Original Research Article

Arterial blood gas analysis is a marker of the severity of acute bronchiolitis

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ABSTRACT

Background: Acute bronchiolitis is a common lower respiratory tract infection in infants and young children, primarily caused by viral agents such as respiratory syncytial virus (RSV). It is characterized by inflammation, edema and mucus production in the bronchioles, leading to airway obstruction and respiratory distress. This study was done to assess the status of arterial blood gas in children with acute bronchiolitis admitted to the hospital.
Methods: This cross-sectional study was carried out in the Pediatric Department of ICMH, Matuail, Dhaka, from February 2020 to January 2021. All Children of both sexes with ages below 2 years admitted to the pediatric department diagnosed with acute bronchiolitis were enrolled in the study. A total of 52 children were selected as study subjects by purposive sampling technique. Data were entered using a statistical package for the social sciences (SPSS) version 21. A p-value of <0.05 was considered statistically significant.
Results: Among the 52 acute bronchiolitis cases, 25% were mild, 53.8% moderate and 21.2% severe. All patients had cough, runny nose, respiratory distress and tachypnea, while cyanosis was seen only in severe cases. The mean respiratory rate, heart rate and SpO_2 were 73.34±6.82 b/m, 149.25±7.05 b/m and 90.59±6.10%, respectively. ABG analysis showed mean PO_2 of 124.98±56.78 mmHg and O_2 saturation of 95.30±9.37%, both significantly lower in severe cases (p<0.01), indicating a strong association with disease severity.
Conclusions: The majority of admitted acute bronchiolitis cases were of moderate severity, with over one-fifth classified as severe. A significant variation in partial pressure of oxygen and oxygen saturation was noted across different severity grades, indicating a clear association between these respiratory parameters and the clinical severity of acute bronchiolitis.

Keywords: Arterial blood gas, Acute bronchiolitis, Marker of severity, Respiratory distress

INTRODUCTION

Bronchiolitis is an acute lower respiratory tract infection in early childhood caused by different viruses, with coughing, wheezing and respiratory distress as the significant symptoms. Bronchiolitis is one of the most common reasons for the hospitalization of children in many countries, challenging both economy, area and staffing in Pediatric Departments.[1] About 21% of under-five children who attend hospitals in Bangladesh for respiratory complaints suffer from bronchiolitis.[2] In the majority of infants with bronchiolitis, the illness is mild, but approximately 1%-5% require hospitalization, of this respiratory failure develops in 3%-7% and 1% die.[3] The

diagnosis of acute bronchiolitis is clinical, particularly in a previously healthy infant presenting with a first-time wheezing episode during a community outbreak. Supportive interventions remain the mainstay of management.[4] Supportive interventions include cool, humidified oxygen, maintaining optimum body position, nutritional management, frequent suctioning of nasal and oral secretions.[1] Measurement of oxygen saturation by pulse oximetry is widely used to see the oxygen saturation level in blood. CBC should be done to exclude bacterial infection and to see hemoglobin level. Chest X-ray findings are wide from normal to increased translucency (79.8%), hyperinflation (75.8%), increased interstitial marking (60.5%) and streaky densities (59.9%).

Blood gas analysis is done to look into respiratory acidosis and hypercapnia.[5] Arterial blood gas sampling represents a very pertinent investigation to assess a patient's acid-base status. Evaluating the acid-base status of any critically ill patient is crucial to their proper management. The physician caring for the patient is to rely on the clinical impression to assess the severity of the episode. The arterial pH usually reflects the ventilation. The net effect of a markedly decreased arterial PO2 with increased PCO2 denotes impending respiratory failure. Arterial blood gas (ABG) analysis is the gold standard test that measures PO2 and PCO2 in the blood and the acidity (pH) of the blood. An ABG analysis evaluates how effectively the lungs deliver O2 to the blood and how efficiently they are eliminating CO2 from it.

Blood gas studies are usually done to assess respiratory diseases and other conditions that may affect the lungs. Also, the acid-base component of the test provides information on kidney function. ABG has been performed from an artery predominately radial artery. It measures PO2, PCO2, pH, HCO3 and O2 saturation. ABG is fundamentally recommended if the physician suspects significant O2–CO2 exchange aberration or acid-base imbalance. Therefore, in suspected patients, the measurement of ABG plays a very crucial role. Other indications for ABG are: to manage patients in the ICU, to guide therapy in patients in ICUs and to determine prognosis in clinically ill patients.[6] Acute bronchiolitis is characterized by bronchiolar obstruction with edema, mucus and cellular debris.

If obstruction becomes complete trapped distal air will be resorbed and the child will develop atelectasis. The infant first develops minor upper respiratory tract infection with frequent sneezing episodes and watery nasal discharge, accompanied by diminished frequency of feed and fever of 100 F. Within 24 to 48 hours the disease may progressively worsen; the infant may develop tachypnea, dyspnea, irritability, vomiting, wheezing episodes and chest retractions. Hypoxemia is a consequence of ventilation-perfusion mismatch early in the course of the disease and with severe obstructive disease and

exhaustion of respiratory efforts, hypercapnia will supervene.[7]

The utilization of blood gas analysis in acute bronchiolitis is common with wide variation between hospitals, its use only in those with severe respiratory distress who are tiring but evidence for such practice is sparse. A study found that increased PCO2 levels in blood were associated with longer hospital stays and need for ICU or HDU is more.[8] The current study was done to assess the status of arterial blood gas in children with acute bronchiolitis admitted to the hospital.

METHODS

This cross-sectional study was carried out in the Pediatric Department of ICMH, Matuail, Dhaka, from February 2020 to January 2021. All Children of both sexes with ages below 2 years admitted to the pediatric department diagnosed with acute bronchiolitis were enrolled in the study. A total of 52 children were selected as study subjects by purposive sampling technique. For assessing the severity assessment of bronchiolitis Modified New Zealand guidelines and SIGN guidelines were followed (1). The normal reference ranges for ABG parameters are: pH 7.35–7.45, pCO_2 35–45 mmHg, pO_2 80–100 mmHg, HCO_3^- 22–26 mmol/l and O_2 saturation 95–100%.

Each patient underwent detailed history taking, clinical examination and assessment of peripheral oxygen saturation (SpO_2) using a pulse oximeter, followed by clinical severity grading. Routine investigations, including CBC and CRP, were performed while preparing for arterial blood gas (ABG) sampling. Using a heparin-flushed 1 cc syringe with a 24G needle, 1 cc of arterial blood was drawn from the radial artery and sent to the ICMH laboratory for analysis using the MEDICA easy blood gas analyzer (USA).

Management included supportive care with oxygen inhalation, nebulization with 3% hypertonic saline every 6–8 hours, nutrition via IV fluids, nasogastric or breastfeeding as needed, oropharyngeal suction SOS and paracetamol for fever. A pre-tested, semi-structured questionnaire was used to collect data. Data were entered using a statistical package for the social sciences (SPSS) version 21.

Thereafter data were edited and analyzed. Categorical variables were expressed as frequency and percentage. Continuous data were expressed as mean and standard deviation. The difference between continuous variables was determined by one-way ANOVA. A p-value of <0.05 was considered as statistically significant. Written informed consent was secured from mothers or guardians. The protocol was approved by the Institutional Ethical Review Board (IERB).

Inclusion criteria

Child below 2 years. Rapid onset of respiratory distress associated with wheezing. Preceded by coryzal symptoms with or without fever. Chest X-ray shows features of bronchiolitis such as hyperinflation and increased translucency.

Exclusion criteria

Children having a clinical (toxic, high fever, crepitation on auscultation) laboratory (leukocytosis, raised CRP) or radiological (patchy opacity, consolidation) evidence of bronchopneumonia. Children having congenital heart disease. Previous repeated attacks of cough and wheezing or asthma.

RESULTS

The majority (76.9%) of the babies were aged between 2 to <6 months and only 23.1% were 6 to 12 months. The mean age of the study population was 4.26±2.03 months (Table 1). 55.8% of the study population were male and 44.2% of them were female. Among all, 25% had mild acute bronchiolitis, 53.8% had moderate and 21.2% had severe acute bronchiolitis (Table 2).

Among the study population, the mean level of respiratory rate was 73.34±6.82 b/m, temperature was 100±0.56o F, heart rate was 149.25±7.05 b/m and mean SPO2 was 90.59±6.10% (Table 3).
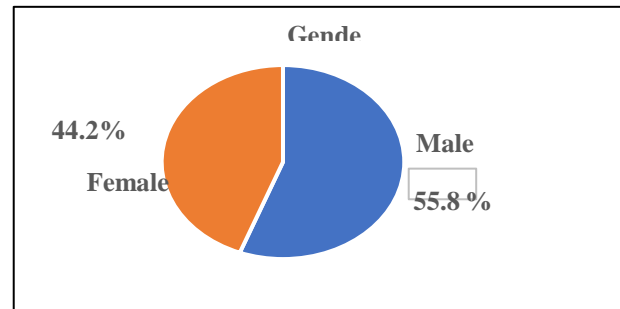

Figure 1: Gender distribution of study population (n=52).

Table 1: Distribution of the study population by age group (n=52).

Age group	Frequency (N)	(%)
2 to <6 months	40	76.9
6 to 12 months	12	23.1
Total	52	100
mean±SD	4.26±2.03	

Table 2: Grades of severity of acute bronchiolitis cases (n=52).

Grade of severity	Frequency (N)	(%)
Mild	13	25
Moderate	28	53.8
Severe	11	21.2

Table 3: Clinical presentation of bronchiolitis patients (n=52).

Clinical presentation	Mild	Moderate	Severe	Total
Symptoms (n %)				
Cough	13 (100)	28 (100)	11 (100)	52 (100)
Runny nose	13 (100)	28 (100)	11 (100)	52 (100)
Respiratory distress	13 (100)	28 (100)	11 (100)	52 (100)
Tachypnea	13 (100)	28 (100)	11 (100)	52 (100)
Chest in drawing	10 (76.9)	28 (100)	11 (100)	49 (94.2)
Rhonchi	13 (100)	28 (100)	10 (90.9)	51 (98.1)
Wheezing	13 (100)	28 (100)	10 (90.9)	51 (98.1)
Crepitation	11 (84.6)	23 (82.1)	10 (90.9)	44 (84.6)
Cyanosis	0 (0)	0 (0)	9 (81.8)	9 (17.3)
Signs (Mean±SD) Respiratory rate (b/m)	68.0±2.0	72.78±6.04	81.09±5.46	73.34±6.82
Temperature (^{0}F)	100.0±0.57	99.96±0.58	100.09±0.54	100.0±0.56
Heart rate (b/m)	143.38±5.85	148.86±5.23	157.81±3.52	149.25±7.05
SPO$_2$ (%)	96.61±0.51	91.43±1.43	83.73±7.52	90.59±6.10

SPO$_2$=Peripheral Capillary Oxygen Saturation.

Table 4: ABG parameter of the study population (n=52).

ABG parameter	Mean± SD
pH	7.39±0.12
PCO$_2$ (mmHg)	27.72±7.73
PO$_2$ (mmHg)	124.98±56.78
HCO$_3^-$ (mmol/l)	18.76±1.34
O$_2$ saturation (%)	95.30±9.37

ABG=Arterial Blood Gas, PO$_2$=Partial pressure of oxygen, PCO$_2$=Partial pressure of carbon dioxide, HCO$_3^-$=Bicarbonate.

Table 5: Association between ABG findings and clinical severity of acute bronchiolitis (n=52).

ABG parameter	Mild	Moderate	Severe	P value*
	Mean±SD	Mean±SD	Mean±SD	
pH	7.43±0.04	7.39±0.15	7.37±0.04	0.325
PCO2	24.63±6.01	27.57±6.49	31.75±10.85	0.077
PO2	133.76±33.93	148.75±52.40	54.09±20.92$^{\$\&}$	<0.01
HCO$_3^-$	18.42±2.08	19.35±2.46	18.53±1.95	0.087
O$_2$ saturation	99.39±0.59	98.63±1.76	81.97±13.83$^{@\#}$	<0.01

ABG=Arterial Blood Gas, p value was determined by one-way ANOVA, $^\$$ denotes a significant difference between Mild vs Severe bronchiolitis and $^\&$ denotes a significant difference between Moderate vs Severe bronchiolitis with PO$_2$ besides, $^@$ denotes a significant difference between Mild vs Severe bronchiolitis and $^\#$ denotes a significant difference between Moderate vs Severe bronchiolitis with O$_2$ saturation.

Among all, the mean value of pH was 7.39±0.12, PCO2 was 27.72±7.73 mm of Hg, PO2 was 124.98±56.78 mm of Hg, HCO3- was 18.76±1.34 mmol/l and O2 saturation was 95.30±9.37 (%) (Table 4). PO2 and O2 saturation level was significantly associated with the severity of acute bronchiolitis (Table 5).

DISCUSSION

The total study population was 52, who were aged between 2 months to 2 years. Among them 25% had mild acute bronchiolitis, 53.8% had moderate and 21.2% had severe acute bronchiolitis. In this study majority (76.9%) of the babies were aged between 2 to <6 months; among them mild 76.9%, moderate 82.1%, severe 63.6%. Only 23.1% were 6 to 12 months, in this group mild 23.1%, moderate 17.9%, severe 36.4%, with a mean age of 4.26±2.03 months. More than half of the study population was male. Current findings were quite similar to other studies regarding gender distribution group and age.[9-11] About 21% of under-five children who attend hospitals in Bangladesh for respiratory complaints suffer from bronchiolitis.[12] Most of the children (83%) were below six months of age, having a modal period of 3 months.

All the patients in this current study were suffering from cough, runny nose, respiratory distress and tachypnoea. Besides, 98.1% had wheezing and Ronchi, 94.2% had the chest in drawing and 84.6% had crepitation. Cyanosis (17.3%) and Tachycardia (13.5%) were also found in a small amount in the current study. In the study of Lino et al, at the time of diagnosis, patients had tachypnea, dyspnea and wheezing or rales at auscultation besides, 27 (77%) had a cough, 9 (26%) had cyanosis, 7 (20%) and 22 (63%) had chest deformity.[11] Among the study population, the mean level of respiratory rate was 73.34±6.82 b/m, the temperature was 100±0.56 oF and heart rate was 149.25±7.05 b/m. The respiratory rate was relatively higher among the study population. Previous other studies also found similar findings and revealed that respiratory rate, heart rate increased with the severity of acute bronchiolitis patients.[1,13] The current study found that the mean value of pH was 7.39±0.12, PCO2 was 27.72±7.73 mm of Hg, PO2 was 124.98±56.78 mm of Hg, HCO3- was 18.76±1.34 mmol/L and O2 saturation was 95.30±9.37 (%). The mean pH in mild cases was 7.43±0.04, in moderate cases 7.39±0.15, severe cases 7.37±0.04. PCO2 level in mild cases 24.63±6.01, moderate cases 27.57±6.49, severe cases 31.75±10.85. PCO2 level in mild cases was 133.76±33.93, in moderate cases 148.75±52.40 and severe cases 54.09±20.92. HCO3- were changes with the severity of acute bronchiolitis, but no significant difference has been found.

O$_2$ saturation level in mild cases was 99.39±0.59, moderate cases 98.63±1.76, severe cases 81.97±13.83. PO2 and O2 saturation levels significantly differ with the severity of Acute Bronchiolitis (p value<0.01). Cecunjanin et al, correlate arterial blood gases and oxygen saturation with illness severity. Oxygen saturation and arterial carbon dioxide tension (PCO2) best predicted the need for high concentration oxygen therapy and also revealed that the low level of oxygen saturation on admission could predict the severity of the illness.[9]

An increased rate of breathing, which was demonstrated by a high respiratory frequency and the need for oxygen supply, has also been noticed by others to predict more severe disease and the need for admission.[14] The current

study revealed that hypoxemia, tachypnea, age less than six months in respiratory-distressed infants are important parameters were prevalent in more severe form of bronchiolitis which was similar to a previous study by Voets et al.[13]

There was no comparison group. All samples were collected from a single site. Moreover, the sample size was not representative to generalize the findings.

CONCLUSION

The study observed that the majority of admitted acute bronchiolitis cases were of moderate severity, with over one-fifth classified as severe. A significant variation in partial pressure of oxygen and oxygen saturation was noted across different severity grades, indicating a clear association between these respiratory parameters and the clinical severity of acute bronchiolitis.

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