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Research Article

A STUDY OF ACID BASE DISTURBANCES IN MEDICAL INTENSIVE CARE UNIT AT KING GEORGE HOSPITAL, VISAKHAPATNAM

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A R T I C L E I N F O

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A B S T R A C T

Acid–base disturbances are very common in medical intensive care unit patients as well as contribute significantly to morbidity and mortality. An understanding of the pathophysiology of these disorders is vital to their proper management. This review will discuss the etiology, pathophysiology and treatment of acid–base disturbances in intensive care patients.

Materials and methods: Arterial blood gas (ABG) analysis was done in 155 patients admitted in Medical intensive care unit (MICU) regardless of its primary cause in at department of General Medicine, andhra medical college from From April 2018 To March 2019 patient at time of admission to the MICU. Type of acid base disorder was primary variable of interest.

Results: Of the 155 patients, ABG was Normal in present in 30 patients (19.35%), 39 patients (25.16%) had simple acid base disorder, 84 patients (54.19%) had combined ABD and remaining 2 (1.29%) had Triple acis base disorder. The most common aetiology was Sepsis (16.1%) followed by CKD (12.9%) and COPD (10.3%). Among the study population, Mortality was seen in 39 (25.16%) subjects and the remaining 116(74.84%) were alive.

Conclusion: Increasing age (≥ 60 years) is associated with increased risk of acid base disturbances mostly between 40 to 70 years. The most common acid base disorder observed was mixed type is metabolic and respiratory acidosis and most common simple acid base disorder was metabolic acidosis. Most common etiologies were sepsis, COPD, CKD. SEPSIS has high mortality with poor recovery. The mortality and morbidity was more severe in extreme academia and alkalemia.

INTRODUCTION

Acid Base abnormalities are common in critically ill patients. Our ability to describe acid base disorders must be precise. Small differences in corrections for anion gap, different types of analytical processes, and the basic approach used to diagnose acid base aberrations can lead to markedly different interpretation and treatment strategies for the same disorder.[1]

To maintain homeostasis the body has to keep [H+] ions concentration at 40nanomoles/L.[2] A blood pH less than normal (normal range 7.35 –7.45) is called acidemia; the underlying process causing acidemia is called acidosis. Similarly alkalemia and alkalosis refer to the pH more than normal and underlying process respectively.

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The metabolic and respiratory that regulate systemic pH are described by the Henderson – Hasselbach equation;[3]

$pH = 6.1 + \log (HCO3 / PaCO2 \times 0.03)$

Alternatively H+ ions can be expressed directly as

$H+ = 24 \times (PCO2 / HCO3-)$

Primary change in PaCO2 can cause acidosis or alkalosis, depending on whether PaCo2 is above or below the normal value of 40 mm Hg. Primary alkalosis of PCo2 evokes cellular buffering and renal adaptation. A primary change in the plasma HCO3– as a result of metabolic or renal factors results in compensatory changes in ventilation that blunt the changes in blood pH.

Such respiratory alterations are referred as secondary or compensatory changes, since they are occurring in response to primary metabolic changes. Simple and mixed acid base disorders are commonly encountered in clinical practice and are particularly frequent in critically ill patients.

Acid base disorders contribute importantly to patient morbidity and mortality, especially in critically ill.[4] Therefore

it is essential to recognize and properly diagnose acid base disorders and understand their impact on organ function.

Aims and Objectives

To study the pattern of acid base disturbances and to elicit the causes for acid base disturbances.

MATERIALS AND MEDTHOD

This is a Hospital based descriptive cross sectional study conducted on 155 patients 18 years and above admitted in MICU regardless of its primary cause in at department of General Medicine, andhra medical college from From April 2018 To March 2019

Inclusion Criteria

- All patients, aged more than 18 years, who got admitted in MICU

Exclusion Criteria

- Less than 18 years age
- All surgical patients
- All obstetrics and Gynaecological patients

An arterial sample taken from either radial artery or femoral artery from every patient at time of admission to the MICU and sent for ABG analysis. Type of acid base disorder was primary variable of interest. Age, gender, aetiology etc. were considered as other relevant variables. Mortality was considered as the outcome to be compared across various explanatory variables.

Descriptive analysis: Descriptive analysis was carried out by mean and standard deviation for quantitative variables, frequency and proportion for categorical variables. The association between explanatory variables and categorical outcomes was assessed by cross tabulation and comparison of percentages. Chi square test was used to test statistical significance. P value < 0.05 was considered statistically significant.

RESULTS

Sex Distribution: Among 155 patients 95 were males and 60 were females.

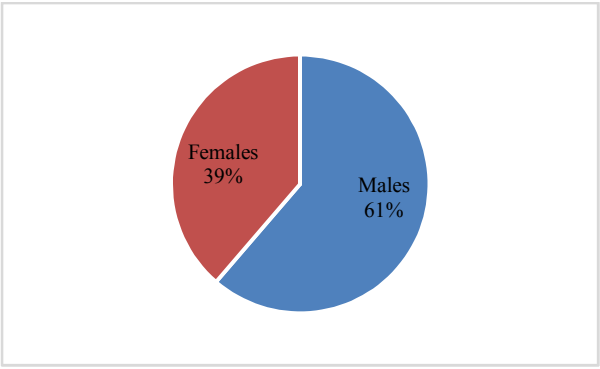

Figure I Percentage of sex distribution

Age Disrtibution: The mean age was 49.23 ± 16.75 the youngest person was aged 15 years and eldest was aged 84 years in the study population.

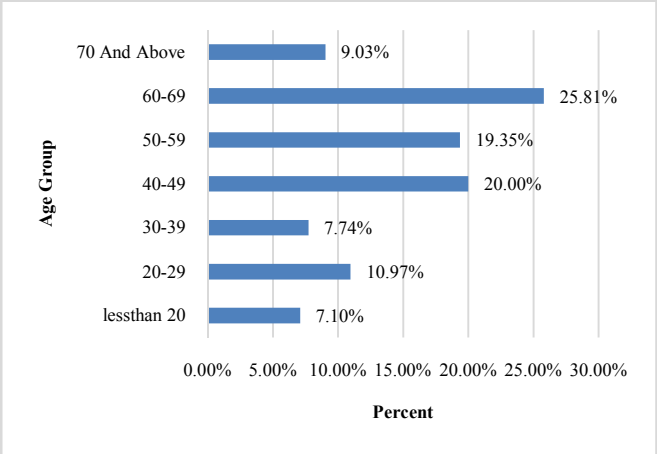

Figure II Bar chart of Age Group distribution in study group (N=155)

Among the study population, the no acid base disorder was present in 30(19.35%), 39(25.16%) subjects had simple acid base disorder, 84(54.19%) had combined ABD and remaining 2 (1.29%) had Tripple ABD.

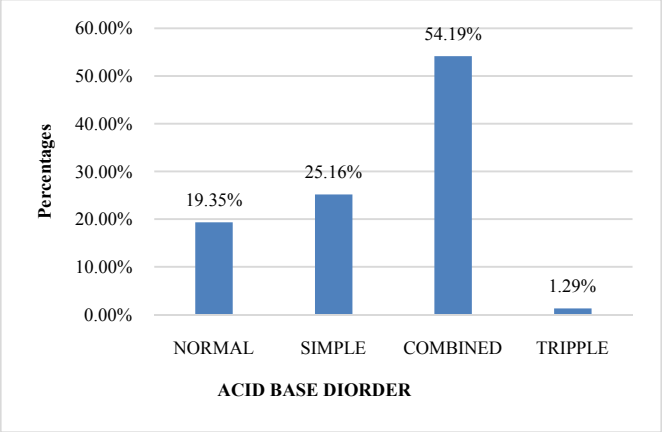

Figure III Prevalence of various acid base disorders

Among those 39 patients with simple acid base disorders, Metabolic Acidosis in 21(13.55%), Metabolic Alkalosis in 3(1.94%), Respiratory Acidosis in 8(5.16%) and Respiratory alkalosis in 7(4.52%).

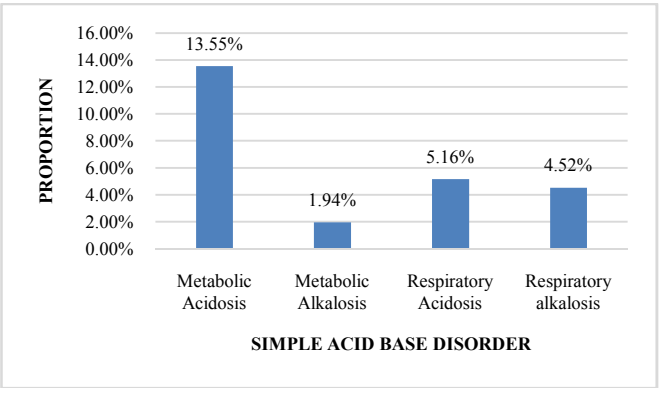

Figure IV Prevalence of various simple acid base disorders

Among those 84 patients with combined acid base disorders, metabolic acidosis plus respiratory acidosis in 27(17.42%), respiratory acidosis plus metabolic alkalosis in 15(9.68%), metabolic alkalosis plus respiratory alkalosis in 19(12.26%), metabolic acidosis plus respiratory alkalosis in23(14.84%)and triple disorder in 2(1.29%) samples respectively

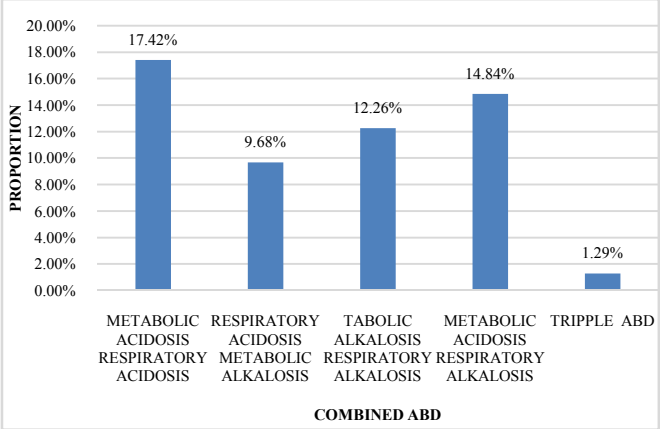

Figure V Prevalence of combined acid base disorders in study group

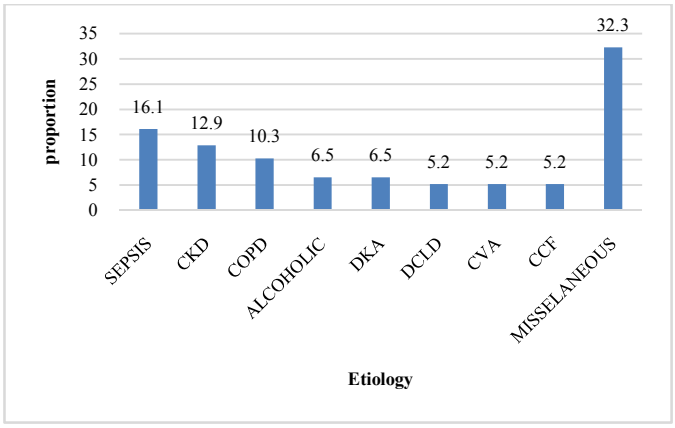

Figure VII BAR graph showing proportion of Various aetiologies in study population

Table I Descriptive analysis for P^H, PCo2, PO2, HCO3, Na, K, Cl, anion gap, in study population (N=155)

Parameter	Mean ± STD	Median	Min	Max	95% C.I. for EXP(B)	
					Lower	Upper
pH	7.340 ± 0.147	7.37	6.87	7.62	7.32	7.36
PCo2	44.00 ± 24.87	38.00	7.00	169.40	40.05	47.95
PO2	86.11 ± 23.74	91.30	17.10	200.00	82.34	89.88
HCO3	23.23 ± 9.395	24.00	2.10	59.10	21.75	24.73
Na	132.0 ± 8.073	134.00	1.80	36.00	130.74	133.31
K	4.091 ± 2.726	3.90	1.80	36.00	3.66	4.52
Cl	101.4 ± 10.09	100.00	73.00	140.00	99.83	103.03
anion gap	7.461 ± 13.38	7.00	-31.00	59.00	5.34	9.59

The mean pH., PCo2, PO2, HCO3, Na, K, Cl, and anion gap, are summarized in table 1. The minimum and maximum anion gap in study population was-31.00 and 59.00 respectively. (Table 1)

Among the study population, Mortality was seen in 39 (25.16%) subjects and the remaining 116(74.84%) were alive.

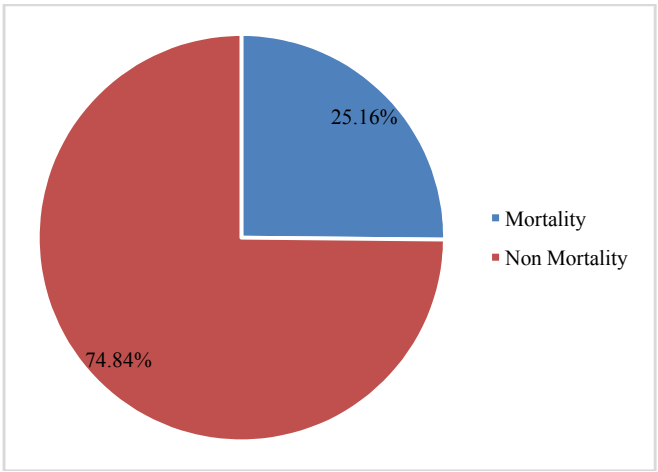

Figure VI Pie chart of Outcome distribution in study group (N=155)

The most common aetiology was Sepsis (16.1%) followed by CKD (12.9%) and COPD (10.3%). Other common aetiologies were alcoholism, DKA, DCLD, CVA and CCF.

Table XIV Acid base disorder pattern in different aetilogies

Diagnosis	ABD 4 GROUPS		
	NORMAL	SIMPLE	COMBINED (Double & triple)
COPD	0 (0%)	4 (25%)	12 (75%)
SEPSIS	0 (0%)	8 (32%)	17 (68%)
CKD	0 (0%)	4 (20%)	16 (80%)
DCLD	2 (25%)	3 (37.5%)	3 (37.5%)
CVA	7 (87.5%)	0 (0%)	1 (12.5%)
ALCOHOLIC	3 (30%)	3 (30%)	4 (40%)
CCF	0 (0%)	2 (25%)	6 (75%)
MISSELANEOUS	18 (36%)	13 (26%)	19 (38%)
DKA	0 (0%)	2 (20%)	8 (80%)

Table IV Comparison of mortality in different aetiologies

Diagnosis	Outcome	
	Mortality	Non Mortality
COPD	5 (31.25%)	11 (68.75%)
SEPSIS	18 (72%)	7 (28%)
CKD	6 (30%)	14 (70%)
DCLD	4 (50%)	4 (50%)
CVA	0 (0%)	8 (100%)
ALCOHOLIC	0 (0%)	10 (100%)
CCF	0 (0%)	8 (100%)
MISSELANEOUS	8 (16%)	42 (84%)
DKA	0 (0%)	10 (100%)

DISCUSSION

Disturbances of the acid base equilibrium occur in a wide variety of critical illnesses and are among the most commonly encountered disorders in the ICU. In addition to reflecting the seriousness of the underlying disease, these disorders have their own morbidity and mortality. This study has been undertaken to focus on acid base disturbance in critically ill patient, admitted in King George Hospital, Visakhapatnam.

Among the study population, number of females was 60(38.71%), and number of males was 95(61.29%).

Among the study population, majority of the subjects were age between 40 to 49 years account for 31(20%).

The most common acid base disorder observed in our study is of mixed variety, with 54.19% of patients and only 25.16% of the patients had simple acid base disorder. This observation is consistent with the study of Ataman Köse *et al*.[5]

Among the simple acid base disorder the most common is metabolic acidosis 21(13.55%). This is not consistent with Tripathy S[6] study shows metabolic alkalosis is most common Next common respiratory acidosis 8 (5.16%), respiratory alkalosis 7 (4.52%), metabolic alkalosis 3 (1.94%). Song ZF *et al*[7] study shows mixed acidbase disorder is most common and metabolic acidosis is most common in critically ill patients.

Among the combined acid base disorder, most common is metabolic acidosis and respiratory acidosis in 27(17.42%), followed by respiratory acidosis and metabolic alkalosis in 15(9.68%), metabolic alkalosis and respiratory alkalosis in 19(12.26%), metabolic acidosis and respiratory alkalosis in 23(14.84%) and tipple disorder in 2(1.29%) respectively.

SEPSIS, COPD, CKD, DKA, DCLD, CCF, CVA, ALCOHOLIC INTOXICATION are the most common causes of acid base disorders in intensive medical care unit together accounting for 62% of cases

SEPSIS is the most common cause of acid base disturbance in our study, which is 16%. CKD accounts for 12.9%.COPD accounts for 10%, DKA and alcoholics accounts for 6.5% each. DCLD, CVA, and CCF accounts for 5%. MISCELLENEOUS account for 32%.

In sepsis 32% had simple acid base disorder and 68% had mixed acid base disorder. The most common acid base disorder is mixed metabolic and respiratory alkalosis. Simon Kreü *et al*[8] study shows metabolic alkalosis most common cause of acid base disturbance in sepsis, my study results shows metabolic alkalosis in mixed form. Most Common simple acid base disorder in sepsis is metabolic acidosis, This study is consistent with results of Noritomi *et al*[9], Toedo Maciel A *et al*[10] showing simple metabolic acidosis is common in patients with severe sepsis and poor recovery. (Mixed metabolic acidosis and respiratory alkalosis accounts for 4 cases, mixed respiratory acidosis and metabolic alkalosis accounts for 2 cases, mixed metabolic acidosis respiratory acidosis accounts for 2 cases and simple respiratory alkalosis account for 2 cases. Out of 25 cases 18 had expired, accounting for a mortality rate of 72%. 2 patients had pH less than 7.2, and the rest in between 7.2 – 7.6.

Blood gas analysis may often reveal hypoxemia due to intra pulmonary shunting before the classical radiological appearance of ARDS develops. It is evident that patient do not usually die of hypoxemia but from the complex disturbances that result from multiple organ system failure. Thus the aim in the management of ARDS is to support all body systems until the integrity of the alveolar capillary membrane is restored. Early recognition with appropriate pharmacological and supportive therapy favourably influences the prognosis. Patients treated with antimicrobials to which the organisms are sensitive do survive better than those in whom the treatment was not appropriate. However the general condition and the presence or absence of shock is powerful independent variables.

The onset of hypoxia indicates severe disease and high risk for ARDS. This has been proved in our study which shows major acid base disturbance in sepsis is metabolic and respiratory alkalosis; most patients had expired thus providing hypoxia is a marker of severity of illness. Statistical analysis of survival in response to pH, The severe alkalemia and severe acidaemia is associated with high mortality. Several studies have shown that severe alkalemia and acidaemia is associated with high mortality in medical ward patients. Studies by Tripathy S[6] have shown the death rate is higher among the medical patients with alkalemia and mixed metabolic and respiratory alkalosis appears to be associated with a particularly poor prognosis.)

CKD is seen in 20 patients; of whom 6 patients had expired. The simple metabolic acidosis is seen in 4 cases and mixed acid base disorder in 16 cases. Most common cause of acid base disorder is metabolic acidosis in CKD either in simple or mixed form .This study is matched with Jeffrey A.Kraut[11], study showing metabolic acidosis common in CKD patients.

COPD is seen in 16 patients. All of them had type II respiratory failure. Out of which 5 had expired and 12 had mixed acid base disorders (75%). The most common acid base disorder in COPD is mixed respiratory acidosis and metabolic alkalosis followed by simple respiratory acidosis. My study consistent with Cosimo Marcello Bruno[12] showing respiratory acidosis is common acid base disturbance in COPD , followed by respiratory acidosis and metabolic alkalosis in chronic cases due to renal compensation. Respiratory acidosis and metabolic acidosis accounts for 2 cases and respiratory alkalosis and metabolic alkalosis 1 case. Only 4 patients had pH less than 7.2. Non-invasive ventilation is an important recent advance in the management of patients with acute respiratory failure complicating COPD. A number of large, well conducted, randomized studies have shown that non-invasive ventilation improves survival in COPD patients with an acute respiratory acidosis and reduces the need for intubation. The achievement of adequate alveolar ventilation, as indicated by falling $PaCO_2$, improving pH and satisfactory inspiratory chest wall movement, is the target.

DKA is seen in 10 patients,. Mixed acid base disorder is the most common abnormality seen in 80% of the cases. All of them had pH in between 7.2 – 7.6. All the patients with DKA had an element of metabolic acidosis either simple or mixed form. The underlying ketosis causes high anion gap acidosis.

Vomiting or nasogastric suction can cause metabolic alkalosis in DKA. Underlying sepsis precipitating DKA can cause respiratory alkalosis apart from neurogenic hyper ventilation. Mixed metabolic acidosis and respiratory alkalosis is most common acid base disorder followed by simple metabolic acidosis this is matched with. Elisaf MS *et al*[13] study, this study shows metabolic acidosis most common followed by mixed metabolic acidosis and respiratory alkalosis in presence of DKA with pneumonia or sepsis.

Alcoholic intoxication is seen in 10 patients. 40% of patients had mixed disorder, most common is metabolic alkalosis and respiratory alkalosis. Respiratory alkalosis is seen in 2 patients. Metabolic acidosis in one patient. This observation is consistent with Dobes M[14] (1993) who did a prospective study

of 77 alcoholics with delirium tremens and in 62 patients (80.5%) respiratory alkalosis was detected. The main cause of respiratory alkalosis is rebound phenomenon of the respiratory center which causes hyper ventilation. Whatever the acid base disturbance in alcoholic ketosis, administration of glucose, thiamine and rehydration is usually adequate to deal with the metabolic disturbance.

DCLD is seen in 8 patients, The most common acid base disorder was mixed metabolic and respiratory alkalosis. This is consistent with VANAMEE P *et al*[15] shows respiratory alkalosis most common in hepatic coma. 2 patients had respiratory alkalosis and 1 patient had metabolic alkalosis. The mortality rate was 50%.

CCF is seen in 8 patients, The most common acid base disorder was mixed metabolic and respiratory acidosis, this is matched with Avery WG *et al*[16] study.

CVA is seen in 8 patients, most of patients had normal acid base balance, acid base imbalance seen in one patient is metabolic and respiratory alkalosis.

In the miscellaneous accounts for 50 patients, 4 had anaemia, 4 had hyponatraemia, 3 had bronchopneumonia, 3 had pneumothorax, 3 had diarrhea, 2 had ARDS, 3 had CVT, 3 had GTCS, 2 had OSA , 2 had IWMI, 2 had OPC poisoning, 2 had ILD, 2 had ITP, 1 had pyelonephritis , PTE, PTB, myasthenia , muscular dystrophy, hanging, hypoglycemic seizures, amitryptiline poisoning, bronchiectasis, cardiorenal syndrome, cerebral abcess, cerebral neurocysticercosis, dengue shock , EVANS SYNDROME with thrombocytopenia, GBS, snakebite, tuberculoma. The most common acid base disorder observed in this group is metabolic acidosis. Out of 50 patients 8 patients had expired accounting for a mortality rate of 16%.

While analyzing p^H and survival rate our study is well correlated with any other studies. Of the total 155 patients 39 patients had expired accounting for a mortality rate of 25.16%. Of which 22 of them had p^H less than 7.2; and 133 were between 7.2 and 7.6. Of the total cases of 22 who fall under p^H less than 7.2, the mortality rate was 40%. Among the 133 cases, pH between 7.2 and 7.6, 30 patients expired with mortality rate of 22.55%.

Irrespective of primary pathology it is the severe acidemia and alkalemia that largely determines the patient status and prognosis. Our study is consistent with the statement.

CONCLUSION

- Increasing age (≥ 60 years) is associated with increased risk of acid base disturbances mostly between 40 to 70 years
- The most common acid base disorder observed was mixed type is metabolic and respiratory acidosis and most common simple acid base disorder was metabolic acidosis
- Most common etiology was sepsis, COPD, CKD, DKA, DCLD, CCF, CVA, Alcoholic intoxication.
- SEPSIS has high mortality with poor recovery
- The mortality and morbidity was more severe in extreme academia and alkalemia

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