ARC Journal of Pediatrics
Volume 10 Issue 3, 2025, PP 1-6
ISSN 2455-5711
DOI: https://doi.org/10.20431/2455-5711.1003001
www.arcjournals.org

Correlation between Arterial Blood Gas Parameters (PH, PaO2, PaCO2, and HCO3) and the Severity of Bronchiolitis

Dr. Rehana Ahmed[1*], Dr. Shanta Dutta[2], Dr. Feroza Akter[3], Dr. Wahida Akter[4], Prof. Dr. Mahmood Ahmed Chowdhury[5]

[1]*Assistant Professor, Department of Paediatrics, Chattogram Maa Shishu O General Hospital, Chattogram, Bangladesh*

[2]*Assistant Professor, Department of Paediatrics, Chattogram Maa Shishu O General Hospital, Chattogram, Bangladesh*

[3]*Associate Professor, Department of Neonatology, Chattogram Maa Shishu O General Hospital, Chattogram, Bangladesh*

[4]*Assistant Professor, Department of Paediatrics, Chattogram Maa Shishu O General Hospital, Chattogram, Bangladesh*

[5]*Professor, Department of Paediatrics, Chattogram Maa Shishu O General Hospital, Chattogram, Bangladesh*

Received: 23 April 2025 Accepted: 09 May 2025 Published: 15 May 2025

Corresponding Author: *Dr. Rehana Ahmed, *Assistant Professor, Department of Paediatrics, Chattogram Maa Shishu O General Hospital, Chattogram, Bangladesh.*

Abstract

Background: *Bronchiolitis is a major cause of lower respiratory tract infections and hospitalizations in infants, particularly under two years of age. Accurate severity assessment is crucial for informing treatment decisions, optimizing resource utilization, and preventing complications. Although oxygen saturation is routinely monitored, the clinical relevance of arterial blood gas (ABG) parameters such as pH, PaO_2, $PaCO_2$, and HCO_3 in assessing disease severity remains uncertain. This study aims to evaluate the correlation between arterial blood gas (ABG) parameters and the clinical severity of bronchiolitis in children.*

Methods: *This cross-sectional observational study was conducted at the Pediatric Ward, Chattogram Maa-Shishu O General Hospital from January to July 2015. Fifty children aged 2 months to 2 years, diagnosed clinically with bronchiolitis, were included in this study. Participants were stratified into moderate and severe categories based on clinical signs and oxygen saturation levels. Demographic and clinical data, including pulse oximetry and arterial blood gas (ABG) results, were collected using a structured questionnaire. Statistical analysis was performed using SPSS version 19.0, with significance set at $p<0.05$.*

Results: *The mean age of the participants was 5.21 ± 1.90 months. Of the 50 children, 35 (70%) were male and 15 (30%) were female. Twenty-eight (56%) had moderate bronchiolitis, while 22 (44%) had severe disease. Hypoxemia (SpO_2 <90%) was observed exclusively in the severe group. Although abnormal arterial blood gas findings—including low PaO_2, altered pH, and reduced HCO_3—were more frequent in severe cases, the differences in pH ($p=0.503$), PaO_2 ($p=0.432$), $PaCO_2$ ($p=0.453$), and HCO_3 ($p=0.231$) were not statistically significant between severity groups.*

Conclusion: *Arterial blood gas parameters did not show a significant correlation with bronchiolitis severity. Clinical assessment and pulse oximetry remain the most reliable tools for severity evaluation in pediatric bronchiolitis.*

Keywords: *Bronchiolitis, ABG, pH, PaO_2, $PaCO_2$, HCO_3, oxygen saturation, respiratory distress, pediatric, severity assessment.*

1. Introduction

Bronchiolitis is the primary lower respiratory tract infection affecting young children under one year old. The respiratory infection, characterized by acute inflammation, causes tissue swelling and cell death in the small airway epithelium, resulting in airway blockage and impaired gas exchange. RSV stands as the primary virus responsible for bronchiolitis; however, parainfluenza and adenovirus, along with other viruses, also play roles in triggering this condition [1,2].

The disease spectrum of bronchiolitis begins with simple respiratory symptoms and progresses to

the point where intense hypoxemia requires critical medical attention [3,4]. The accurate determination of disease severity is an essential factor in clinical decision-making when deciding whether to admit a patient to the hospital and determine their respiratory support requirements [5,6]. The evaluation of disease severity in bronchiolitis traditionally relies on measurements of respiratory rate, retractions, and oxygen saturation (SpO_2). These evaluation methods yield inconsistent results because they are influenced by both the observation methods of healthcare providers and external environmental factors [6,7].

The analysis of arterial blood gases reveals the degree of respiratory distress through measurements of pH, oxygen partial pressure (PaO_2), carbon dioxide partial pressure ($PaCO_2$), and bicarbonate (HCO_3) levels. Studies have shown that analyzing arterial blood gases provides information about ventilation-perfusion mismatch and alveolar hypoventilation in patients with bronchiolitis [8,9]. The current evidence regarding links between particular arterial blood gas abnormalities and bronchiolitis disease severity remains weak, particularly in these resource-limited areas.

The development of hypoxemia alongside hypercapnia and acid-base disturbances is a natural consequence for patients with severe airway obstruction from bronchiolitis [10]. The systematic identification of children who face deterioration risks improves through objective assessment, which also leads to more effective therapeutic interventions and superior prognostic predictions compared to average clinical observations [2,8]. Profound comprehension of ABG parameter Disease severity correlations support both reducing improper hospitalizations and improving resource efficiency [5,6].

This investigation examines the relationship between blood gas parameters (pH, PaO_2, $PaCO_2$, and HCO_3) and bronchiolitis severity in hospitalized children, after accounting for relevant conditions. The research identifies important arterial blood gas markers that indicate moderate and severe disease severity, generating objective clinical measures to support better pediatric bronchiolitis management decisions.

2. Objective

- The objective of this study was to assess the correlation between arterial blood gas parameters (PH, PaO_2, $PaCO_2$, and HCO_3) and the clinical severity of bronchiolitis in children aged 2 months to 2 years.

3. Methodology & Materials

This cross-sectional observational study was conducted at the Pediatric Ward of Chattogram Maa-Shishu O General Hospital, a 250-bedded tertiary care hospital in Chattogram, Bangladesh, from January to July 2015. The study population comprised children aged between 2 months and 2 years who were diagnosed with bronchiolitis and either admitted to the inpatient department or evaluated in the outpatient department (OPD) of the hospital.

3.1. Sample Selection

Inclusion Criteria

- Children aged 2 months to 2 years
- Clinical diagnosis of bronchiolitis (cough, wheeze, respiratory distress)

Exclusion Criteria

- Children with congenital heart disease
- Known chronic pulmonary conditions (e.g., bronchopulmonary dysplasia, cystic fibrosis)
- Neuromuscular disorders affecting respiration
- Known metabolic or renal disorders
- Immunodeficiency disorders
- Children previously admitted for respiratory illness in the last two weeks

3.2. Data Collection Procedure

Data were collected using a structured pro forma that included demographic details, clinical findings, history of presenting illness, and laboratory results. Trained pediatric residents recorded physical findings through standardized clinical examination. ABG samples were collected under aseptic precautions and analyzed using an automated blood gas analyzer. A radiologist interpreted chest radiographs. Pulse oximetry was used to assess oxygen saturation. Data accuracy and consistency were ensured through supervisor cross-verification and double entry.

3.3. Ethical Consideration

The study approved by the institutional ethical review committee of Chattagram Maa-Shishu O General Hospital. Informed written consent was obtained from the parents of all participating children. The confidentiality of patient information was strictly maintained, and data

were used solely for research purposes, in accordance with the Declaration of Helsinki guidelines.

3.4. Statistical Analysis

Data analysis was performed using SPSS version 19.0. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used for baseline variables. Comparative analysis between groups (moderate vs. severe bronchiolitis) was conducted using the chi-square test and the independent t-test. Pearson correlation coefficients were used to assess relationships between ABG parameters and severity scores. A p-value <0.05 was considered statistically significant.

4. RESULTS

Table I. *Sociodemographic characteristics (n=50)*

Characteristics		Frequency (n)	Percent (%)
Mean Age		5.21±1.90	
Gender	Male	35	70
	Female	15	30
Residents	Rural	20	40
	Urban	30	60
History Evaluation	Cough	50	100
	Respiratory distress	50	100
	Fever	26	52
	Feeding difficulty	25	50
	Nasal congestion	30	60

Table I presents the baseline characteristics of the study population. The mean age was 5.21 ± 1.90 months. Of the 50 children, 35 (70%) were male and 15 (30%) were female. Most children (60%) resided in urban areas. All participants presented with cough and respiratory distress. Additional symptoms included nasal congestion (60%), fever (52%), and feeding difficulty (50%).

Table II. *Physical and clinical findings of the children with bronchiolitis (n=50)*

Findings	Frequency (n)	Percentage (%)
Ill looking	42	84
Respiratory rate >60/min	38	76
Nasal flawing	27	54
Chest indrawing	50	100
SO_2 on pulse oximetry (<95)	39	78
CRP(>l0)	12	24
Hyperinfation in Cheast X-Ray	38	76

Table II outlines key clinical signs and relevant laboratory findings. Ill-looking appearance was noted in 84% of patients, and 76% had a respiratory rate exceeding 60 breaths per minute. All children exhibited chest in drawing, while nasal flaring was observed in 54% of cases. Hypoxemia, defined as SpO_2 <95%, was documented in 78% of participants. Hyperinflation was present on chest radiography in 76% of cases. Elevated C-reactive protein (CRP >10 mg/L) was observed in 24% of patients.

Table III. *Relation of PH, PaO_2 and $PaCO_2$, HCO_3 with severity of bronchiolitis*

Severity		Moderate	Severe	P value
SO_2 in air	<90	0	22	
	≥90	28	0	
PH	7.35-0 7.45	21 (42.0)	17 (34.0)	0.503
	<7.35	3 (6.0)	1 (2.0)	
	>7.45	4 (8.0)	4 (8.0)	
PaO_2	80-100	0 (0.0)	6 (12.0)	0.432
	>100	28 (56.0)	0 (0.0)	
	<80	8 (16.0)	8 (16.0)	

$PaCO_2$	35-45	2 (4.0)	1 (2.0)	0.453
	>45	0 (0.0)	0 (0.0)	
	<35	26 (52.0)	21 (42.0)	
HCO_3	22-28	8 (16.0)	5 (10.0)	0.231
	<22	20 (40.0)	17 (34.0)	
	>28	0 (0.0)	0 (0.0)	

Table III presents the distribution of arterial blood gas parameters according to clinical severity (moderate vs. severe). Of the 50 patients, 28 (56%) were classified as having moderate bronchiolitis, and 22 (44%) were classified as having severe bronchiolitis. SpO_2 levels below 90% were observed exclusively in the severe group. The majority of children in both groups had pH values within the normal range (7.35–7.45). Low PaO_2 (<80 mmHg) was recorded in 16% of both groups. Most participants had $PaCO_2$ values below the normal range (<35 mmHg), and no cases exhibited hypercapnia. Bicarbonate levels were below 22 mmol/L in 40% of moderate and 34% of severe cases. Differences in ABG parameters between the groups were not statistically significant ($p>0.05$ for all comparisons).

5. Discussion

A study analyzed how arterial blood gas (ABG) variables, including pH, PaO_2, $PaCO_2$, and HCO_3, influence the clinical severity of bronchiolitis in children between 2 months and 12 months of age. Among 50 cases of bronchiolitis patients, 44% had severe presentations because of hypoxemia, but most of them (56%) exhibited moderate disease severity. The occurrence of abnormal arterial blood gas values was higher among severe patients; however, their pH, PaO_2, $PaCO_2$, and HCO_3 measurement levels between different severity categories did not reach statistical significance.

This research confirms the difficulty in understanding the biology behind bronchiolitis while highlighting how the disease presents differently in patients. The clinical assessment using SpO_2 demonstrated a strong ability to identify moderate and severe cases; however, blood gas analysis proved insufficient to discriminate between disease severity levels in this patient sample. Some prior research highlighted the diagnostic significance of acute bronchiolitis ABG changes, but our study findings produced different results.

The research by Cecunjanin et al. demonstrated that patients with bronchiolitis experienced significant changes in acid-base balance and oxygenation during treatment, as indicated by ABG laboratory results [11]. Our study results showed no significant changes in ABG parameters based on the initial disease severity of patients. The comparison yielded inconsistent results due to variations in the timing of blood sampling, disease stages, and exposure to treatments before conducting the test.

According to Casademont, patients with bronchiolitis exhibit either mild to moderate acidosis or alkalosis in their arterial blood gases, depending on the disease stage and severity [10]. The majority of our patient cohort presented with $PaCO_2$ measurements below normal limits (nižé 35 mmHg) as a result of hyperventilatory compensation. The severity level of respiratory issues among patient groups did not result in significant changes in PaCO2 levels. Natural variations in ventilation could explain these findings, or $PaCO_2$ measurements might not establish direct relationships with clinical disease severity.

According to Saijo et al., our study demonstrated that inflammatory markers, as indicated by CRP levels above 10 mg/L, occurred in 24% of patients [9]. The observation strengthens medical knowledge that bronchiolitis exists as a viral condition while showing restricted inflammatory activity. Hence, laboratory results offer weak indicators of disease severity. Research by Martinez-Baylach et al. and Mulholland et al. Confirmed our observation that chest radiograph hyperinflation occurred in 76% of our patients with bronchiolitis [12, 13].

The findings of Shay et al. support our study by showing that medical practitioners heavily depend on clinical observations and oxygen saturation measurements when evaluating and admitting bronchiolitis patients rather than using laboratory or radiologic results [14]. Our study data validate the use of physical examination findings as the primary tool for assessing bronchiolitis, as it showed 100% chest in drawing and 78% of patients with SpO_2 less than 95%.

The integration of ABG parameters within emergency department bronchiolitis management protocols according to Johnson et al. fails to demonstrate substantial benefits in routine assessment of patients with limited resources [5]. The research by Mallory et al. demonstrated that healthcare providers should monitor SpO_2 precisely, as it represents an effective method for stratifying disease severity, despite the potential for incorrect admissions due to the heavy reliance on respiratory rate and pulse oximetry measurements [6].

The different results between our study and some past literature may have multiple justified explanations. Our sample provides sufficient data for exploratory analysis, yet demonstrates a possible weakness in detecting minimal changes in ABG measurement results. The laboratory tests were performed immediately after admission, but they may not have revealed the peak extent of illness, as disease progression was rapid in some cases. The administration of early supportive measures, which included supplemental oxygen, may have altered the test results before blood collection for ABGs.

The disease severity and progression of bronchiolitis depend on both host factors, such as patient age and immune status, as described in studies by Glezen et al. and Eriksson et al. [1, 4]. The clinical study results may not be applicable to complex patient populations, as our patient selection process excluded those with comorbidities. The study failed to identify meaningful differences in ABG values because individuals display varying capacities for ventilation compensation and acid-base buffering.

The study results provide valuable insights for medical practitioners. This study reveals that ABG measurements provide important biological information; however, they should not be used as a substitute for bedside clinical examinations in bronchiolitis care. Healthcare providers should reserve routine blood gas testing for hospitalized patients with severe hypoxemic conditions because the procedure affects patient comfort and healthcare expenses while showing insignificant discriminating ability in this research. The assessment principles for bronchiolitis include clinical observation and pulse oximetry measurements, as recommended by the Scottish Intercollegiate Guidelines Network and the American Academy of Pediatrics [9, 15].

The analysis of arterial blood gases continues to provide essential information during epidemiological uncertainty or when suspected respiratory failure is present, facilitating proper patient care escalation. Acidosis depth, along with severe hypoxemia or increasing $PaCO_2$ levels, helps clinicians determine when to refer patients to intensive care units and when to start ventilator support.

The research showed that severe bronchiolitis is strongly associated with hypoxemia when SpO_2 levels fall below 90%. However, ABG measurements, including pH, PaO_2, $PaCO_2$, and HCO_3, do not reveal meaningful differences across severity levels. The available evidence suggests that clinicians can rely on their clinical skills and pulse oximetry readings to assess bronchiolitis severity; however, blood gas analysis remains a useful tool for medical teams to diagnose specific patients who require advanced care evaluation.

6. Limitations and Recommendations

This single-center study had a relatively small sample size, which may limit the generalizability of its findings. The timing of ABG collection and the lack of serial monitoring could have affected the observed correlations. Future research should involve multicenter studies with larger cohorts and longitudinal assessments of arterial blood gases (ABGs) to evaluate dynamic changes. It is recommended that clinicians prioritize clinical judgment and SpO_2 in managing bronchiolitis, using ABG selectively. Further exploration is needed to refine objective severity assessment tools, especially in settings with limited resources and high pediatric respiratory disease burden.

7. Conclusion

This study demonstrated that while oxygen saturation (SpO_2) effectively differentiates between moderate and severe bronchiolitis, arterial blood gas (ABG) parameters—PH, PaO_2, $PaCO_2$, and HCO_3—did not show a significant correlation with disease severity. These findings suggest that routine ABG analysis may have limited clinical utility in the initial assessment of bronchiolitis unless respiratory failure is suspected. Clinical evaluation and pulse oximetry remain the cornerstone for severity stratification and management decisions. ABG testing should be reserved for selected cases requiring further diagnostic clarity or escalation of care.

ACKNOWLEDGMENT

I would like to express my sincere gratitude for the invaluable support and cooperation provided by the staff, participants, and my co-authors/colleagues who contributed to this study.

FINANCIAL SUPPORT AND SPONSORSHIP

No funding sources.

CONFLICTS OF INTEREST

There are no conflicts of interest.

ETHICAL APPROVAL

The study was approved by the Institutional Ethics Committee.

REFERENCES

[1] Glezen WP, Taber LH, Frank AL, Kasel JA. Risk of primary infection and reinfection with respiratory syncytial virus. American journal of diseases of children. 1986 Jun 1; 140(6):543-6.

[2] Hall CB. Respiratory syncytial virus and parainfluenza virus. New England journal of medicine. 2001 Jun 21; 344(25):1917-28.

[3] Wang EE, Law BJ, Stephens D. Pediatric Investigators Collaborative Network on Infections in Canada (PICNIC) prospective study of risk factors and outcomes in patients hospitalized with respiratory syncytial viral lower respiratory tract infection. The Journal of pediatrics. 1995 Feb 1; 126(2):212-9.

[4] Eriksson M, Bennet R, Rotzén-Östlund M, Von Sydow M, Wirgart BZ. Population-based rates of severe respiratory syncytial virus infection in children with and without risk factors, and outcome in a tertiary care setting. Acta Paediatrica. 2002 May; 91(5):593-8.

[5] Johnson LW, Robles J, Hudgins A, Osburn S, Martin D, Thompson A. Management of bronchiolitis in the emergency department: impact of evidence-based guidelines? Pediatrics. 2013 Mar 1; 131(Supplement_1): S103-9.

[6] Mallory MD, Shay DK, Garrett J, Bordley WC. Bronchiolitis management preferences and the influence of pulse oximetry and respiratory rate on the decision to admit. Pediatrics. 2003 Jan 1; 111(1): e45-51.

[7] British Thoracic Society. Scottish intercollegiate guidelines Network. British guideline on the management of asthma. 2016 Sep:58.

[8] Cecunjanin Z, Selimovic A, Milisic S, Mujicic E. Assessment of hematological parameters, acid-base status and arterial blood gas test before and after treatment of acute bronchiolitis in children. International Journal of Surgery and Medicine. 2020 Apr 20;2(3):171-.

[9] Saijo M, Ishii T, Kokubo M, MURONO K, TAKIMOTO M, Fujita K. White blood cell count, C-reactive protein and erythrocyte sedimentation rate in respiratory syncytial virus infection of the lower respiratory tract. Pediatrics International. 1996 Dec; 38(6):596-600.

[10] Casademont J. Harrison's Principles of Internal Medicine 16th Edition, Dennis L. Kasper, Eugene Braunwald, Antoni S. Fauci, Stephen L. Hauser, Dan L. Longo, J. Larry Jameson (Eds.), McGraw-Hill Professional Publishing (2004), 2680 pages, ISBN: 0071402357, Hardcover, Illustrated, Price£ 90.

[11] Cecunjanin Z, Selimovic A, Milisic S, Mujicic E. Assessment of hematological parameters, acid-base status and arterial blood gas test before and after treatment of acute bronchiolitis in children. International Journal of Surgery and Medicine. 2020 Apr 20;2(3):171-.

[12] Martínez-Baylach J, Castan AR, Rieró JC. Clinical and epidemiological study of acute bronchiolitis in patients less than one year of age. Acta Pediatrica Espanola. 2004 Jul 1; 62(7):275-80.

[13] Mulholland EK, Olinsky A, Shann FA. Clinical findings and severity of acute bronchiolitis. The Lancet. 1990 May 26; 335(8700):1259-61.

[14] Shay DK, Holman RC, Newman RD, Liu LL, Stout JW, Anderson LJ. Bronchiolitis-associated hospitalizations among US children, 1980-1996. Jama. 1999 Oct 20; 282(15):1440-6.

[15] American Academy of Pediatrics Subcommittee on Diagnosis and Management of Bronchiolitis. Diagnosis and management of bronchiolitis. Pediatrics. 2006 Oct; 118(4):1774-93.

Citation: *Dr. Rehana Ahmed et al. Correlation between Arterial Blood Gas Parameters (PH, PaO2, PaCO2, and HCO3) and the Severity of Bronchiolitis. ARC Journal of Pediatrics. 2025; 10(3):1-6. DOI: https://doi.org/10.20431/2455-5711.1003001.*