

Original Research Article

Blood Gas Analysis in SARS-COV-2 Infected Patients Admitted to SMHS Hospital:

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Abstract

Blood gases are a measurement of how much oxygen and carbon dioxide is in blood. These determine the acidity of blood. The blood gas testing is generally used for detecting and monitoring lung and kidney problems. The blood gas testing measures partial pressure of oxygen (O_2), partial pressure of carbon dioxide (CO_2), oxygen saturation ($O_2\text{Sat}$), bicarbonate (HCO_3) concentration. Here in study Patients aged more than 18 years confirmed Covid 19 positive by reverse transcription, PCR (RT-PCR). Patients suffering from moderate to severe Covid 19 as per WHO diagnostic guidelines and underwent at least one ABG were included in the analysis. The ABG test was done on ABG analyzer in department of Biochemistry, SMHS hospital. All the data which was related to study was gathered and recorded in case record forms using files as well as reports of patients from medical record section and we concluded, Patients with COVID 19 frequently experience an acid base imbalance. Although respiratory alkalosis is predominant, the study also found respiratory acidosis with mixed metabolic acidosis and alkalosis. The study discovered a strong relationship between pH and $PaCO_2$ as well as $PaCO_2$ and HCO_3 . Regular ABG monitoring can aid in the early detection of silent hypoxia, and respiratory injury. With early management start-up, many lives can be spared with early diagnosis.

1. Introduction

In December 2019, the COVID-19 outbreak began in a seafood market in Wuhan, Hubei Province, China. It has since spread to over 215 countries/territories/areas, becoming a global pandemic. The World Health Organization declared it a Public Health Emergency of International Concern on January 30, 2020, and officially labeled it a pandemic on March 11, 2020. [Casella et al., 2022]. Individuals who have contracted the virus display a wide range of symptoms, ranging from mild to severe. These symptoms can include a fever, upper respiratory tract infection symptoms like a dry cough and sore throat. In more severe cases, the immune system becomes dysregulated, leading to hyperinflammation and the development of acute respiratory distress syndrome (ARDS). Patients may also experience a variety of other health issues such as respiratory, digestive,

liver, and neurological problems, including ARDS, acute heart damage, or secondary infections. [Drosten et al.,2003]. Individuals with chronic kidney disease, chronic respiratory disease, diabetes, cardiovascular disease, obesity, or cancer are at a higher risk of experiencing severe illnesses that could potentially result in death. [Lu et al.,2012]. Derangement in acid-base homeostasis is common in severely ill patients. In the majority of cases, acid-base abnormalities are moderate and infrequently symptomatic and seldom have a propensity to affect organ homeostasis. On the contrary, moderate-to-severe acid-base abnormalities may lead to severe multiorgan consequences [Kaplan et al.,2005]. The virus's tropism for the lungs and kidneys might result in frequent acid-base changes as a result of pneumonia and kidney impairment, respectively [Ronco et al.,2020;Zu et al.,2020]. The virus's preference for the lungs and kidneys could lead to frequent changes in acid-base balance due to pneumonia and kidney impairment. Throughout different stages of COVID-19, several pathological mechanisms, including fever, widespread inflammation, blood clot formation, respiratory tract infections, and carotid body suppression, may occur. The blood's acid-base equilibrium may shift towards acidosis or alkalosis depending on the underlying processes [Mondal et al .,2021].The major respiratory symptom of COVID-19 is arterial hypoxia, which causes significant pulmonary mechanics abnormalities (decreased lung compliance) [Yang et al.,2020;Bhat raju et al .,2020]. Hypoxemia caused by COVID-19 is often accompanied by an elevated alveolar-to-arterial oxygen gradient, which indicates either ventilation-perfusion mismatch or intrapulmonary shunting [Tobin et al.,2012]. Arterial blood gas (ABG) analysis can help in predicting mortality among COVID-19 patients, managing the ventilatory settings for better outcomes in these patients, and can help in predicting underlying comorbid conditions in COVID-19 patients [Lakhani et al., 2021].To date, different laboratory findings were detected as risk factors that can aid in disease monitoring, staging, therapy, and prognosis of COVID-19 patients. The bulk of these investigations, however, have concentrated on hematological and biochemical laboratory markers, with very little available data on ABG analysis [Bezuidenhout et al.,2021].

2. Materials and methods:

The study was conducted in the Department of Biochemistry Government Medical College (GMC) Srinagar and its associated SMHS Hospital between October 2020 and November 2021. Total 100 patients (RT-PCR confirmed SARS-CoV-2 positive) and twenty control subjects (RT-PCR confirmed SARS-CoV-2 negative) were included in this cohort study. The patients were diagnosed as per standard WHO/CDC criteria 2020 for Covid-19 disease. The study was initiated only after obtaining approval from Ethical committee of Government Medical College, Srinagar (IEC/GMC-Sgr/27,19th December). Written informed consent and response questionnaire from patients and healthy controls were documented and recorded as per hospital protocol. The patients were followed twice (14th day and 28th day) for a period of 28 days for either death or

.Patients aged more than 18years confirmed Covid19 positive by reverse transcription, PCR (RT-PCR). Patients suffering from moderate to severe Covid 19 as per WHO diagnostic guidelines and underwent at least one ABG were included in the analysis. The ABG test was done on ABG analyzer in department of Biochemistry, SMHS hospital. All the data which was related to study was gathered and recorded in case record forms using files as well as reports of patients from medical record section.

3. Results:

A retrospective Arterial Blood Gas (ABG) data of total 75 covid -19 patients was collected and analysed. The ABG analysis showed the following results: It was found that out of total patients, 26.6% individuals were males and 77.33% were females. Most of covid-19 patients were >60 years of age (82.33%). Most of patients were of urban residence (60%). In this research it was found that 88% of patients were severe (severity was determined on the basis of oxygen saturation levels (<90%). Fever was most common symptom found (84% of patients). Cough was found in 89.33% of patients and pneumonia was found in 96% of patients. Alkaline pH was found in 57.33% individuals. 36% individuals were having normal pH and the percentage of individuals having acidic pH was 6.66%. Low PaO₂ was found in 45.33% individuals. Normal PaO₂ levels were found in 21.33% and high PaO₂ levels were found in 33.33% individuals. Low PaCO₂ (<35 mmHg) were found in 56%, normal (35-45 mmHg) levels were found in 37.33% and high levels (>45 mmHg) were found in 6.66%. Low HCO₃⁻ (<22 mmol/L) were found in 16%, normal (22-26 mmol/L) in 38.66% individuals and high (>26 mmol/L) were found in 45.33% individuals would be expected in the case of respiratory alkalosis.

4. Discussions:

ABG tests are routine lab procedures that serve as the gold standard for identifying respiratory failure and issues with acid-base balance. In our research it was found that alkalosis was predominant in patients which were under study (57.33%). It was found that a significant no. of patients were having low PaO₂. Although not significant a good no. of patients were having low PaCO₂. The HCO₃⁻ levels were found >26 in 45.33% of individuals suggesting respiratory alkalosis. To explain why respiratory alkalosis was predominant in most patients, many theories were put forth. According to one of the theories, covid Covid19 reduces hyperventilation and, as a result, CO₂ buildup in the blood by inhibiting the carotid body's response to oxygen deprivation.

The involvement of ACE2 receptors in the carotid body is likely related to this process, as the virus that causes COVID-19 has been found to have an affinity for these receptors [Ronco et al., 2020]. This virus leads to the collapse of the air sacs in the lungs of patients, rather than filling them with fluid or pus, resulting in hypoxia. However, the normal ability of the lungs to expel carbon dioxide is not affected during this process, and patients do not experience shortness of breath due to the absence of CO₂ buildup. [Bertolino et al., 2022]. The most prevalent finding in this investigation, which was comparable to that of a study done in Italy. The so-called "quiet" or "happy" hypoxia is caused by hypocapnic hypoxia, which is shown by a positive association between PaO₂ and PaCO₂. Air hunger is not a symptom of hypocapnic hypoxia; instead, a sense of calm and wellbeing may develop, making it challenging to assess the severity of the illness and delaying hospitalisation. Hypocapnia in COVID-19 disease may potentially result from activating carotid chemoreceptors. It is significant to note that all of the patients had a severe version of the illness, and several of them had SOB, which caused air hunger and hypercapnia. Notwithstanding their rarity, a small proportion of COVID-19 patients also showed signs of respiratory acidosis, which is normal in cases of air hunger. A similar result was also observed in an intubated COVID-19 patient who had hyperpyrexia and obstructive lung disease [Castro et al., 2022]. In addition to diarrhoea, vomiting, and dehydration, many COVID-19 patients also showed signs of those conditions, which can cause metabolic alkalosis because of a potassium deficit. By activating the mineralocorticoid system, prior usage of corticosteroids at home or in any other hospital setting can also result in metabolic alkalosis. In this study, % of patients experienced metabolic acidosis. The primary cause of metabolic acidosis in the COVID-19 patient was multiorgan failure, including acute kidney. Although metabolic alkalosis predominated, a significant positive correlation between PaCO₂ and standard bicarbonate shows that patients with hypocapnia also have low bicarbonate levels, which can cause metabolic acidosis. This compensatory metabolic acidosis may be present in some patients.

The arterial carbon dioxide pressure (PaCO₂) value provides information about the ventilation state (acute or chronic) and the acid-base condition, whereas the arterial oxygen pressure (PaO₂) value provides information about the oxygenation state. The pH is the first parameter examined when examining arterial gases, and it stays within the range of (7.35–7.45). The concentration of hydrogen ions changes in response to a little change in pH. In the present investigation, patients with covid-19 had varying PO₂ and SO₂ levels, demonstrating the well-known effect of covid-19 on the respiratory system.

Pneumonia is the most common symptom of COVID-19 and is almost always identified in hospitalized patients. Bilateral ground-glass opacities with or without consolidations are a frequent symptom. (Jubran, 2015). The most prevalent COVID-19 symptom, pneumonia, is virtually invariably found in hospitalized patients. Minute ventilation and interference with respiratory gas exchange are two factors that make extensive pneumonia a potentially lethal infectious disease. As a result, problems in our COVID-19 group were predicted to be acid-base imbalances of respiratory origin. Metabolic alkalosis in our population, it was challenging to identify the underlying cause of this disease. Dehydration brought on by a fever, dyspnea, and a lack of appetite is the most plausible scenario. Compared to patients with normal pH, no statistically significant differences in pulmonary gas exchange or diuretic use were identified. (18). Our study's participants had an average age of 64.94 years, and 22.66% of them were male. 66 people were discovered to be really ill. The very ill patients were mostly females. It is unknown why such a high number of COVID-19 ICU patients had alkalemia, which is thought to be unusual in critical care (Kovesdy, 2014). Certainly, alkalemia produced at the kidney level appears to be the most plausible cause, with increased mineralocorticoid activation (endogenous or exogenous) being a potential cause. COVID-19 is thought to upregulate the conventional RAS pathway and produce metabolic alkalemia. The RAS is largely responsible for regulating blood pressure, hydration balance, electrolyte concentrations, and the body's acid-base condition. It has two well-defined arms: the conventional vasoconstrictive route and the protective pathway. Alternately, due to its impact on the mineralocorticoid system, corticosteroid medication could be a contributing cause. Dexamethasone has received a lot of attention for its usage in critically sick patients receiving ventilator support, where higher survival rates have been seen. The activation of mineralocorticoids will cause hypertension, alkalemia, and hypokalemia (Raphael et al., 2013). It is interesting to note that in the current study most of the patients have high blood sugar levels and worse prognosis. In COVID-19, diabetes is linked to poorer outcomes, including a larger percentage of ICU

admissions, ARDS, and mechanical ventilation (Gauthier et al., 2002). The retrospective nature of the study, the small number of patients, and the lack of a control group limit the generalizability of these findings. Larger investigations are thus required to establish the distribution of acid-base abnormalities in COVID-19 patients and to confirm the potential link between metabolic acidosis and death risk in this subset of patients.

5. Conclusion:

Patients with COVID-19 frequently experience an acid-base imbalance. Although respiratory alkalosis predominated, the study also found respiratory acidosis with mixed metabolic acidosis and alkalosis. The study discovered a strong relationship between pH and PaCO₂ as well as PaCO₂ and HCO₃⁻. Regular ABG monitoring can aid in the early detection of silent hypoxia, and respiratory injury. With early management start-up, many lives can be spared with early diagnosis.

Limitation(s):

Very ill COVID-19 patients who had been hospitalised to the ICU participated in the trial.

It would have been preferable to include ABG analysis of patients who were just mildly and moderately unwell. The association between ABG and patient outcomes in terms of survival and the alteration in ABG report pattern over time with illness progression were not covered in the current study, which calls for more investigation. The discovery of operational causes of pulmonary alkalosis in the study constituted a significant limitation. Although all ABG reports were obtained at the time of ICU admission, many patients were already receiving home oxygen assistance or were even receiving BiPAP (Bilevel Positive Airway Pressure) treatment from some other nursing homes before admission. They could have overcorrected for natural respiratory acidity, resulting in the findings of the current investigation.

Declarations

Ethics Committee Approval: The work was ethically approved by the ethical committee of GOVT Medical College and associated SMHS Hospital. Approval no: Ref No.IEC-GMC-Sgr/27.

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Table 1: represents socio demographic features and clinical features in SARS-CoV-2 patients

PARAMETER	FREQUENCY(n=75)	PERCENTAGE%
AGE		
<60		
>60	13	17.33%
	62	82.66%
SEX		
MaleF	17	22.66%
emale	58	77.33%

RESIDENCE		
Rural	30	40%
Urban	45	60%
SEVERNESS		
Moderate	9	12%
Severe	66	88%
SYMPTOMS		
FEVER		
Yes	63	84%
No	12	16%
COUGH		
Yes	67	89.33%
No	8	10.66%
PNEUMONIA		
Yes	72	96%
NO	3	4%

Table 2: represents arterial blood gas analysis in SARS-CoV-2 patients (n=75)

Parameter	Frequency	PValue
pH		
Acidosis(<7.35)	5	0.342
Normal(7.35-7.45)	27	
Alkalosis(>7.45)	43	
PaCO2(mmHg)		
Acidosis(>45)	5	0.614
Normal(35-45)	28	
Alkalosis(<35)	42	
PaO2(mmHg)		

Low(<75)	34	P<0.001
Normal(75-100)	16	
High(>100)	25	
HCO ₃ (mmol/L)		
Low(<22)	12	0.378
Normal(22-26)	29	
High(>26)	34	

UNDER PEER REVIEW