



ARTERIAL BLOOD GAS (ABG) ANALYSIS AMONG CHRONIC RESPIRATORY PATIENTS ADMITTED IN A TERTIARY CARE TEACHING INSTITUTION AT KOLKATA, INDIA

Pulmonary Medicine

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ABSTRACT

Background-Arterial blood gas (ABG) is a gold standard to obtain information on the potential of hydrogen (pH), partial pressure of carbon dioxide (PCO₂), partial pressure of oxygen (PO₂), and bicarbonate (HCO₃⁻) in order to measure the severity AECOPD.

Objectives-to estimate PCO₂, PO₂, pH and HCO₃⁻ levels among patients of chronic respiratory illness with acute exacerbation.

Materials and Methods-A cross-sectional survey was conducted in department of Respiratory Medicine of Nilratan Sircar Medical College and Hospital involving 49 eligible patients selected randomly. Data were collected via interview using a schedule and laboratory technique for arterial blood gas analysis.

Results-Age of participants was 55.79±13.24 years. Exposure to smoke either from tobacco or cooking oven or inorganic dust was explored from 61% respondents. In present study blood level of pH, PCO₂, PO₂, and HCO₃⁻ were estimated to be 7.39±0.079 (mean±sd), 50.00 (median), 74.00 (median) and 28.2(median), respectively.

Conclusion-ABG analysis is to be done systematically to choose effective treatment option required for each type of respiratory failure and to establish determinants of variation in ABG level among these patients.

KEYWORDS

respiratory failure, arterial blood gas analysis, determinants

INTRODUCTION:

Chronic obstructive pulmonary disease (COPD) is one of the heaviest burdens placed on health care facilities, not to mention governments, all over the world. [1] According to the World Health Organization (WHO), 210 million people globally have COPD. In 2005, more than 3 million died from this disease and the WHO estimates that in 2030, 7.8% of all deaths will be caused by COPD, making it the third leading cause of death in the world. On the other hand, more than 70% of patients are under diagnosed. [2] Acute exacerbation of COPD (AECOPD) is defined as a progressive deterioration of ventilatory function in patients with COPD, leading to hypoxia and hypercarbia. [3] COPD exacerbations have a very high risk of mortality; 50% of people with a severe exacerbation will die within 4 years of an admission. [4] The recognition that high flow oxygen therapy can induce hypercapnia in susceptible patients during exacerbations of COPD [5] and that respiratory acidosis is associated with a worse outcome [6,7] led to a rise in arterial blood gas (ABG) sampling to measure pH, PaCO₂, PaO₂, and HCO₃⁻. Arterial blood gas (ABG) is a gold standard to obtain information on the potential of hydrogen (pH), partial pressure of carbon dioxide (PCO₂), partial pressure of oxygen (PO₂), and bicarbonate (HCO₃⁻) in order to measure the severity AECOPD according to the recommendations of National Institute for Health and Care Excellence (NICE). [8] The role of ABG can be well exemplified by considering the concept of respiratory failure, the term which does not help much in deciding whether the respiratory failure is due to primary oxygenation failure or ventilatory failure. Only ABG can specify and quantitate the respiratory failure. High PaCO₂, moderately low PaO₂ and acidic pH indicate ventilatory failure whereas low PaCO₂, low PaO₂ and alkaline pH indicate primary oxygenation failure. The management plan is ventilatory support in former case and oxygen therapy in the later. [9]

Rapid and accurate assessment of oxygenation, ventilatory and acid-base status of the patients is highly required for decision making regarding prompt treatment of this serious medical emergency. For this urgency, point-of-care testing (POCT) for ABG is needed to get evidence based establishment and to be preferred over clinical laboratory testing. [10,2] or near the patient as POCT by ABG as well as understanding and correct interpretation of parameters is a prerequisite for treating this life threatening condition. Nil Ratan Sircar Medical College & Hospital (NRMCH), Kolkata is a referral teaching Institution which caters a huge patients drained from the adjoining part of Kolkata as well as from adjacent districts of West Bengal like North 24 Parganas, Howrah, Hooghly, Nadia. The present study was planned to estimate the arterial blood gases and acid-base level in respect to PCO₂, PO₂, pH, and HCO₃⁻ and to find out influencing factors of arterial blood gases, if any among patients suffering from acute exacerbation of Chronic Respiratory Disease.

MATERIALS AND METHODS:

A cross-sectional survey was carried out for a period of Eight months (August,18 to March,19) among the patients suffering acuter exacerbation of chronic respiratory disease and admitted in the department of Respiratory Medicine, NRSMCH with dyspnoea. Only, patients with acute exacerbation of chronic respiratory illnesses were included in this study. Patients having cardiac and other causes for dyspnoea were excluded. On an average five such patients get admitted daily in the department of Respiratory Medicine. Data collection was planned for six months on the basis of once in a week. The day for data collection was selected via simple random sampling by lottery method done at the beginning of each week. Two patients were selected via simple random sampling method out of all patients got admitted on that particular day. After obtaining informed consent forty nine eligible patients were included in the study. Data pertaining to socio-demographics, smoking habit, exposure to biomass fuel and or inorganic dusts, previous pulmonary tuberculosis (PTB), presence of other comorbidity and treatment relating to the chronic respiratory illness were explored via interview using a predesigned interviewer administered questionnaire. Then each of the participants underwent clinical assessment that included physical examination, chest X-ray, Pulse oximetry, ABG analysis. For ABG analysis -1 ml of arterial blood was collected from radial artery into a heparinised syringe. PaO₂, PaCO₂, pH, and HCO₃⁻ levels were mainly estimated.

Type I of respiratory failure: PaCO₂< 45 mmHg (6kPa)–normal or low; PaO₂ is low (hypoxemia); this represents a ventilation/perfusion mismatch; indicating partial respiratory insufficiency.

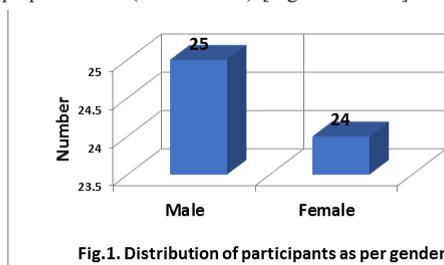
Type II of respiratory failure: PaCO₂> 45 mmHg (6kPa), PaO₂< 60 mmHg (8kPa). It reflects a global or hypoventilation respiratory insufficiency. [11]

Data were compiled in a Micro Soft Excel sheet. Analysis was done through describing data by means of estimated mean, standard deviation (SD) and median for continuous variables and proportion for the categorical variables. Displaying of data was done using tables and charts. Shapiro-Wilk normality test was applied to continuous data and it was revealed that age and pH followed normal distribution but PCO₂, PO₂ and HCO₃⁻ didn't. For drawing inference, independent t test, one way analysis of variance (ANOVA) and Pearson correlation test (r) were applied to those continuous variables which were normally distributed whereas Mann-Whitney U test, Spearman correlation (ρ) test and Kruskal-Wallis ANOVA tests were adopted for continuous variables with skewed distribution. For categorical variables Chi-square test was used. Statistical Package for Social Sciences (SPSS) software IBM 22 version was used for data analysis. P value of < 0.05 was considered significant at 95% confidence level.

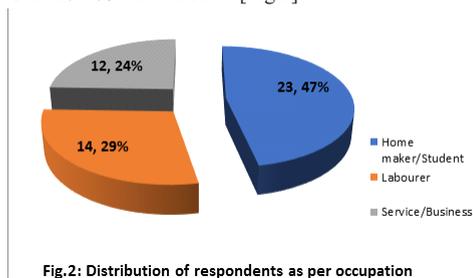
The study was done after obtaining approval of the Institutional Ethics Committee, NRSMCH, Kolkata.

RESULTS:

Data obtained from forty nine study subjects were analysed as per statistical plan of analysis. Univariate analysis showed slight male and urban preponderance (51.02% each). [Fig.1 & Table-1]



Analysis revealed that 47.0% of the participants were home maker or students and 29.0% were labourer. [Fig.2]

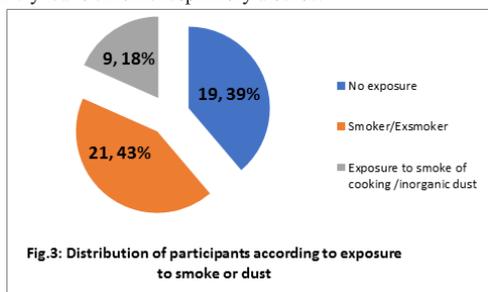


Six out of every ten participants belonged to lower socio-economic status, 36.73% had history of previous PTB, more than 3/4th informed about repeated previous hospitalization because of the breathing trouble. Around 40% confessed irregular treatment of their chronic respiratory illness. [Table-1]

Table-1: Distribution of participants according to some characteristics (n=49)

Variables	Attribute	Number	Percentage
Residence	Urban	25	51.02
	Rural	24	48.98
Socio-economic status	Low	30	61.22
	Middle	19	38.78
Past H/o Pulmonary TB	Present	18	36.73
	Absent	31	63.27
H/o hospitalization for breathing problem	Present	38	77.55
	Absent	11	22.45
Treatment of Chronic respiratory disease	Regular/not required	30	61.22
	Irregular	19	38.78
Co-morbidity	Present	21	42.86
	Absent	28	57.14

As depicted in Fig.3 around 61% respondents were reportedly exposed to smoke either from tobacco or cooking oven or inorganic dust. However, rest of the study subjects were victims other respiratory illness (Chronic Asthma, cystic bronchiectasis, post tubercular pulmonary fibrosis) or chest deformity (Kyphoscoliosis) which ultimately led to chronic respiratory disease.



Age of the participants was estimated to be 55.79±13.24 (mean±sd) with a median of 58 and range of 58 years. Median duration of chronic respiratory illness was revealed to be 5.0 years. Average value of pH

was 7.39±0.079 whereas median value of PCO₂, PO₂ and HCO₃⁻ were estimated to be 50.00, 74.00 and 28.2, respectively. [Table-2]

Table-2: Summary of other continuous variables of the participants (n=49)

	age	Duration Of Illness	pH	Pco2	Po2	HCO3
N	Valid	49	49	49	49	49
	Missing	0	0	0	0	0
Mean	55.7959	6.8827	7.3949	49.5347	76.0000	28.5816
Median	58.0000	5.0000	7.4000	50.0000	74.0000	28.2000
Std. Deviation	13.24604	7.80209	.07869	15.67469	16.32228	7.87797
Range	58.00	44.75	.39	92.00	99.00	38.70

Bivariate analysis revealed that age didn't have any correlation with other variables like pH, PCO₂, PO₂, HCO₃⁻, duration of illness and years of exposure to smoke/inorganic dust particles.

Independent 't' and ANOVA test couldn't find any statistically significant association with any sociodemographics and other correlates like gender, residence, socio-economic status, past history of PTB, treatment of chronic respiratory illness, past history of hospitalization due to exacerbation of chronic respiratory illness, comorbidity, occupation and addiction. Mann-Whitney U test revealed that HCO₃⁻ level was significantly higher among the urban residents (p=0.019) and those who were affected previously by PTB (p=0.030). However, both PCO₂ as well as HCO₃⁻ were found to be significantly higher among the participants who had repeated previous hospital admission because of their chronic respiratory illness (p=0.003 & 0.002, respectively).

None of the categorical correlates was found to be associated with Past History of pulmonary tuberculosis, repeated past hospitalization.

DISCUSSION:

In the present study blood level of pH, PCO₂, PO₂ and HCO₃⁻ were estimated to be 7.39±0.079 (mean±sd), 50.00 (median), 74.00 (median) and 28.2(median), respectively.

Mckeeper TM and co-workers reported PO₂-91.0 (4.0), pH 7.40 (0.09), HCO₃⁻ (mEq/L) 29.7 (6.3), pCO₂ (kPa) 6.89 (2.40) [8.0kPa=60mm of Hg].^[8]

In a study Agarwal A et al. observed PaO₂ (mmHg)-77.294±47.13, PaCO₂ (mmHg)- 52.65±14.39, pH 7.40±0.067, HCO₃⁻ (Meq) 32.80±8.13.^[12]

From their study carried out in Nepal, Adhikari S et al. revealed pH 7.39±0.09, PCO₂(mmHg) 36.37±11.75, HCO₃⁻(mmol/L) 22.36±5.67.^[13]

From a study conducted in a Government hospital at Guntur, India Amalakanti S et al. Reported PO₂ 63±18 and PCO₂ 67±12 (mean±sd) mm of Hg.^[14]

ABG analysis with PO₂ (mmHg) 57.52±16.74, PCO₂ (mmHg) 53.23±15.25, pH 7.39±0.07 7.30±0.1 and HCO₃⁻ (mmol/L) 32.16±8.9 among the survivor was reported by Kumar H and his associates from their study conducted in Department of Respiratory Medicine, Sir Sunderlal Hospital, Institute of Medical Sciences, Banaras Hindu University, Varanasi.^[15]

From a study carried out in Ireland in view of comparison between Arterial and Venous Blood Gases, O'Connor TM et al. observed PO₂, pH, PCO₂ and HCO₃⁻ levels between normal control and COPD patients as 9.02 vs 10.68, 7.39 vs 7.42, 6.63 vs 5.43 and 29.66 vs 25.53, respectively with p<0.0001 in all cases.^[16]

Variation of HCO₃⁻ level between Urban-Rural inhabitants, respondents with past history of PTB as well as variation of both PCO₂ and HCO₃⁻ among individuals got repeated hospital admission for exacerbation of chronic respiratory illness might be due to small sample size in individual subgroups.

CONCLUSION:

The study results gave an opportunity to the new apprentice physicians to systematically interpret ABG analysis for decision making about the therapeutic strategy to manage each case. However, for effective

implementation of ABG test, it is important to select a multidisciplinary team within an institution that is led by the clinical laboratory for the purpose of making POCT viable.^[17] This multidisciplinary team, also known as a POCT committee, may consist of medical and nursing staff and representation from pharmacy, IT, supplies, planning and finance departments and even patients. A large scale prospective study may be recommended for the purpose to explore the correlates of ABG during AECOPD as well as determinant of mortality among this group of patients.

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