PATTERN OF ARTERIAL BLOOD GASES DISORDERS IN ICU SETTING

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ABSTRACT

Objective: To determine the frequency and percentage of metabolic and respiratory acid base disorders in neonatal and adult intensive care units.

Material and Methods: This cross-sectional study was conducted in department of chemical pathology & endocrinology, Armed Forces Institute of Pathology, Rawalpindi from Jan 2018 to December 2018.

A total of 261 blood samples were collected in neonatal and adult Intensive Care Setting (ICU) from patients indwelling arterial catheters, sealed anaerobically, chilled, heparinized and sent for immediate analysis of Arterial Blood Gases (ABGs) on COBAS b 221 by potentiometric and voltammetry principles. Statistical analysis was done on SPSS 21.

Result: Among 261 patients, 163 (62.5%) were male and 98 (37.5%) we females. Test of normality (Shapiro-Wilk) was significant (p-value <0.001) showing non-parametric nature of data. The median age was 49 years with interquartile range (IQR) 33 years. When age was divided into different groups; <18 years was 24 (9.2%), 18-25 years was 21 (8.0%), 26-35 years 46 (17.6%), 36 -45 years was 35 (13.4%) and >45 years was 135 (51.7%). Outcome analysis of arterial blood gases (ABGs) showed; Only two (0.8%) patients had evidence of normal results, 49(18.8%) had partially compensated metabolic acidosis, 13(5.0%) were suffering from partially compensated metabolic alkalosis,14(5.4%) with partially compensated respiratory alkalosis, 49(18.8%) had partially compensated respiratory acidosis, 98(37.5%) with double disorder metabolic acidosis and respiratory alkalosis, 9(3.4%) with double disorder metabolic acidosis and respiratory acidosis, 14(5.4%) with double disorder metabolic alkalosis and respiratory alkalosis, 9(3.4%) double disorder metabolic alkalosis and respiratory acidosis, 2(0.8%) with uncompensated respiratory acidosis and 2(0.8%) with uncompensated respiratory alkalosis.

Conclusion: Metabolic acidosis with respiratory alkalosis i.e. double acid base disorder was the commonest acid base disorders in critically ill patients (both neonate and adult) because of multi-organs disease and without any significant difference among male and female patients.

Keywords: Arterial blood gases (ABGs), Acid base disorders, anion gap (AG).

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INTRODUCTION

Arterial blood gases (ABGs) analysis is a common test in emergency department and intensive care units for monitoring patients with acid-base imbalances [1-2].There are different acids base disorders; single i.e. metabolic and respiratory acidosis and alkalosis with or without partial compensation, secondly, double disorders (metabolic acidosis with respiratory alkalosis, and metabolic alkalosis with respiratory acidosis) and triple disorders calculated by delta delta ratio (aniongap-12/24- $HCO3^-$) [3]. Kidneys and lungs help to maintain this balance which is accomplished by a most common bicarbonate enzyme system in our body. In case of imbalance, there may be an acidosis or an alkalosis [4]. ABGs are sampled by drawing blood from radial artery mostly as it is easily palpated and provides the most efficient assessment of PCO2 and PO2 in the body. This test is used to check how our renal and lungs systems are working and can exchange oxygen and carbon dioxide [5]. Accuracy in the ABGs results depend on the proper collecting, handling, and analyzing the specimen. Most commonly encountered errors include sample taken from non-arterial source, air bubbles in the sample, inadequate or excessive anticoagulant in the sample, and delayed analysis of a non-cooled sample. Lungs (respiratory compensation) and the kidneys (metabolic compensation) are the two main organs which regulate acid-base balance. In blood gases analyzers Direct potentiometry is most commonly used, whereas direct potentiometry is commonly used in large chemistry analyzers. An arterial blood gas analyzer measures partial pressure of oxygen (PO2), carbon dioxide (PCO2), pH measures hydrogen ions(H+) in the blood, Bicarbonate (HCO3) and Oxygen saturation (SO2) [6-7] were indirectly measured with Henderson-Hasselbalch equation. Critical care setting both in adult and neonate is an important field worldwide for patient care and acid base disorders was identified as a terminal diseases

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outcome in critically ill patients [8-9]. This is the most important cause of death after ischemic heart diseases. Interpretation of ABGs parameters along with electrolytes is cumbersome for diagnosing different single, double and triple acid base disorders and technical expertise required in most cases [10-11]. This field was less developed in Pakistan and minimal studies available on this issue. The nature of illness and management of diseases in ICU setting are very difficult and urgent. So in order to enhance the awareness, we had planned a study to check the prevalence of different acid-base disorder in ICU setting, so, that we can understand the acute or chronic nature of acid base disorders and their compensation and find out the importance of different ABGs measured and calculated parameters for diagnosis of metabolic and respiratory acid base disorders in ICU setting.

MATERIAL AND METHODS

This study was conducted in Department of Chemical Pathology & Endocrinology, Armed Forces Institute of Pathology, Rawalpindi from January 2018 to December 2018 and blood samples were taken from 261 patients admitted in neonatal/adult, medical and surgical ICUs with consent. Blood samples were collected from patients indwelling arterial catheters, sealed anaerobically, chilled, heparinized and sent for immediate analysis of ABGs and electrolytes (sodium, potassium and chloride) on COBAS b 221 by potentiometric and voltammetry principles. For diagnosis of different acid base disorders, following compensation formulas had been used; for metabolic acidosis partial compensation (PCO2=1.5 x HCO3 +8 ±2), for metabolic alkalosis partial compensation (PCO2= 0.9 x HCO3 + 9), for respiratory acidosis-acute compensation (HCO3 increase by 1 mmol/l for each 10mmHg within 24 hours of admission with this disorder and chronic respiratory acidosis compensation in which HCO3 increase by 3.5 mmol/l for each 10mmHg after 24 hours of admission with this disorder and similarly, for respiratory alkalosis acute compensation (HCO3 decrease by 2 mmol/l for each 10mmHg fall and for chronic cases HCO3 decrease by 5mmol/l for each 10mmHg fall. Anion gap was calculated by formulae = ($Na^+ + K^+$) - ($Cl^- + HCO3^-$) with reference range of 07 to 18 mmol/l. The delta ratio is used for the determination of a mixed acid base disorder in an elevated anion gap metabolic acidosis with formulae = Measured anion gap –12 / 24 – measured HCO3 with following interpretation; <0.4 - hyperchloremic normal anion gap acidosis, 0.4 - 0.8 -renal failure or Combined high AG & normal AG acidosis, 1 to 2 uncomplicated high-AG acidosis and >2 -a pre-existing elevated HCO3 level due to: a concurrent metabolic alkalosis, or a pre-existing compensated respiratory acidosis as mentioned in Fundamental of clinical chemistry by TIETZ edition sixth. Statistical analysis done on Statistical Package of Social Sciences 21 by both descriptive (frequencies and percentages for qualitative variables and median and IQR for nonparametric quantitative variables) and inferential statistics in the form of nonparametric independent t statistic.

RESULTS

Among 261 patients, 163 (62.5%) were male and 98 (37.5%). Test of Normality (Shapiro-Wilk) was significant (p-value <0.001) showing non-parametric nature of data. The median age was 49 years with interquartile range (IQR) 33 years. Admitted patient's distribution were; from NICU 8 (3%), Medical 227(87%) and surgical 26(10%) ICUs. Age was divided into different groups; <18 years was 24 (9.2%), 18-25years was 21 (8.0%), 26-35 years 46 (17.6%), 36-45 years was 35 (13.4%) and >45 years was 135 (51.7%) as shown in Figure-1.

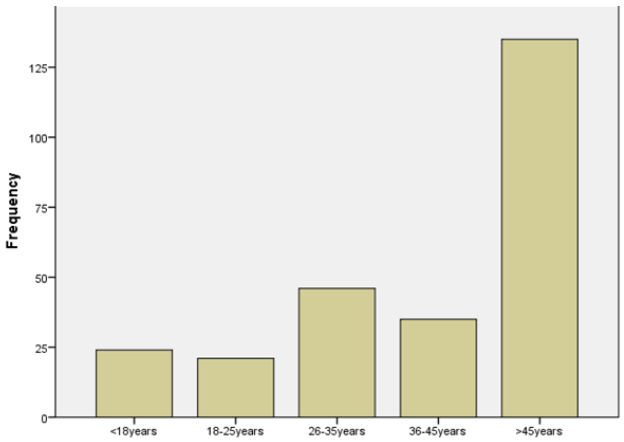

Figure-1: Distribution of study population in different age's groups.

Descriptive statistics showed median (IQR) of pH 7.393 (0.09), PO2 mmHg 92.2 (75.6), PCO2 mmHg 31.9 (10.8), HCO3 mmol/l 19.8 (6.45), SO2 % 96.8 (6.95) and anion gap 12 (3) respectively. Independent t statistics of non-parametric data was done showing no difference among gender for age (p-value=0.987), pH (p-value=0.936), PO2(p-value=0.107), PCO2 (p-value=0.575), HCO3(p-value=0.218) and anion gap (p-value=0.360), while significant difference observed in SO2 (%)(p-value=0.022) in male and female. Median (IQR) of study population were shown in table 1 and mean

plot of quantitative variables (pH, PO2, PCO2, HCO3, SO2 and Anion gap) showing the nonparametric distribution of data in Figure-2.

Table-1: Base line characteristic of study group (n=261).

	Median (IQR)
Age (years)	49(33)
pH	7.393(0.09)
PO2 (mmHg)	92.2(75.6)
PCO2(mmHg)	31.9(10.8)
HCO3 (mmol/l)	19.8(6.45)
SO2 (%)	96.8(6.95)
Anion gap	12(3)

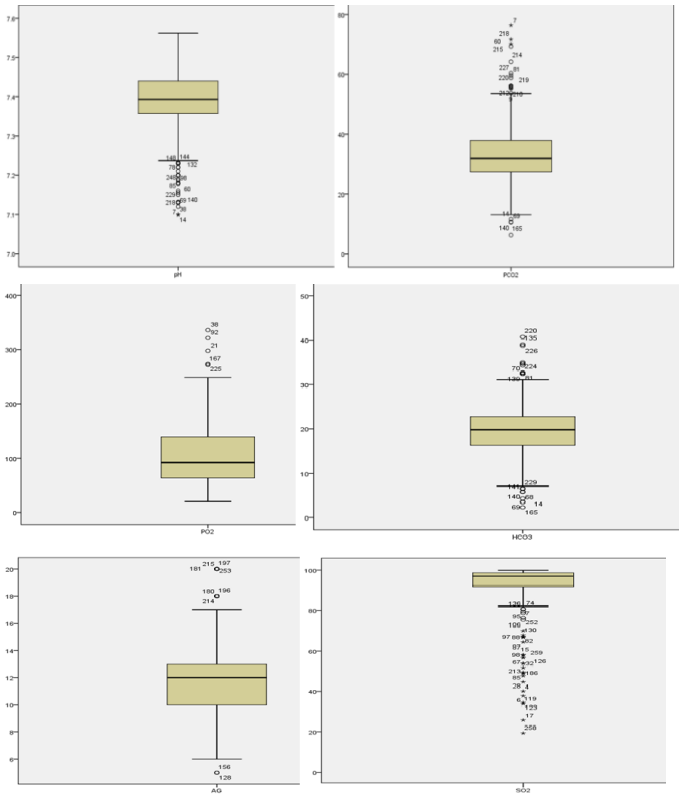

Figure-2: Mean plot for normality assessment of arterial blood gases parameters.

Outcome analysis of ABGs showed; Only two (0.8%) patients had evidence of normal results, 49(18.8%) had partially compensated metabolic acidosis, 13(5.0%) were suffering from partially compensated metabolic alkalosis,14(5.4%) with partially compensated respiratory alkalosis, 49(18.8%) had partially compensated respiratory acidosis,98(37.5%) with double disorder metabolic acidosis and respiratory alkalosis, 9(3.4%) with double disorder metabolic acidosis and respiratory acidosis, 14(5.4%) with double disorder metabolic alkalosis and respiratory alkalosis, 9(3.4%) double disorder metabolic alkalosis and respiratory acidosis, 2(0.8%) with uncompensated respiratory acidosis and 2(0.8%) with uncompensated respiratory alkalosis as shown in Figure-3.

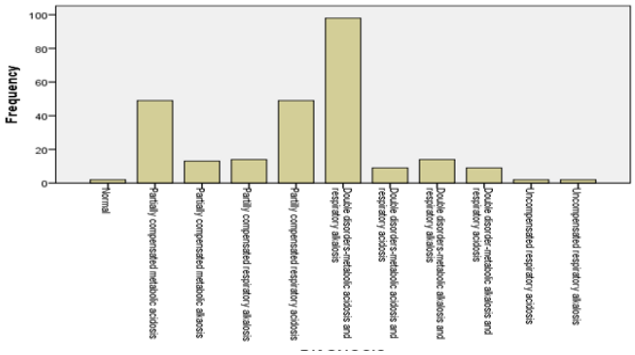

Figure-3: Outcome analysis of study population.

DISCUSSION

In our study which was done on ABGs analysis in ICU setting both in neonatal and adult population showing variable diagnosis of patients. The most common being double disorder-metabolic acidosis and respiratory alkalosis. The reason for this disorder was most probably due to participants medical illness related with diabetes mellitus, renal failure, and septicemias in which compensatory process was not who were suffering from lung diseases as terminal illness were minimum and were only those who need ventilator support. It was not matched with the one of the previous studies which showed hyperchloraemic metabolic acidosis was the commonest disorder following open cardiac surgery in the clinical setting [14]. Majority of previous studies showed metabolic acidosis as a single acid base disorder in most critical care setting which may be either high anion gap due to diabetes mellitus and renal failure or hyper chloraemic metabolic acidosis due to diarrhea [12]. In our ICU setting, male predominance was observed over female patients which is quite similar to previous study because critically ill male population has more influx in hospitals. Females due to lack of knowledge, limited social circle have less influx in hospitals which was similar to previous studies [13]. Anion gap was calculated for complete assessment of acid base disorder showing non-significance nature of this parameter for both male and female in critical care setting as no case of triple acid base disorder was identified in our study, this finding was dissimilar to previous studies [14-15] done in ICUs setting The reason may be due to acute nature of diseases of our study participants. So, for provision of prompt management, delta ratio calculation used for triple

disorder diagnosis was not required, in this way we could avoid unnecessary delay in treatment and this fact would also be helpful in small laboratory due to non-availability of modern analyzer containing both ABGs and electrolytes simultaneously.

There were some limitations in our study which include single center study, disease progression and detailed case history was not taken and small sample size was used in our study.

CONCLUSION

Metabolic acidosis with respiratory alkalosis i.e. double acid base disorder was the commonest acid base disorders in critically ill patients (both neonate and adult) because of multi-organs disease and without any significant difference among male and female patients.

AUTHORS CONTRIBUTION

Muhammad Aamir: Manuscript preparation and proof reading

Barka Urooj: Data collection

Safia Fatima: Literature review, manuscript preparation

Asif Ali Memon: Statistical Analysis

Sobia Iram: Literature review

Muhammad Tahir Khadim: Overall supervision

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