Original Article

To Study the Spectrum of Acid Base Disorders in Critically Ill Patients

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Objective: To study the spectrum of ABGs in critically ill patients of Mayo hospital, Lahore in 15 days.

Methods: All samples received from ICU 23.10.18 to 6.11.18, referred to emergency laboratory for ABGs were included. The results and other relevant information were recorded on proforma. The collected data was analyzed by using Statistical package for social sciences (SPSS version 20).Quantitative variables like age was presented as mean ± SD. Qualitative variables like gender, single, double or triple disorder and type of disorder were presented as frequency and percentage.

Results: Out of total 200 samples, 126 (63%) and 74 (37 %) were of male and females respectively. Mean age ± SD was 40.4±10.7 years. The frequency of acid base disorders was 94%. Single disorder were121 (60.5%), 57 (28.5) were double, 10 (5%) were triple disorder and 12 (6%) were normal. 60 (50%), 6 (5%), 51 (42%), 4 (3 %) were metabolic acidosis, metabolic alkalosis, respiratory alkalosis, respiratory acidosis respectively. Hyperoxemia was present in 70 (35%) cases.

Conclusions: Metabolic acidosis is the most frequent disorder in our study and single disorder were common followed by double and triple disorder.

Keywords: ABGs, pattern, critically ill patients.

Introduction

Laboratory testing has an important role in the patient-centered approach for the delivery of health care services. 60-70% of the most important decisions on admission, discharge and medication are based on laboratory test results.[1]

Arterial blood gas analysis is frequently ordered laboratory test in emergency and intensive care unit (ICU).[2] It is used to monitor the acid base balance of patients.[3] Acid base disorders are common cause of high rates of morbidity and mortality in critically ill patients in our health care system.[4]The common indications for ABG analysis are shock, trauma, toxin/ poison ingestion, septicemia, burns, hypoxia, ventilated patients, cardiac failure, diabetic ketoacidosis, liver failure and respiratory failure.[5]

Artery is the preferred site for the sampling of blood gas analysis.[5] Radial artery is more preferred using heparin as an anticoagulant of choice.[2] Sample must be analyzed within 30 minutes. The sample should obtained in anaerobic conditions.[6]

Common parameters included in ABG analysis are partial pressure oxygen (PO_2), partial pressure carbon dioxide (PCO_2), pH and bicarbonates (HCO_3). Additional parameters are base excess, glucose, lactate, anion gap, serum levels of hemoglobin and electrolytes (Na^+, K^+ and chloride). Electrolytes are done for the calculation of anion gap.[5] Among these parameters, pH, PO_2, PCO_2, are measured parameters while HCO_3 is the calculated parameter.[7] Acid base balance is very important for the well-being of person.[8] The body functions normally at the optimal pH of 7.35-7.45.[9] The kidneys and lungs are the main regulators of acid-base balance in body.[5] In addition to them, buffers also play an important role. The main buffers of the body are bicarbonate, phosphate buffer and plasma proteins including Hemoglobin. Out of these, bicarbonate is a major contributing buffer.[7] ABG disorders are generally of respiratory or metabolic origin. Metabolic disorders are compensated by lungs and respiratory disorders are compensated by kidneys and other buffers of the body. Lungs regulate acid base balance by hyperventilation or hypoventilation whereas kidneys regulate blood pH by either reclamation or regeneration of bicarbonate and by secretion of H^+ ions. The compensation of ABG disorders of respiratory origin is done by kidneys and other buffers of the body. The compensation does not start immediately but efficient enough to achieve full compensation. On the other hand, the compensation of metabolic ABG disorders by the lungs is immediate but is not efficient enough to achieve full compensation.[7]There are five types of acid base disorders; respiratory acidosis, Respiratory Alkalosis, Metabolic Acidosis, Metabolic Alkalosis and mixed acid base disorders (double and triple).[2,8]

In metabolic acidosis pH is less than 7.35 and a bicarbonate level is less than 22mmol/Land it is the result of bicarbonate deficiency or an excess of acids like severe diarrhea, laxative abuse, burns, severe dehydration, hypoxia, renal failure, starvation, lactic acidosis and salicylate poisoning.[10] In metabolic alkalosis pH is greater than 7.45 and HCO3 is more than 26mmol/L. Causes of metabolic alkalosis are vomiting, excessive us1e of antacids, Conns syndrome, aggressive gastric suction, hyper aldosteronism, pyloric stenosis and excessive use of diuretics.[10,11] Respiratory acidosis is caused by retention of Co_2 in the body, pH is less than 7.35 and PCO_2 greater than 45 mmHg.[11] Common causes of respiratory acidosis include narcotics, sedatives, anesthesia, neuromuscular diseases, respiratory distress syndrome and other disorders.[12] Respiratory alkalosis is caused by decrease in CO_2 level less than 35 mmHg and pH is greater than 7.45. Common conditions include fever, sepsis, pregnancy, central nervous system lesion, pulmonary edema, salicylates, trauma, infection and psychological response such as anxiety and stress.[13,14]

The timely diagnosis of acid base balance will help to prevent potentially deadly outcome.[5] It will help to guide clinician in adjusting the ventilator settings to meet the patient's needs.[15] In this background, this study was planned to study the pattern of ABGs in critically ill patients of emergency Laboratory of Mayo Hospital/ King Edward Medical University in 15 days.

Methods

It was a descriptive study conducted at emergency laboratory of Mayo Hospital/ King Edward Medical University, Lahore, after approval of the Institutional Review Board. The study included all ABGs done on critically ill patients in Emergency laboratory of Mayo hospital/King Edward Medical University. Clotted sample, hemolyzed sample, insufficient sample and sample in inappropriate vials were excluded. The duration of study was 2 months after the approval of synopsis. Sample technique was non probability convenient sampling.

Samples were collected over a period of15 consecutive days. Blood was collected in identical heparinized syringes and analyzed in M 348 (Siemens) blood gas analysis machine. The relevant information and results of ABG analysis were recorded on prescribed proforma. The result of each sample was analyzed and marked as normal or abnormal according to the type of disorder.

All collected data was entered and analyzed by using Statistical package for social sciences (SPSS version 20). Quantitative variables like age was presented as mean ± SD. Qualitative variables like gender, normal or abnormal reports, single, double or triple disorder and type of disorder were presented as frequency and percentage.

Results

Total samples in the study were 200. The mean age ± SD was 40.4±10.7 years. Out of 200 samples, 12 (6%) were normal and Acid Base Disorders were present in 188(94%) samples. Single disorders were 120 (60.5%) and 67 (33.5%) were mixed disorders. Out of 200 cases, 126 (63%) were male and 74 (37%) were female. The frequency of single, double, triple disorders and normal ABGs were 60.5%, 28.5%, 5%, 6% respectively. Out of 121 single disorders, metabolic acidosis (50%) was the commonest disorder followed by respiratory alkalosis (42%),

Table-1: Summary of results.

Study variable	Mean ±SD%
Age	40.4± 10.7years
Gender (M:F)	63%: 37%
Total Samples	200
Single	121 (60.5%)
Double	57 (28.5%)
Triple	10(5%)
Normal	12 (6%)
Metabolic Acidosis	60 (50%)
Metabolic Alkalosis	6 (5%)
Respiratory Acidosis	4 (3%)
Repiratory Alkalosis	51 (42%)
Mixed	76 33.5%)

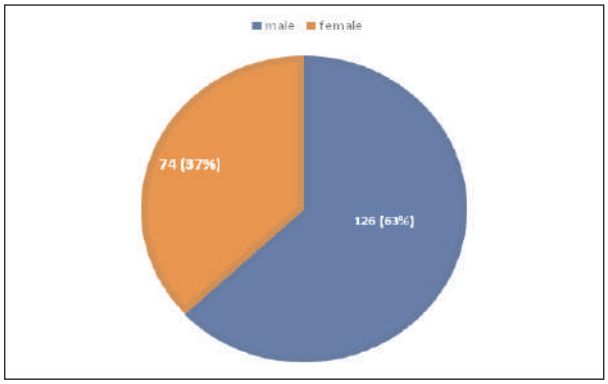

Fig-1: Frequency of male and female patients.

metabolic alkalosis (5%) and respiratory acidosis (3%) respectively.

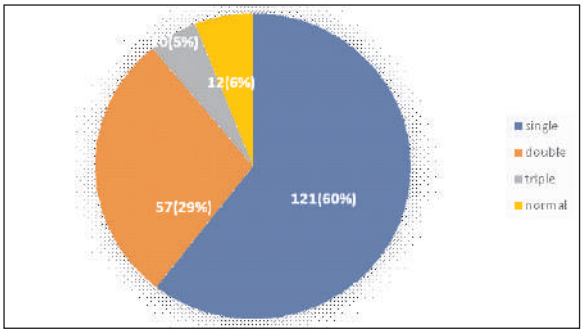

Fig-2: Frequency of Single, Double, Triple ABGs disorders.

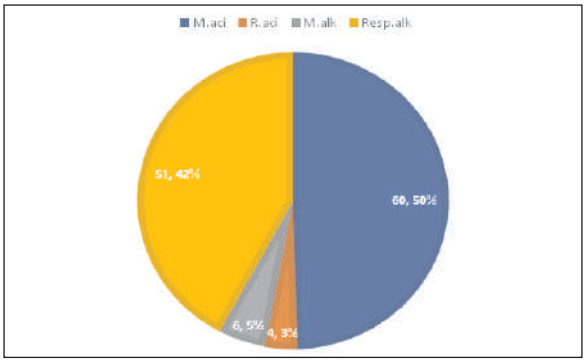

Fig-3: Frequency of different types of acid base disorders.

Discussion

Acid-base balance is very important for normal body function. The acid base disorders can complicate diseased state. It can disturb electrolyte balance and may affect optimal effectiveness of medications.[6] Arterial blood gas analysis is one of the most common investigation in intensive care units and emergency departments as ABDs are more frequent in emergency patients. It is utilized to establish diagnosis, guides treatment plan and helps to adjust ventilator settings of mechanically ventilated patients. The delay in the diagnosis of acid-base disorder can result in serious outcome. The timely management of ABD and its underlying cause significantly reduces morbidity and mortality. However, the pattern of acid base disorders among critically ill patients is not commonly reported.[8] So, this study was planned to study the pattern of ABDs in critically ill patients. ABG results should not be relied on alone in making clinical decisions. Rather it should be interpreted in the background of patient's medical history, present health condition and therapeutic intervention.[5] The accurate results of ABGs are pivotal for patients' management. This needs proper collection, transportation, handling and analysis of the blood sample as ABG measurements are particularly prone to preanalytical errors. The most common encountered errors are air bubbles in the sample, inadequate or excessive anticoagulant, inappropriate temperature for transportation or delayed transportation or analysis.[6,7] In our study, out of total 200 samples, 126 (63%) were males and 74 (37 %) were females. This is comparable to study by Kose et al in which 53.5% were male and 46.5% were female.[4] The mean age ± SD of patients in our study was 40.4 ± 10.7, in contrast with the study of Kose et al in which the mean age of patients was 60.7±17.1 years (4).Like our study, some other researchers also reported ABDs to be more common in males.[8,16,17] The frequency of ABD in our study was 94% that is comparable to studies carried out by Song et al, Ren et aland Zhao et al in which frequency was 97.3% and 94.2%-96.8% respectively. This reflects an increased burden of ABD in critical settings (8,18). In our study single disorders were the commonest (121, 60.5%) followed by double(57, 28.5%) normal (12,6%) and triple disorders (10,5%).This is in contrast with study by Songet alin which double disorders were the commonest (525, 70.5%). One possible explanation for it might be the age of patients (40.4 ±10.7 years) in our study which is less than that of study by Song et al in which mean age was 70.5±17.4 years.[8] In advanced age, patients are usually suffering from more than one comorbid condition like renal insufficiency, cardiac failure or chronic obstructive pulmonary disease that can also affect ABGs results. Moreover, medications like diuretics can also affect the results of ABGs in the elderly patients.[19] Another reason for this contrast might be that emergency laboratory in our study setting mainly deals with patients of general medicine and general surgery. The ABGs of patients of cardiovascular diseases, respiratory problems and burns are performed in their respective departments. Among the double disorders, the common combination in our study was metabolic acidosis and respiratory alkalosis followed by respiratory acidosis and metabolic acidosis. This is similar to study by Song et aland Kose et al.[4,8] The triple disorders were least frequent in our study. This is also comparable to study by Song et al.[8] In our study, the most common single disorder was metabolic acidosis 60(50%) followed by respiratory alkalosis 51(42%), metabolic alkalosis 6(5%) and respiratory acidosis, 4(3 %).This is in accordance with study by Song et al and Ahmad et al. [8,20] The underlying cause of metabolic acidosis could be hyperoxemia and poor systemic perfusion leading to lactic acidosis in end stage organ failure and shock patients.[8,20,21] The frequency of mixed acid base disorders was significant in our study 67(33.5%) which is comparable to study by Ahmad et al.[20] The

patients in critical setting are actually suffering from multiple problems that can lead to mixed acid base disorders.[4] The prompt diagnosis and proper management of these abnormalities have a great effect on the outcome of critically ill patients. Hyperoxemia was observed in 70(35%) cases in our study. It is consistent with other studies showing 22% to 50% frequency in of mechanically ventilated patients in the ICU.[22,23] Hyperoxemia is defined as an increase in arterial oxygen partial pressure (PaO2) greater than 120 mmHg.[22,24] Hyperoxemia is associated with the duration of mechanical ventilation, the ICU stay and the hospital stay. It is also associated with a higher mortality rate in addition to hypoxemia.[22] Despite widespread use of oxygen supplementation in hospitalized patients, guidelines for the optimal use of oxygen are not available. Generally, in critical situations oxygen supplementation is started without checking for hypoxemia and often not adjusted to lower level despite partial oxygen pressures (PaO_2) within normal range.[2,25,26] The hyperoxemia results in mitochondrial dysfunction and depletion of cellular ATP levels resulting in formation of reactive oxygen species. It also results in peripheral vasoconstriction, cerebral vasoconstriction, neuronal cell death, and seizures, coronary vasoconstriction and a decrease in cardiac output while increasing peripheral vascular resistance.[27] Due to major neurologic and hemodynamic problems faced by critically ill patients, hyperoxemia must be addressed in this population in addition to ABD.

Conclusion

Acid base disorders are frequent in critically ill patients. They are more common in males as compared to females. Single disorders are more common than mixed disorders (double and triple disorders). Metabolic acidosis is the most frequent single disorder in our study.

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