Research Paper

Evaluation of Clinical Predictors of Hypoxemia in Children With Bronchiolitis: A Bidirectional Cohort Study

Indumathi Dhayalan[1*], Sruthi Mangalath[1], Jaishree Vasudevan[1]

1. Chettinad Hospital and Research Institute, Kelambakkam, Chengalpet, Tamil Nadu, India.

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ABSTRACT

Background: Bronchiolitis is common in children under 2 years of age and is a leading cause of hospitalization in infants and children. Children with bronchiolitis are generally well-appearing and active despite being tachypneic or hypoxic.

Objectives: This study aims to identify the predictors of hypoxia in children with bronchiolitis, as well as to find the average duration of oxygen requirement and hospitalization in children with hypoxia.

Methods: A total of 65 children between the age group of 1 month to 2 years with bronchiolitis were included in the study. Data were collected retrospectively from case records and prospective cases were consecutively enrolled. Oxygen saturation was monitored in all hospitalized children. An oxygen saturation (SpO_2)<92% was considered hypoxia. The relationship between presenting clinical features and subsequent development of hypoxia was assessed using the Pearson chi-square test.

Results: The presenting features of bronchiolitis in our study were cough, fever, tachypnea, increased work of breathing, and wheezing. Cough was the most common symptom and fever was the least common symptom. A total of 59.3% of children with a cough had hypoxia. Of the 23 children who had a fever, 52.1% of them had hypoxia. Among 51 children with tachypnea, 68.6% had hypoxia (P=0.001). Among 57 children whose respiratory work was increased, 68% of children had hypoxia (P=0.000); 71.8% of children with wheezing had hypoxia (P=0.05).

Conclusion: Our study shows that in children with bronchiolitis, the presence of tachypnea, increased work of breathing and wheezing increases the risk of developing hypoxia. Identifying these predictors of hypoxia can help as a guide for deciding on the need for hospitalization in children with bronchiolitis.

** Corresponding Author:*
Indumathi Dhayalan, MD.
Address: *Chettinad Hospital and Research Institute, kelambakkam, Chengalpet, Tamil Nadu, India.*
E-mail: *indu.ich@gmail.com*

Introduction

Bronchiolitis is common in children under 2 years of age and is a leading cause of hospitalization in infants and children [1, 2]. Bronchiolitis usually starts with cold-like symptoms but progresses to cough, wheezing, tachypnea and chest retractions, poor feeding, or irritability [3, 4]. The peak incidence is between the age group of 2-6 months [5]. In India, most outbreaks occur from September to March [6]. The incidence of acute bronchiolitis is 76% in less than 1 year and 94% in less than 2 years [7]. The common viruses causing bronchiolitis are respiratory syncytial virus (75%), rhinovirus, para influenza virus, influenza virus, and adenovirus [4-6].

The severity of bronchiolitis may range from mild to severe illness. Bronchiolitis severity score is used to assess the children (Table 1).

Children with bronchiolitis are generally well-appearing and active despite being tachypneic or hypoxic. Among them, identifying those at risk of hypoxia based on easily assessable clinical parameters as predictors may be helpful. Children with hypoxia may require hospitalization for nebulization or oxygen supplementation thus identifying the risk factor that can predict hypoxia will be helpful in monitoring and treatment.

The primary objective of this study is to identify the predictors of hypoxia in children presenting with bronchiolitis from the age of 1 month to 2 years based on clinical presentation. Children may present with clinical features, such as tachypnea, wheezing, cough, or fever. This study aims to identify which of the presenting features could predict hypoxia and subsequent oxygen supplementation.

The secondary objective of this study is to identify the average duration of oxygen requirement and the hospitalization of children with bronchiolitis from the age of 1 month to 2 years.

Methods

This retrospective, prospective cohort study (data were collected retrospectively from case sheets of patients admitted from August 2021 to November 2021; patients admitted from December 2021 to February 2022 were enrolled prospectively) was conducted at Chettinad Hospital and Research Institute, Kelambakkam.

Patient visit with symptoms consistent with the diagnosis of bronchiolitis [6] (children presenting with complaints of cough, respiratory distress, fever, and wheezing) between the age group of 1 month to 2 years was included.

Sample size

In a study conducted by Kripasindhu Chatterjee in West Bengal, India, the prevalence of bronchiolitis in children <2 years was 94% [7].

where, P=Prevalence

Q=100-P

L=Error

$n=4PQ/L^2$

=4x94x6/6x6

=2256/36

n=63

Adding a 10% non-response rate and rounding it off to the nearest whole number, n=70

Out of the 70 sample size, 5 people were excluded due to incomplete records, and only 65 children were included in the study.

Children who received treatment (oxygen/been nebulized) outside the hospital for the present illness within 8 hours were excluded from the study.

All children admitted with bronchiolitis were clinically monitored and using RAD 97 Masimo pulse-oximetry every 4 hours. Oxygen saturation (SPO_2) below 92% was considered hypoxia. Primary data collection was performed on a pre-tested proforma for all children admitted with bronchiolitis (Figure 1).

Descriptive statistics, such as Mean±SD, and median were calculated for quantitative variables. The chi-square test was used to assess the association between the variables. MS Excel and SPSS software, version 16 were used to analyse the study. P<0.05 was considered significant.

Table 1. Bronchiolitis severity score

Score	Respiratory Rate	Wheezing	Retraction	General Condition
0	<30	None	None	Normal
1	30–45	Terminal expiration or only with the stethoscope	Intercostal	
2	46–60	Entire expiration or audible on expiration without the stethoscope	Tracheosternal	
3	>60	Inspiration and expiration without the stethoscope		Irritability, lethargy, poor feeding

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Results

A total of 65 eligible children with bronchiolitis were included in the study. Of these, 56 children (86%) were in the age group of 1 month to 12 months and only 9 children (14%) children were in the age group of 1 to 2 years. The mean weight and height were 6.7 kg and 65 cm respectively. Out of a total of 65 children, 39(60%) were male and 26(40%) were female (Figure 2).

Children presented with symptoms of cough, fever, increased work of breathing, and wheezing or crepitation. Out of the 65 children who were included in the study, 64 children (98.4%) had a cough, 57 children (87.6%) had increased work of breathing, and 23 children (35%) had a fever. In the examination, 52 children (80%) had tachypnoea and 32(49.2%) had a bilateral wheeze.

Out of 65 children, 39(60%) had hypoxia (SPO_2 level below 92% in room air) (Figure 3). The lowest level of documented saturation was 88%. Children with hypoxia were started on O_2 via face masks or nasal prongs.

Although almost all children had a cough (98%), only 38 of them (59.3%) had hypoxia. Of the 23 children with fever, 12(52.1%) had documented hypoxia. 51 children had tachypnea, of which 35(68.6%) had hypoxia. Among 57 children whose respiratory work wasincreased, 39(68%) children had hypoxia. Of the 32 children who were found to have wheezing on examination, 23(71.8%) had hypoxia.

It was found that fever and cough had P=0.341 and P=0.411, respectively (P>0.05) which indicated a weak relationship with hypoxia. The presence of tachypnea (P=0.001), wheezing (P=0.054) and increased work of

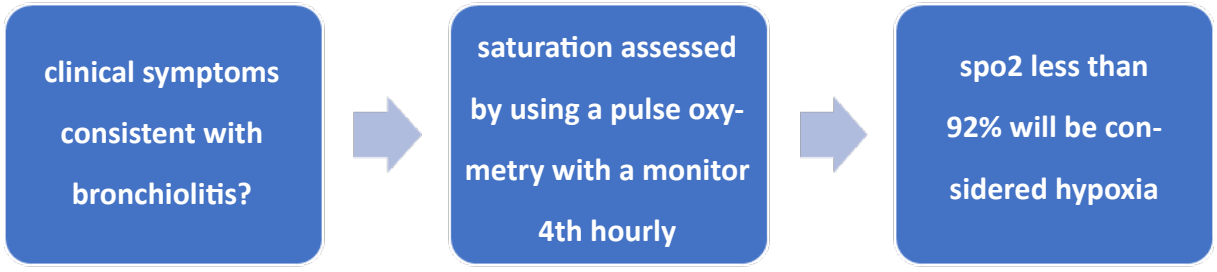

Figure 1. Clinical assessment and detection of hypoxia

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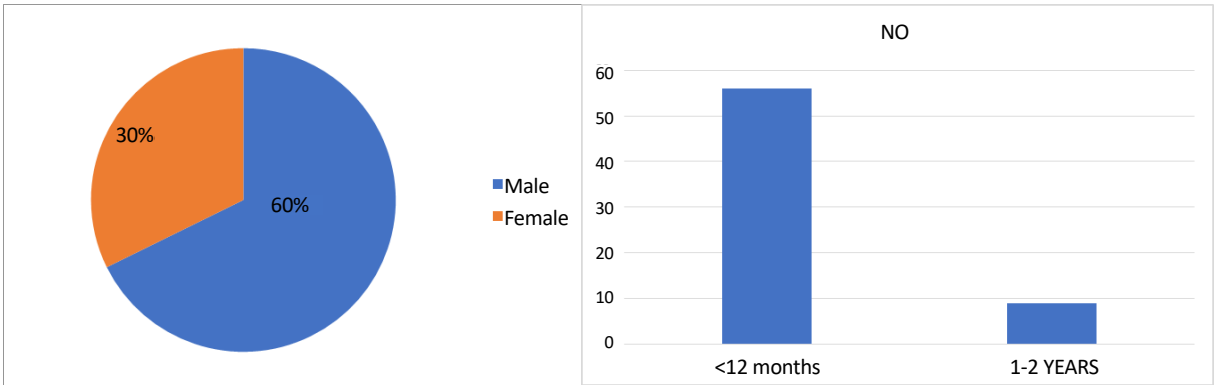

Figure 2. Demographic features

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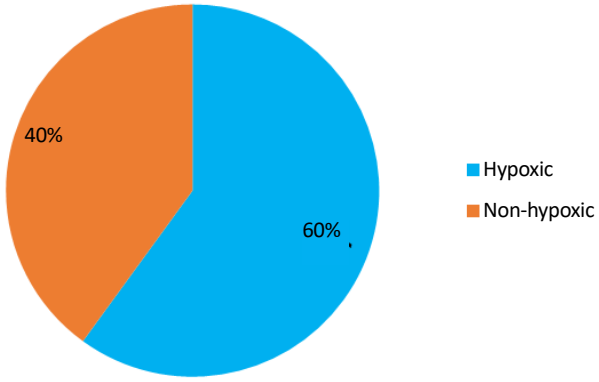

Figure 3. Percentage of hypoxic and non-hypoxic children

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breathing (P=0.0001) showed a significant relationship with hypoxia.

A chest X-ray was performed on admission. A total of 46(70%) children had normal chest X-ray findings, 11 children (16%) had increased bronchovascular signs, 2 children (3%) had bilateral chest infiltrates and 6 children had lung hyperinflation in a chest X-ray. The Mean±SD of number of days number with oxygen requirement in the hypoxic group was 3.1±1.6 days and it was 1.4±1.8 days in the non-hypoxic group (Table 2).

Discussion

In the present study, the clinical presentation of bronchiolitis and its association with the development of hypoxia during hospitalization was assessed.

Table 2. Analysis of statistical significance of association of presenting features and hypoxia

Variables		No. (%)/(Mean±SD)		Total	P
		Hypoxic (>92% SPO_2)	Non-Hypoxia (<92% SPO_2)		
Age	1-12 (month)	36(64.3)	20(35.7)	56	0.083
	1-2 (y)	6(66.6)	3(33.4)	9	
Gender	Male	28(71.8)	11(28.2)	39	0.386
	Female	16(61.6)	10(38.4)	26	
Fever	Yes	12(52.1)	11(47.9)	23	0.341
Wheeze/Crepts	Yes	23(71.8)	9(28.2)	32	0.054*
Cough	Yes	38(59.3)	26(40.7)	64	0.411
WOB	Increased	39(68.4)	18(31.6)	57	0.0001*
RR	Increased	35(68.6)	17(33.4)	51	0.001*
	Normal	4(30.7)	9(69.3)	13	
No hospitalization		4.6±2.1	4.1±1.3		
Duration of O_2 requirement		3.1±1.6	1.4±1.8		

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Abbreviations: SPO_2: Oxygen saturation; WOB: Work of breathing; RR: Respiratory rate. *P<0.05 is considered significant.

In a study conducted by Pelletier et al., the frequency of hospitalizations was higher among children aged <1 year of age, male gender, and non-white race [1] This is similar to the present study where most hospitalized children were <1 year (86%). In our study, we observed a male predominance (60%). This compares with a study conducted by Nagayama et al. that showed a male predilection and increased hospitalization [8].

In a study by Angurana et al., it was found that the most common symptoms were rapid breathing (98.8%), a cough (98.3%), and a fever (74%) [9]. In our study, out of 65 children, (98%) had cough, (78.4%) had tachypnea and fever was a less common symptom (35.3%). In a study conducted by Rajesh et al., tachypnoea is the best predictor of hypoxia [10].

In the present study, we found that children with increased work of breathing (P=0.0001) and tachypnoea (P=0.001) had developed hypoxia.

In our study, 32 children (49%) had wheezing or crepitation at admission which also showed a significant relationship (P=0.05) with hypoxia. In a similar study conducted by Angurana et al., on the clinical assessment, tachypnea (98.8%), chest retractions (93.6%), respiratory failure (84.4%), wheezing (49.7%), and crepitations (23.1%) were observed [9]. In a study conducted by Al Hamwandi et al., out of 154 infants, 43 infants (93%) had hypoxia, and infants with high respiratory rate and heart rate was negatively associated with the development of hypoxemia. Hypoxemia was also significantly associated with the level of consciousness, cyanosis, use of accessory muscles, ability to sleep, and ability to feed [11]. Children with comorbidities, chest retraction, respiratory failure, and shock at presentation required PICU admission [9]. In our study, none of the children required admission to the intensive care unit.

Though cough was a predominant presenting complaint in our study (98% of patients), it had no significant association (P=0.41) with development of hypoxia. In the present study, we found no relationship between gender (P=0.386) and age (P=0.08) with the development of hypoxia.

Hypoxic children were started on oxygen supplementation and continuous SPO_2 monitoring was performed. It was found that the mean duration of oxygen requirement was 3.1±1.6 days. Non-hypoxic children required oxygen supplements for 1.4±1.8 days. In a study conducted by Mahant et al., intermittent and continuous pulse oximetry monitoring was performed in stabilized infants with bronchilolitis, the median hours of hospitalization in the continuous group was 27 hours and it was 25 hours in the intermittent group [12]. In our study, the mean length of stay was 4.6±2.1 days due to the oxygen requirement.

Conclusion

This study concludes that children presenting with tachypnea, increased work of breathing, or wheezing are at increased risk of hypoxia compared to children who do not. Hence Knowledge about clinical predictors of hypoxia would be helpful as a guide to assess the need for hospitalization of children who may require prolonged hospitalization.

Study limitations

In our study, most children were <1 year of age. This could be due to the limited sample size. We did not observe any children with underlying co-morbid conditions, such as cardiac disorders, prematurity, or chronic lung disease. Hence, the results of the present study may not be applicable to such children. This could also be due to the smaller sample size.

Ethical Considerations

Compliance with ethical guidelines

No ethical consideration was involved in the present study and it was approved by the Institutional Human Ethical Committee (Ref No.: IHEC-II/0112/21).

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Authors contributions

All authors equally contributed to preparing this article.

Conflicts of interest

The author declared no conflict of interest.

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