our study is metabolic acidosis followed by respiratory alkalosis. Metabolic alkalosis and respiratory acidosis is rare abg abnormality in patients with heart failure. All expired patient has abnormal ABG. So abnormal ABG in heart failure in particular Respiratory alkalosis may indicate poor outcome as this seen in 83 percent of expired patient.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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