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A Study On Arterial Blood Gas Analysis in Patients With Severe Acute Bronchial Asthma

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Abstract:*Arterial blood gas analysis is widely used and is a direct measurement of pH , PaO_2 , $PaCO_2$. The advent of arterial gas analysis has revolutionized the field of Respiratory medicine especially bronchial asthma.****Aim:****To compare and correlate the values of arterial blood gas analysis in patients with severe acute bronchial asthma* ***Objectives:*** *To measure PaO_2,$PaCO_2$ variations in pH, variations in bicarbonate levels in severe acute bronchial asthma.* ***Settings and Design:****It is a hospital based observational study conducted at Siddhartha medical college, Vijayawada, Andhra Pradesh during the period from May 2019 to July 2019.* ***Methodology:*** *40 Patients aged between 25 to 75 years both male and female presented to hospital with severe acute attack of asthma are included in the study.****Results:*** *It is a hospital based observational study, patients tested for ABG analysis, Tables are generated age wise, gender wise, acid base, PaO_2, $PaCO_2$ variations in Severe Acute Asthma and percentages calculated using IBM SPSS software. Total no of patients of ABG analysis, (n=40);* ***Age distribution*** *25-40 Years (n=11), percentage (%) of severe acute asthma 27.5% , 41-50 Years (n=6), percentage (%) of severe acute asthma 27.5%, 51-60 Years (n=6), percentage (%) of severe acute asthma 27.5%, 61-70 Years (n=8), percentage (%) of severe acute asthma 27.5%,71-80 Years (n=9), percentage (%) of severe acute asthma 27.5%;* ***Gender wise****, Female (n=23) percentage (%) of severe acute asthma 57.5, Male (n=17) percentage (%) of severe acute asthma 42.5;* ***pH Range****: normal (n=5), percentage (%) of severe acute asthma 17.5, respiratory acidosis percentage (%) of severe acute asthma 72.5%, respiratory alkalosis percentage (%) of severe acute asthma 10 %;****PaO_2 variations:*** *Normal (n=13) percentage (%) of severe acute asthma 32.5%, Decreased PaO_2: (n=27) percentage (%) of severe acute asthma 67.5%;* ***$PaCO_2$variations****: Normal (n=2) percentage (%) of severe acute asthma 5%, Hypocapnia: (n=5) percentage (%) of severe acute asthma 12.5%, Hypercapnia PaCO2: (n=33) percentage (%) of severe acute asthma 82.5%;* ***Bicarbonate levels:*** *Normal (n=29) percentage (%) of severe acute asthma 72.5%, Decreased HCO_3^- Levels: (n=3) percentage (%) of severe acute asthma 7.5%; Increased HCO3 levels (n=8) percentage (%) of severe acute asthma 20%.* ***Conclusions:*** *This study revealed that there are disturbances in acid base status, ventilation in severe acute bronchial asthma as analysed by ABG analysis. This serves as good guidefor physicians inmaking crucial decision regarding treatment of ill patients.*

Key words: Asthma, Arterial Blood Gas Analysis, PaO_2, $PaCO_2$, pH, Bicarbonate

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I. Introduction

Arterial blood gas analysis is widely used and it is a direct measurement of pH, PaO2, PaCO2. The advent of Arterial Blood Gas analysis has revolutionized the field of Respiratory medicine especially bronchial asthma. The evaluation of acid base status and oxygenation of any critically ill patients is crucial in treatment decision making and timely management. Bronchial asthma may be for some patients "the slight ailment that promotes longevity"(Oliver Wendell Holmes) but the aspect seen more commonly in hospital practice is the "Tyranny and cruelty of the disease" (Willis).Severe acute attack of asthma also known as "Status Asthmaticus" is a life-threatening emergency. Therefore, the physician caring the patient should be prompt enough to assess the severity of the episode and tend towards vigorous treatment and management so as to decrease morbidity and mortality of the patients. This makes it necessary to have more reliable methods of assessment, one of which is arterial blood gas analysis.So study of arterial blood gas analysis in asthmatics is helpful to observe the acid-base status, PaO_2, $PaCO_2$, HCO_3^- levels with acute severe attack at the time of admission in hospital.

II. Methodology

It is a hospital based observational study conducted at Siddhartha Medical College, Vijayawada, Andhra Pradesh during the period from May 2019 to July 2019. The target population are patients aged between 25 to 75 years, both males and females who are presented to hospital with severe acute attack of asthma are included in the study. Pregnant women, children, smokers,patients suffering from other respiratory disorders, asthmatic patients who have other co-morbid conditions involving cardiac, neurological, gastrointestinal, renal systems are excluded from the present study.Prior permissionwas taken from the ethical committee,headed by the Principal, Siddhartha Medical College, Vijayawada and Medical Superintendent,to conduct ABG analysis. Due care has been taken before, during and after the blood collection procedure for ABG analysis, educating about theblood collection procedure to minimize any discomfort or inconvenience to the patients. Blood collection was done under strict aseptic precautions from the right radial artery in the supine position. The blood sample is analysed with "MEDICA" a blood gas analyser giving pH,PaO_2,$PaCO_2$,HCO_3^-values.

Arterial blood collection and subsequent ABG analysis is done in a total of 40 cases of severe acute bronchial asthma,aged between 25 to 75 years presented to hospital. In the patients tested for ABG analysis Tables are generated Age wise, Gender wise, Acid base, PaO_2, $PaCO_2$ Variations in Severe Acute Asthma and percentages are calculated using IBM SPSS software.

III. Results

Figure No.1: Age Distribution of Patients Presented WithSevereAcute Bronchial Asthma

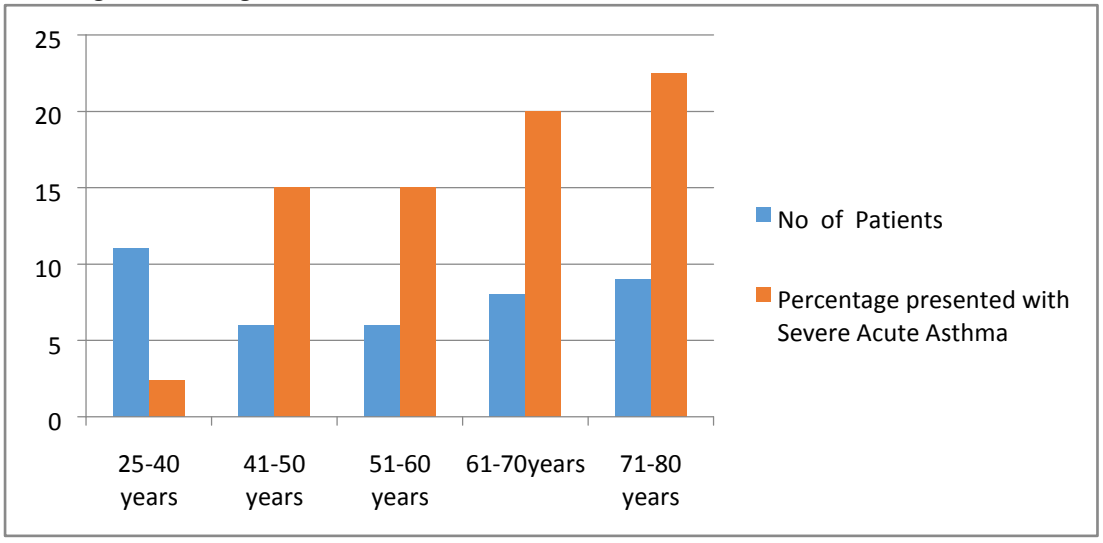

Figure No.2: Sex Distribution of Patients In Severe Acute Bronchial Asthma

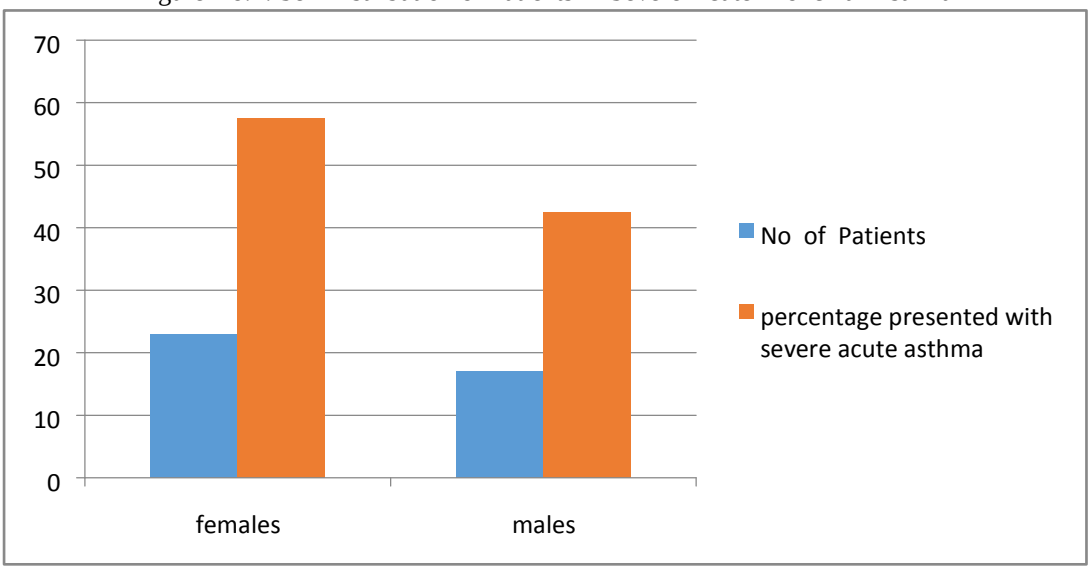

Figure No 3: Acid-Base Status in Severe Acute Bronchial Asthma

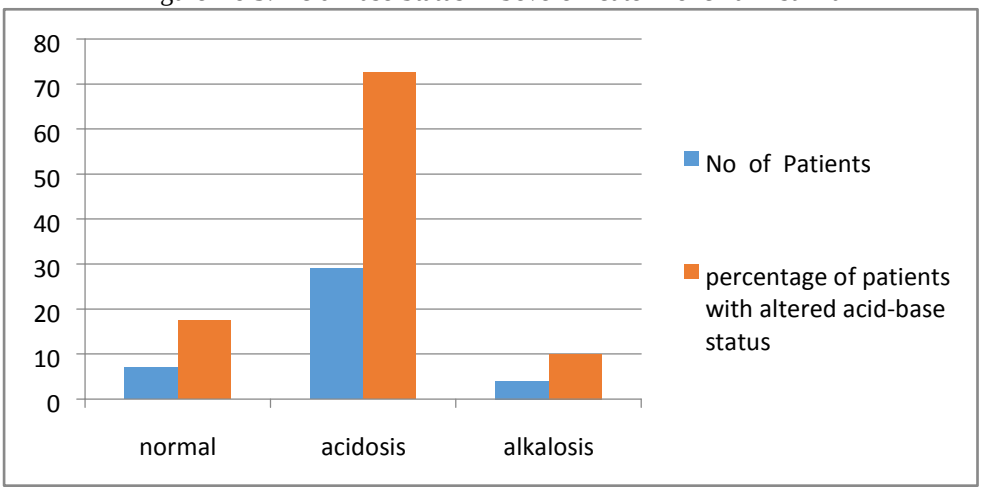

Figure No 4: PaO_2Variations in Severe Acute Bronchial Asthma

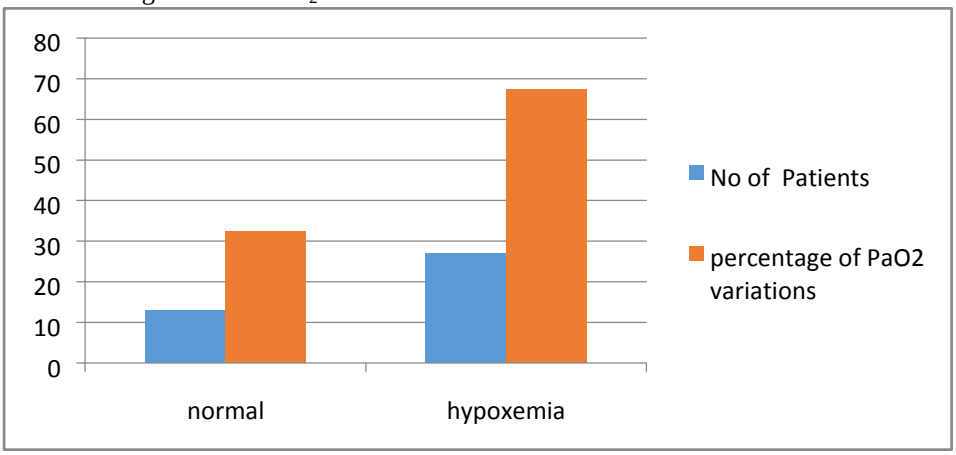

Figure No 5: Bicarbonate levels In Severe Acute Bronchial Asthma

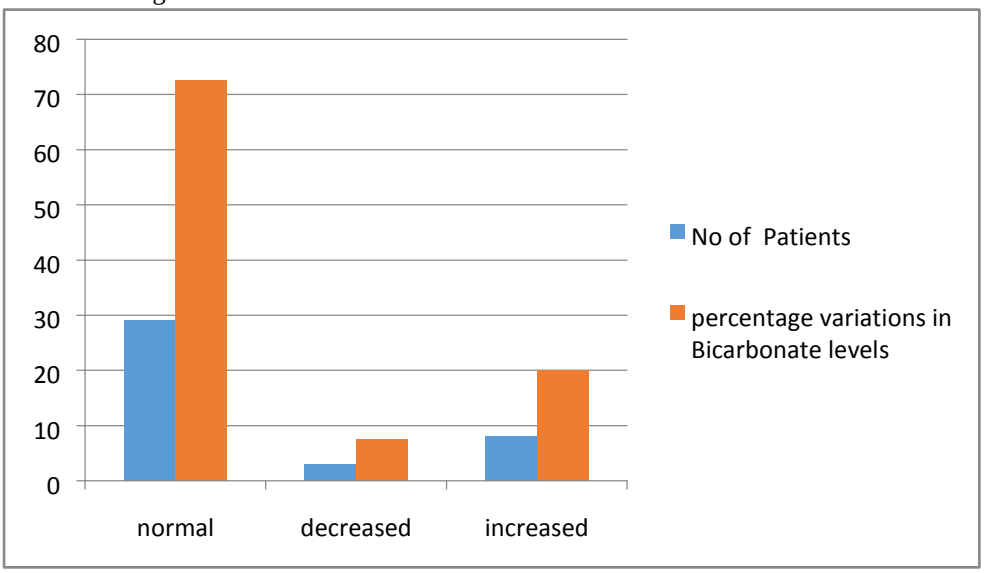

Table No 1: Age wise distribution of patients presented with severe acute bronchial asthma

AGE	NUMBER OF PATIENTS	PERCENTAGE
25-40 YEARS	11	27.5%
41-50 YEARS	6	15%
51-60 YEARS	6	15%
61-70 YEARS	8	20%
71- 80 YEARS	9	22.5%

Table No 2: Sex distribution of patients insevere acutebronchial asthma

SEX	NUMBER	PERCENTAGE
FEMALE	23	57.5%
MALE	17	42.5%
TOTAL	40	

Table No 3: Acid-base status in severe acute bronchial asthma

pH RANGE	NUMBER OF PATIENTS	PERCENTAGE
NORMAL	7	17.5%
RESPIRATORY ACIDOSIS	29	72.5%
RESPIRATORY ALKALOSIS	4	10%
TOTAL	40	

Table No 4: PaO2 variations in severe acute bronchial asthma

PaO_2	NUMBER OF PATIENTS	PERCENTAGE
NORMAL	13	32.5%
DECREASED PaO_2	27	67.5%

Table No 5: $PaCO_2$variations in severe acute bronchial asthma

$PaCO_2$	NUMBER OF PATIENTS	PERCENTAGE
NORMAL	2	5%
HYPOCAPNIA	5	12.5%
HYPERCAPNIA	33	82.5%

Table No 6: Bicarbonate levels in severe acute bronchial asthma

HCO_3^- LEVELS	NO OF PATIENTS	PERCENTAGE
NORMAL	29	72.5%
DECREASED BICARBONATE LEVELS	3	7.5%
INCREASED BICARBONATE LEVELS	8	20%

IV.Discussion:

Asthma is a disease ofpublic health importance. In this condition there occurs inflammation of air passages and effects the sensitivity of nerve endings in airways so that they become easily irritated causing the airways to swell and narrowing,thus decreasing the flow of air in and out of lungs.Severe acute bronchial asthma is a life threatening condition where the airways are very much narrowed affecting the ventilation. The change in ventilation alters the chemical composition of blood, especially PaO2,PaCO2,pH.Hydrogen ion concentration and respiratory gas composition of arterial blood profoundly influence respiration. The morbidity and mortality due to asthma has been greatly increasing,inspite of vast research, the cause for increased mortality and morbidity is still unknown.

Therefore the clinician should rely on the best investigations that gives information about oxygenation and ventilation status of patients,which helps in his/her further plan of management. The arterial blood gas analysis gives us information regarding oxygenation and ventilation status of an individual. So ABG analysis can be done on critically ill patients to derive information regarding their oxygenation and ventilation status.

In the present study pH,PaO_2,$PaCO_2$,bicarbonate levels were estimated in the patients presented with an attack of severe acute bronchial asthma. In the present study of arterial blood gas analysis in severe acute bronchial asthma at the time of admission in hospital, consists of 40 patients aged between 25-80 years , 11 patients between 25-40 years thus accounting for 27.5% study population, 6 patients between age group 41-50 years accounting for 15% of study population ,6 patients between age group of 51-60 years accounting for 15 % of study population,8 patients between age group 61-70 years contributing to 20% of study population and 9 patients between 71-80 years accounting for 22.5% of study population.

Out of 40 patients in study group 23 patients are females accounting for 57.5% and 17 patients out of 40 are males accounting for 42.5% of study population. The pH was less than normal range in 29 patients(72.5%),and was within normal range in 7 patients, and was above normal range in 4 patients(10%).The partial pressure of oxygen was normal in 32.5% of total study population (13 patients), and was decreased in 67.5% of total study population (27 patients) indicating hypoxemia. The partial pressure of carbon dioxide levels showed clear cut respiratory acidosis in 33 patients (82.5%) with PaCO2 levels more than 45 mmHg and pH less than 7.35. From the above results it was clearly indicating that the presentation of arterialblood gas analysis in severe acute bronchial asthma is not an uniform process. Statistical correlation of arterial blood gas analysis together with signs and symptoms serve as reliable guide for physician in monitoring the treatment and serve as prognostic factor. In the initial stages of disease, hypoxemia occurs due to ventilation perfusion mismatch and hypocapnia due to hyper ventilation.Therefore in a patient with severe acute bronchial asthma initial hyperventilation with hypocapnia(decreased partial pressure of carbon dioxide) i.e, respiratory alkalosis appears to be contradictory. This is explained as follows:The change in ventilation and perfusion alters the chemical composition of blood mainly PaO_2 ,$PaCO_2$ and pH.The hydrogen ion concentration and alterations in respiratory gas composition profoundly influence respiration. Response to carbon dioxide and blood pH depend on central chemo receptors located in brain and response to hypoxia depends mostly on peripheral chemoreceptors located in aortic and carotid bodies.In severe acute bronchial asthma there occurs marked airway inflammation resulting in airway narrowing.This causes increased resistance to air flow through airways(i.e.resistance is inversely proportionalto radius).But this increased resistance is not uniform throughout, resulting in preferential direction of inspired air to areas of lowest resistance.Thus relatively small volume of less than 30% of total lung volume is hyperventilated receiving more than 80% of inspired air resulting in washing out excess of carbon dioxide leading to hypocapnia, hyperventilation and increase in ventilation perfusion ratio and respiratory alkalosis.The rest of 75% of lung volume having higher airflow resistance will receive less amount of inspired air and fall in ventilation perfusion ratio resulting in hypoxemia.This hypoxemia can't be compensated by very few hyperventilating units,thus resulting in fall in partial pressure of oxygen. Partial pressure of carbon dioxide will be low, if the hyperventilating units wash off excess CO_2.It will be normal when there is a balance between hypoventilating and hyperventilating units. In the present study 7 patients are showing decreased partial pressure of carbon dioxide indicating early stage of severe acute bronchial asthma. Out of 7 patients with decreased $PaCO_2$ levels, 6 cases are having decreased partial pressures of oxygen indicating that some bodily mechanisms have taken place,i.e. hyperventilation, but this results are indicating that hyperventilating units are able to wash off additional CO_2 levels from body but cannot compensate for severe hypoxemia.

In the present study $PaCO_2$ levels are raised in 21 patients accounting for 52.5% of study population indicating typical cases of respiratory acidosis in which their condition is worsened and overall ventilation perfusion is altered. In the present study $PaCO_2$ levels are normal in 12 patients indicating an equilibriumbetween hypoventilating and hyper ventilating units . In the study conducted byE.Tai and John Reed on 12patients with severe acute asthma,5 patients out of 12 had hypoxemia with PaO_2 ranging between 39 to 62 mmHg,7 patients out of 12 presented with hypercapnia with PaCO2> 50mmHg and the patients are having low pH less than 7.301 at the time of presentation indicating that most of the patients with severe acute bronchial asthma generally present with respiratory acidosis. In my study partial pressure of oxygen is decreased (hypoxemia)in 27 patients (67.5%)out of 40 patients, partial pressure of carbon dioxide is increased in 33 patients(82.5%) and decreased in 5 patients(12.5%). pH is decreased in 29 patients(72.5%),normal in7 patients(17.5%),increased in 4 patients (10%).This study showed closed correlation with my study that in severe acute bronchial asthma most of the patients present with respiratory acidosis withhypoxemia.However somepatients presented with normal pH and decreased $PaCO_2$ indicating some compensatory mechanisms are taking place in response to altered ventilation due to severe airway obstruction. In a study conducted by Odhiambo J.A and Chwala R.D on 40 patients,majority of patients showed marked hypoxemia with PaO2 levels less than 60 mmHg and hypocapnia with mean partial pressure of carbondioxide less than 34 mmHg. Majority of patients showed apparently normal pH with mean pH around 7.384. The partial pressure of carbondioxide was mostly normal or less in severe phases of asthma in their study based on which they concluded that very high partial pressure of carbon dioxide indicates very severe form of disease and therefore assessing arterial blood gas analysis appears crucial, as it alerts the physician to potentially explosive situations. In a study conducted by Tai and Reed decreased oxygen tension was observed in 91% of patients and decreased carbon dioxide tension was observed in 50% of patients out of total 64 patients investigated. In a study conducted by Williams and Zohmann on 15 patients,11 patients out of 15 were observed to have hypoxemia and 8 out of 15 patients had hypercapnia at the time of presentation. In a study conducted by H.Simpson regarding arterial blood gas analysis in 21 children, all the children were found to be hypoxemic with PaO2 less than 85 at the time of admission in hospital and partial pressure of carbon dioxide was raised in 11 out of 21 patients accounting for 55% of study population and half of the patients presented with low pH less than 7.35,which correlates with my study. When the arterial blood gas analysis of severe acute bronchial asthma is made with normal reference values the pH showed variable presentation in severe acute bronchial asthma.Based on severity of airway obstruction,alteration in ventilation perfusion ratio the patients were showing respiratory acidosis and respiratory alkalosis.

V.Conclusion:

Arterial blood gas analysis is widely used investigation in clinical practice while dealing with respiratory diseases especially bronchial asthma, as it gives information regarding oxygenation, ventilation which are seriously disturbed in bronchial asthma. This study revealed that there are disturbances in acid base status, ventilation in severe acute bronchial asthma .Therefore it serves as good guide for physician in crucial decisions regarding treatment.

Most of the patients in this study presented with hypoxemia with respiratory acidosis and remaining number of patients presented with hypoxemia with respiratory alkalosis(i.e. among those patients having abnormal arterial blood gas patterns). However arterial blood gas analysis alone is not sufficient to evaluate severity of attack it should be supported by further investigations like PEFR,FEV1 along with correlation of signs and symptoms clinically.

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