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A COMPARATIVE STUDY ON ABG ANALYSIS IN SEVERE ACUTE BRONCHIAL ASTHMA AND CHRONIC BRONCHIAL ASTHMA

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ABSTRACT:

Introduction: Asthma is a chronic inflammatory condition affecting the airways, characterized by an exaggerated response of the trachea-bronchial system to various stimuli. This condition leads to significant narrowing of the airways, which can be alleviated through medication or may resolve spontaneously Therefore, this study focuses on arterial blood gas analysis in patients experiencing acute severe asthma and chronic bronchial asthma upon hospital admission, with particular attention to acid-base status, PaO2, PaCO2, and HCO3- levels.

Aim and Objectives: To compare arterial blood gas analysis of acute severe bronchial asthma with chronic bronchial asthma.

Materials and Methods: A cross-sectional study was conducted involving 50 asthmatic patients aged between 20 and 75 years, who presented at a tertiary care hospital over a 12-month period. The study excluded pregnant women, children, smokers, and individuals with other respiratory conditions. The entire procedure was thoroughly explained to each patient, and informed consent was obtained.

Results: P-value for comparison pf Ph in between the groups was <0.05 which was statistically significant in between the groups. P-value for comparison of mean $PaCO_2$ levels in between the groups was <0.05 which is statistically significant in between the groups. P-value for comparison if PaO_2levels in between the groups was > 0.05 which was statistically insignificant in between the groups.

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Conclusion: It is important to note that arterial blood gas analysis alone does not adequately reflect the severity of an asthma attack; it should be supplemented with further assessments, including Peak Expiratory Flow Rate (PEFR) and Forced Expiratory Volume in one second (FEV1), in conjunction with a clinical evaluation of signs and symptoms.

Key words: arterial blood gas analysis, respiratory acidosis, hypoxaemia, hypercapnia, hypocapnea.

1. INTRODUCTION:

Asthma is a chronic inflammatory condition affecting the airways, characterized by an exaggerated response of the trachea-bronchial system to various stimuli. This condition leads to significant narrowing of the airways, which can be alleviated through medication or may resolve spontaneously. Asthma is a prevalent disorder, with a notable increase in cases observed in the latter half of the twentieth century. Current estimates suggest that at least 4% of the population is affected, with the highest prevalence among individuals under the age of 10, accounting for 50% of cases(1). In the elderly population, the male-to-female ratio is equal, while in children, it is approximately 2:1. The etiology of asthma is multifactorial, resulting from the interplay of genetic predispositions and environmental influences. In individuals with a genetic susceptibility, exposure to environmental triggers can lead to airway inflammation. For atopic asthmatic patients, inhalation of allergens provokes a Broncho constrictive response, as the allergen interacts with mucosal mast cells through an IgE-dependent mechanism, releasing mediators such as histamine that contribute to bronchoconstriction(2). A wide array of inflammatory cells is involved in sustaining the chronic inflammatory process within the bronchial walls characteristic of asthma. Recent findings indicate that epithelial and smooth muscle cells also play a role in the onset of asthma in non-atopic individuals. The airways may exhibit oedema and infiltration by eosinophils, lymphocytes, and neutrophils, with or without an increase in collagen within the epithelial basement membrane. Key features of asthma include: 1. Microvascular leakage 2. Epithelial shedding 3. Mucous plugging in the airways 4. Reduced mucociliary clearance 5. Ongoing airway inflammation may lead to thickening of bronchial walls due to edema, cellular infiltration, hypertrophy of mucus-secreting glands, and increased smooth muscle mass(3). Regardless of the asthma type, airway inflammation remains a consistent feature. Arterial blood gas analysis is a widely utilized procedure that provides direct measurements of pH, PaO2, and PaCO2. The introduction of this analysis has significantly transformed the domain of respiratory medicine, particularly in the management of bronchial asthma. Understanding the evolution of acid-base balance and oxygenation in critically ill patients is essential for their effective treatment and care. While bronchial asthma may be perceived by some as a minor condition that contributes to longevity, as noted by Oliver Wendell Holmes, it is often experienced in clinical settings as a "Tyranny and cruelty of the disease," as described by Willis. A severe acute asthma attack, referred to as "Status Asthmaticus," poses a life-threatening emergency(4). Consequently, it is imperative for the attending physician to promptly evaluate the severity of the episode and initiate aggressive treatment strategies to reduce patient morbidity and mortality. This underscores the necessity for reliable assessment methods, among which arterial blood gas analysis is paramount. Therefore, this study focuses on arterial blood gas analysis in patients experiencing acute severe asthma and chronic bronchial asthma upon hospital admission, with particular attention to acid-base status, PaO2, PaCO2, and HCO3- levels.

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Aim and Objectives:
To compare arterial blood gas analysis of acute severe bronchial asthma with chronic bronchial asthma.

2. MATERIALS AND METHODS:

A cross-sectional study was conducted involving 50 asthmatic patients aged between 20 and 75 years, who presented at a tertiary care hospital over a 12-month period. The study excluded pregnant women, children, smokers, and individuals with other respiratory conditions. The entire procedure was thoroughly explained to each patient, and informed consent was obtained. Palpation of the radial, ulnar, or femoral arteries was performed, followed by the administration of Allen's test. A 2cc syringe equipped with a 24G needle, pre-flushed with 25,000 IU of heparin in 5 ml, was utilized to draw 2 ml of blood from one of the aforementioned arteries using a syringing technique. The collected blood sample was analysed using the "MEDICA" blood gas analyser, which provided values for pH, PaO2, PaCO2, and $HCO3^{-}$.

3. RESULTS:

TABLE 1: AGE DISTRIBUTION OF STUDY POPULATION

AGE IN YEARS	ACUTE SEVERE BRONCHIAL ASTHMA(NUMBER)	ACUTE SEVERE BRONCHIAL ASTHMA(PERCENTAGE)	CHRONIC BRONCHIAL ASTHMA(NUMBER)	ACUTE SEVERE BRONCHIAL ASTHMA(PERCENTAGE)
20-30	3	15%	2	10%
31-40	3	15%	4	20%
41-50	5	25%	7	35%
51-60	4	20%	6	30%
61-75	5	25%	1	5%

TABLE 2: SEX DISTRIBUTION OF THE STUDY POPULATION

TYPE OF ASTHMA	MALES	PERCENTAGE	FEMALES	PERCENTAGE
ACUTE SEVERE BRONCHIAL ASTHMA	16	64%	9	36%
CHRONIC BRONCHIAL ASTHMA	12	48%	13	52%

GRAPH 1: SEX DISTRIBUTION OF STUDY POPULATION

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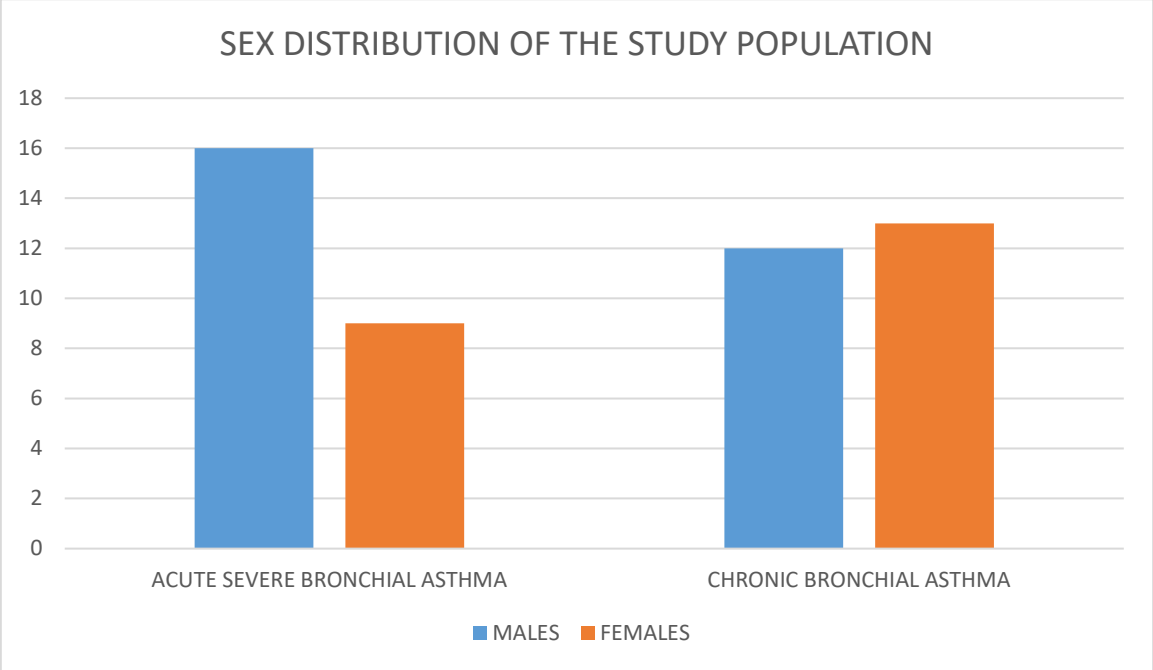

TABLE 3: DISTRIBUTION OF ACID-BASE STATUS IN THE STUDY POPULATION

ACID –BASE STATUS	NORMAL	RESPIRATORY ACIDOSIS	RESPIRATORY ALKALOSIS
ACUTE SEVERE BRONCHIAL ASTHMA	9	12	4
CHRONIC BRONCHIAL ASTHMA	11	0	14

TABLE 4: DISTRIBUTION OF PaO_2 IN STUDY POPULATION

PaO_2	ACUTE SEVERE ASTHMA	CHRONIC ASTHMA
NORMAL	11	10
HYPOXEMIA	14	15

TABLE 5: DISTRIBUTION OF $PaCO_2$ LEVELS IN STUDY POPULATION

$PaCO_2$	ACUTE SEVERE ASTHMA	CHRONIC ASTHMA
NORMAL	8	9
HYPERCAPNEA	11	0
HYPOCAPNEA	6	16

TABLE 6: ANALYSIS OF PaO_2, $PaCO_2$ AND PH IN STUDY POPULATION

VARIABLE	ACUTE SEVERE BRONCHIAL ASTHMA	CHRONIC BRONCHIAL ASTHMA	P-VALUE
MEAN PH	7.32±0.150	7.426±0.045	<0.05
$PaCO_2$	48.95±22.22	31.56±6.01	<0.05
PaO_2	72±16.1	70±15.97	>0.05

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4. DISCUSSION:

Asthma represents a significant public health concern. This condition is characterized by inflammation of the airways, which increases the sensitivity of nerve endings, leading to heightened irritation(5). Consequently, the airways become swollen and constricted, resulting in a reduced airflow in and out of the lungs. Severe acute bronchial asthma poses a life-threatening risk, as the airways become significantly narrowed, impairing ventilation. Such alterations in ventilation can affect the chemical balance of the blood, particularly parameters such as PaO2, PaCO2, and pH. The concentration of hydrogen ions and the composition of respiratory gases in arterial blood have a profound impact on respiratory function(6). Despite extensive research, the rising rates of morbidity and mortality associated with asthma remain largely unexplained. Therefore, clinicians must utilize the most effective diagnostic tools to assess the oxygenation and ventilation status of patients, which is crucial for developing an appropriate management plan(7).

In our study in acute asthma group based on age distribution of the study population 3 subjects (15%) were in age group 20-30 years,3 subjects (15%) were in age group between 31-40 years,5 subjects (25%) were in the age group 41-50 years,4 subjects (20%) were in the age group 51-60 years and in 61-75 years' age group 5 subjects (25%) were present. In chronic bronchial asthma group based on age distribution of the study population 2 subjects (10%) were in age group 20-30 years,4 subjects (20%) were in age group between 31-40 years,7 subjects (35%) were in the age group 41-50 years,6 subjects (30%) were in the age group 51-60 years and in 61-75 years' age group 1 subject (5%) were present. On the basis of sex distribution of the study population in acute severe bronchial asthma group 16 were males accounting for 64% of the study population and 9 were females accounting for 36% of the study population. In chronic bronchial asthma group 12 were males accounting for 48% of the study population and 13 were females accounting for 52% of the study population. On the basis of acid-base status of the study population, in acute severe bronchial asthma group, acid-base status was normal in 12 patients, respiratory acidosis was observed in 12 patients and respiratory alkalosis was observed in 4 patients. In chronic bronchial asthma group acid-base status was normal in 11patients and respiratory alkalosis was observed in 14 patients.

In acute severe bronchial asthma group PaO_2 was normal in 11 patients and hypoxaemia was observed in 14 patients, in chronic bronchial asthma group PaO_2 was normal in 10 patients and hypocapnea was observed in 15 patients in our study. Odhiambo J.A et al studied arterial blood gases and acid base status of 40 adult patients presenting with acute severe asthma(8). Marked degrees of hypoxaemia, (mean PaO2 of 60mmHg) hypocapnia(mean PaCO2 of 35mmHg) with apparently normal pH (mean 7.384) were documented in the majority of these patients. In acute severe bronchial asthma group $PaCO_2$ was normal in 8 patients and hypercapnia was observed in 11 patients and hypocapnea was observed in 6 patients, in chronic bronchial asthma group $PaCO_2$ was normal in 9 patients and hypocapnea was observed in 16 patients in our study. Cochrane G.M et al measured arterial blood gas tensions, pH and peak expiratory flow rate in 29 patients with chronic asthma in a stable state(12). The hypoxia in these patients was found to be comparable with hypoxia seen in normal subjects at high altitude in its effects an arterial pressure of carbon dioxide(PaCO2). These results suggest that in patients with asthma the PaCO2 taken as normal should be related to arterial O2 tension. Any increase in the observed valve compared with this predicted valve indicates impaired respiratory control. This may well help in assessing the patients at greatest risk during attack of asthma. The mean Ph of acute severe bronchial asthma was 7.32±0.150 and in chronic bronchial asthma group was

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7.426±0.045.P-value for comparison pf Ph in between the groups was <0.05 which was statistically significant in between the groups. The mean $PaCO_2$ levels in acute severe bronchial asthma group was 48.95±22.22mmHg and the mean $PaCO_2$ levels in chronic bronchial asthma was 31.56±6.01mmHg.P-value for comparison of mean $PaCO_2$ levels in between the groups was <0.05 which is statistically significant in between the groups. The mean PaO_2levels in acute severe bronchial asthma group was 72±16.1mmHg and in chronic bronchial asthma group the mean PaO_2levels was 70±15.97mmHg.P-value for comparison if PaO_2levels in between the groups was > 0.05 which was statistically insignificant in between the groups .Arterial blood gas (ABG) analysis serves as a valuable tool in this regard, providing essential information about the oxygenation and ventilation status of critically ill patients.

5. CONCLUSION:

The evaluation of arterial blood gases is an essential investigation for determining oxygenation, pH, and PaCO2 in patients experiencing severe acute asthma. The characteristic blood gas pattern in severe asthma in our study is predominantly one of hypoxaemia with respiratory acidosis in a moderate number of cases, while others present with hypoxaemia and respiratory alkalosis among those exhibiting abnormal blood gas patterns. In the group diagnosed with chronic bronchial asthma, the findings indicate that a moderate number of patients experienced hypoxaemia with respiratory alkalosis, with no cases of respiratory acidosis identified. Moreover, the pH levels in this cohort remained within the normal limits of 7.32 to 7.42, indicating a stable clinical condition. The findings of this study indicate that there are notable disruptions in acid-base status and ventilation in patients suffering from severe acute bronchial asthma. As such, it provides a crucial reference for physicians in making important treatment decisions. A significant portion of the patients analysed exhibited hypoxemia with respiratory acidosis, while the remaining patients showed hypoxemia with respiratory alkalosis, particularly among those with abnormal arterial blood gas readings. However, it is important to note that arterial blood gas analysis alone does not adequately reflect the severity of an asthma attack; it should be supplemented with further assessments, including Peak Expiratory Flow Rate (PEFR) and Forced Expiratory Volume in one second (FEV1), in conjunction with a clinical evaluation of signs and symptoms.

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