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**Title:** Evaluation of Clinical Predictors of Hypoxemia in Children with Bronchiolitis – A  
Bidirectional Cohort Study

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## **ABSTRACT:**

**Objective:** Primary aim of this study is to identify the predictors of hypoxia in children with bronchiolitis. The secondary aim is to find the average duration of oxygen requirement and length of hospital stay in children with hypoxia.

**Methodology:** 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 children who were admitted. A SpO<sub>2</sub> <92% was considered hypoxia. The association between presenting clinical features and subsequent development of hypoxia was assessed using Pearson Chi Square test.

**Results:** The presenting features of bronchiolitis in our study were cough, fever, tachypnea, increased work of breathing and wheeze. Cough was the most common symptom and fever was the least common symptom. 59.3% of children with cough were found to develop hypoxia. Of the 23 children who had fever, 52.1% of them developed hypoxia. Among 51 children with tachypnea 68.6% had hypoxia (P=0.001). Among 57 children who had increased work of breathing, 68% children developed hypoxia (P=0.000). 71.8% of children who had wheeze were found to develop hypoxia (P=0.05).

**Conclusion:** Our study shows that in children with bronchiolitis presence of tachypnea, increased work of breathing and wheeze had increased risk of developing hypoxia. Identifying these predictors of hypoxia could help to serve as a guide in deciding the need for hospitalisation in children with bronchiolitis.

**Keywords:** Bronchiolitis, Hypoxia, Predictors, Paediatric, Tachypnea

## INTRODUCTION:

Bronchiolitis is common in children below the age group of 2 years and one of the leading cause of hospitalization in infants and children(1) (2). Bronchiolitis usually starts with symptoms similar to that of common cold, but progresses to cough, wheezing, tachypnea and chest retractions, poor feeding or irritability(3)(4)(12). The peak incidence is between the age group of 2 - 6 months of age(5). In India, outbreaks are more come from the month of September to March (6). The incidence of acute bronchiolitis in less than 1 year is 76 % and in less than 2 years is 94 %(7). The common viruses causing bronchiolitis are, Respiratory syncytial virus (75% ), Rhinovirus, para influenza virus, influenza virus and adeno virus(5)(6)(4)(16).

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

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

**Figure 1:** Bronchiolitis Severity score

Children with bronchiolitis are generally well appearing and active despite being tachypneic or hypoxic. Among them, identifying those who are 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 identify the risk factor that can predict hypoxia will be helpful in monitoring and treatment.

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

Secondary objective of this study is to identify the average duration of oxygen requirement and the length of hospital stay the in children presenting with bronchiolitis from 1 month to 2 years of age.

### **Methodology:**

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

Patient meeting with symptomatology consistent with diagnosis of bronchiolitis(Verma et al., 2013) (children presenting with complaints of cough, respiratory distress, fever, wheeze) between the age group of 1 month to 2 years were included

**Sample size:**

The prevalence of Bronchiolitis among the children <2 years was 94% in a study conducted by Kripasindhu Chatterjee in West Bengal, India (7). where, P= Prevalance,

$$Q= 100-P,$$

$$L= Error$$

$$\begin{aligned}n &= 4PQ/L^2 \\ &= 4 \times 94 \times 6 / 6 \times 6 \\ &= 2256 / 36 \\ n &= 63\end{aligned}$$

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

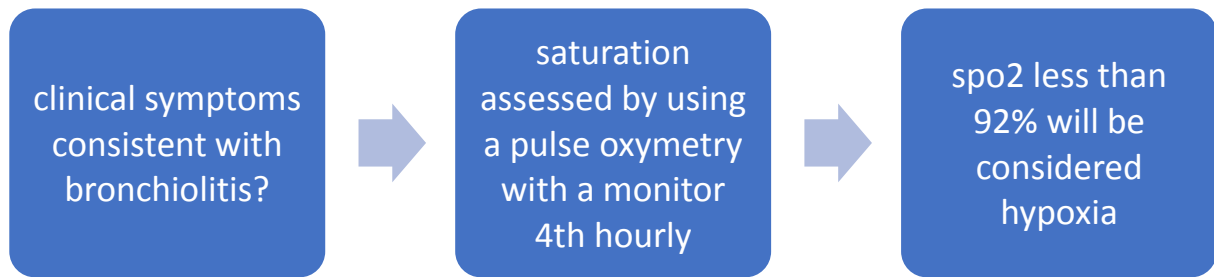
Out of 70 sample size, 5 were excluded due to incomplete records and only 65 children were included in the study.

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

There were no ethical consideration involved in the present study and it was approved by institutional human ethical committee. Ref number-IHEC-II/0112/21.

All children admitted with bronchiolitis were monitored clinically and using RAD 97 Masimo pulse-oximetry every 4<sup>th</sup> hourly. Spo2 below 92% was considered as hypoxia. Primary data collection was made on a pre-tested proforma for all children admitted with bronchiolitis.

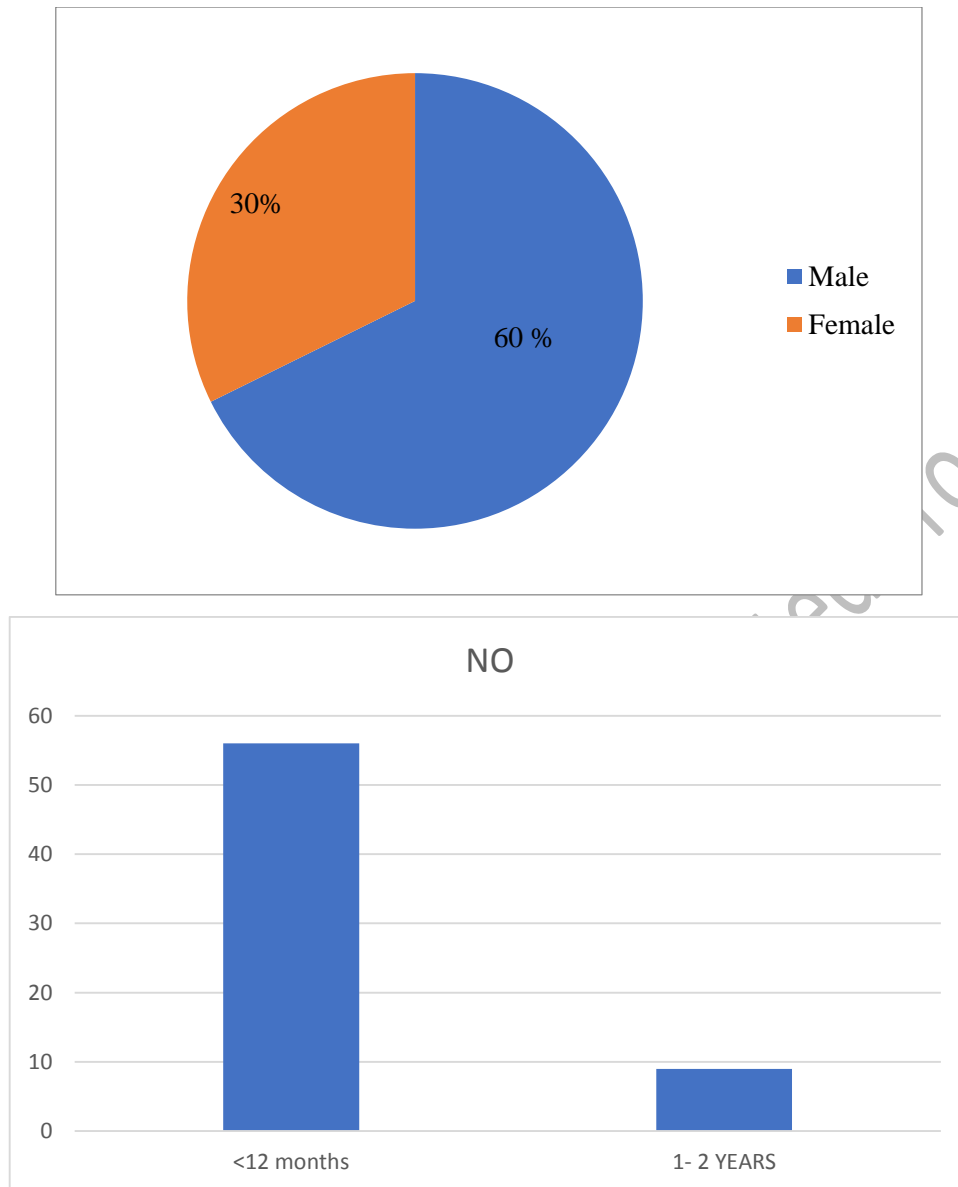
Descriptive statistics such as Mean, Median and Standard Deviation for quantitative variables were calculated. Chi-square test was used to assess the association between the variables. MS Excel and SPSS 16.0 version were used to carry out the analysis for the study. P value <0.05 was considered has significant.



**Figure 2:** Clinical Assessment and Detection of Hypoxia

**RESULTS:**

65 children satisfying the criteria for bronchiolitis were included in the study. Of these, 56 (86%) children were between the age group of 1 month to 12 months and only 9 (14%) children were between the age group of 1 to 2 years. The mean weight and height was 6.7 kg and 65 cm respectively. Out of the total 65 children, 39(60%) were male and 26 (40%) were female(fig 3 ).



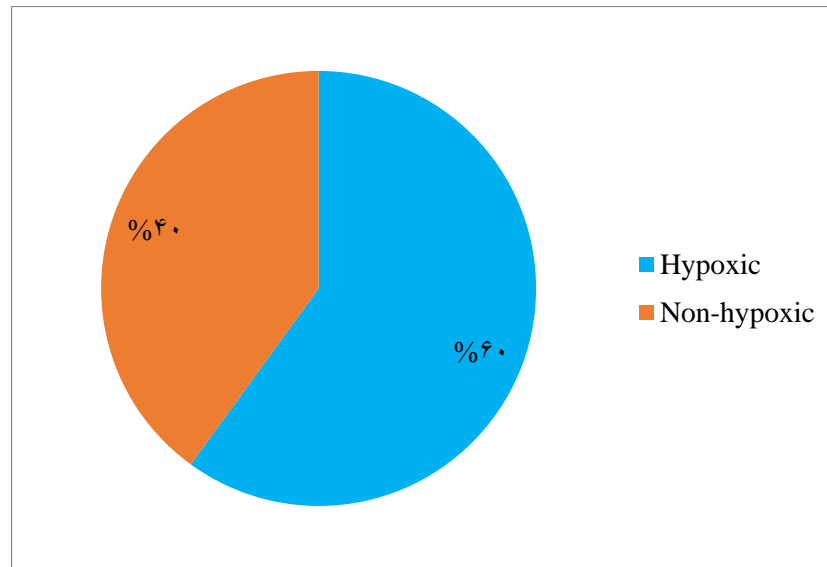
**Figure 3:** Demographic features

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

Out of 65 children 39(60%) were found to have hypoxia (SpO<sub>2</sub> level below 92% in room air) (Fig 3). The lowest level of documented saturation was



at 88%. Children with hypoxia were started on O<sub>2</sub> via face mask or nasal prongs.



**Figure 3:** Percentage of hypoxic and non hypoxic children

Although almost all children had cough (98%), out of them only 38(59.3%) were found to have hypoxia. Of the 23 children who had fever, 12 (52.1%) of them had documented hypoxia. 51 children had tachypnea of which 35(68.6%) developed hypoxia. Among 57 children who had increased work of breathing, 39(68%) children developed hypoxia. Of the 32 children who were found to have wheeze on examination, 23(71.8%) of them were found to develop hypoxia.

It was found that fever and cough had *P* value of 0.341 and 0.411 respectively (*P* value >0.05) which was suggestive of poor association with hypoxia. Presence of tachypnea (*P* value = 0.001), wheeze (*P* Value= 0.054) and increased work of breathing (*P* value= 0.000) showed significant association with development of hypoxia.

Chest X ray was done at admission. 46(70%) children had normal chest X ray findings, 11(16%) of the children had increased bronchovascular markings, 2 (3%) showed bilateral chest infiltrates and 6 children had

hyperinflation of the lungs in chest x ray. The mean number of days of oxygen requirement was  $3.1 \pm 1.6$  (Mean $\pm$ SD) days in hypoxic group and  $1.4 \pm 1.8$  days in non-hypoxic group.

**Table 1** Analysis of statistical significance of association of presenting features and hypoxia

<b>Variables</b>	<b>Hypoxic(&gt;92% SPO2)</b>	<b>Non Hypoxia(&lt;92% SPO2)</b>	<b>Total</b>	<b>P-Value</b>
Age (1month - 12month)	36(64.3%)	20(35.7%)	56	0.083
Age (1year- 2years)	6(66.6%)	3(33.4%)	9	
<b>Gender</b>				
Male	28(71.8%)	11(28.2%)	39	0.386
Female	16(61.6%)	10(38.4%)	26	
<b>Fever</b>				
Yes	12(52.1%)	11(47.9%)	23	0.341
<b>Wheeze/ Crepts</b>				
Yes	23(71.8%)	9(28.2%)	32	0.054*
<b>Cough</b>				
Yes	38(59.3%)	26(40.7%)	64	0.411
<b>WOB</b>				
Increased	39(68.4%)	18(31.6%)	57	0.000*
<b>RR</b>				
Increased	35(68.6%)	17(33.4%)	51	0.001*
Normal	4(30.7%)	9(69.3%)	13	
<b>No of Hospital Stay (Mean-SD)</b>	4.6 $\pm$ 2.1	4.1 $\pm$ 1.3		
<b>Duration of O2 requirement(Mean-SD)</b>	3.1 $\pm$ 1.6	1.4 $\pm$ 1.8		

\* P value <0.05 is taken as significant

## **DISCUSSION:**

In the present study, clinical presentation of bronchiolitis and its association with development of hypoxia during the course of stay in the hospital was assessed.

In a study conducted by Pelletier et al, frequency of hospitalizations was higher among children age < 1 year of age, male gender, and non-white race (1). This is similar to the present study where most of the hospitalized children were <1 year (86%). In our study, we observed a male predominance (60%). This is comparable to a study done by Nagayama Y et al which showed a male predilection and increased hospitalization (15).

In a study by Angurana et al, it is being found that most common symptoms were rapid breathing (98.8%), cough (98.3%), and fever (74%) (11). In our study out of 65 children, (98%) had cough, (78.4%) had tachypnea and fever was less common symptom (35.3%). In a study conducted by Rajesh et al which showed tachypnoea is the best predictor of hypoxia (10).

In the present study we found that children who had increased work of breathing ( $P=0.000$ ) and tachypnoea ( $P=0.001$ ) at presentation developed hypoxia.

In our study 32(49%) children had wheeze or crepitation at admission which also showed a significant association ( $P=0.05$ ) with hypoxia. In a similar study done by Angurana et al, on clinical assessment showed tachypnea (98.8%) had, chest retractions (93.6%), respiratory failure (84.4%), wheezing (49.7%), and crepitations (23.1%) were observed (11). A study done by Al Hamwandi et al, out of 154 infants 43 (93%) of the infants had hypoxia and infants with high respiratory rate and heart rate was negatively associated with development of hypoxemia. Hypoxemia was also significantly associated with level of consciousness, cyanosis, use of accessory muscles, ability to sleep, ability to feed (13). Children with comorbidities, chest retraction, respiratory

failure and shock at presentation required PICU admission (11). 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% patients), it did not have any significant association ( $P= 0.41$ ) with development of hypoxia. In the present study, we did not find any association between the gender ( $P$  value=0.386) and age ( $P$  value= 0.08) with the development of hypoxia.

Hypoxic children were started on oxygen supplementation and continuous Spo<sub>2</sub> monitoring was done. It was found that the mean duration of oxygen requirement was  $3.1\pm 1.6$  days. Non hypoxic children required oxygen supplement for  $1.4\pm 1.8$  day. In a study by Mahant et al, were intermittent and continuous pulse oximetry monitoring was done in stabilized infants with bronchilolitis, the median hours of stay in hospital was for 27 hours in the continuous group and 25 hours in the intermittent group (14). In our study the mean length of stay was  $4.6\pm 2.1$  days, due to the oxygen requirement.

## **CONCLUSION:**

This study concludes that children presenting with tachypnea, increased work of breathing or wheeze have increased risk of developing hypoxia compared with children who don't. Hence Knowledge about clinical predictors of hypoxia would be helpful as a guide to assess the need for hospitalization of the children who might require whereby leads to prolonged hospital stay.

## **LIMITATION OF THE STUDY:**

In our study majority of the children observed were  $< 1$  year of age. This could be due to limited sample size. We did not observe any children with underlying co- morbid conditions like cardiac disorders, prematurity or chronic

lung disease. Hence results of present study may not be applicable in such children. This could also be due to smaller sample size.

**Conflict of Interest:** The author has nil conflict of interest.

**Financial Disclosure:** Nil

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