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Original Research Article

Correlation of hypoxemia with clinical signs in children aged 2 months to 5 years with acute lower respiratory tract infection: a prospective observational study

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ABSTRACT

Background: Acute lower respiratory tract infection (LRTI), particularly pneumonia, is a leading cause of morbidity and mortality in children under five years of age globally. Hypoxemia is a major complication and risk factor for death in these patients. This study aimed to correlate hypoxemia with clinical signs, laboratory markers and outcomes in children with acute LRTI.
Methods: A prospective observational study was conducted in the pediatric intensive care unit (PICU) of a tertiary care hospital Dhiraj Hospital Piparia. The study enrolled 61 children aged 2 months to 5 years diagnosed with WHO-defined community-acquired pneumonia. Clinical signs, anthropometry, laboratory parameters (CBC, CRP) and chest X-rays were recorded. Oxygen saturation (SpO2) was monitored every 6 hours. Hypoxemia was defined as SpO2 ≤ 90%. Statistical analysis was performed to determine associations between hypoxemia and clinical variables.
Results: Of 61 patients, 59.02% (36/61) presented with hypoxemia. The majority were infants (75.41%) and males (73.77%). Hypoxemia was significantly associated with nasal flaring (p=0.022), chest indrawing (p=0.011) and the combination of both (p=0.001). All patients presenting with cyanosis (100%) were hypoxemic. Radiological consolidation was significantly associated with lower SpO2 (p=0.003), as were elevated total leukocyte counts (p=0.029) and C-reactive protein levels (p=0.006). Longer duration of oxygen support was required in hypoxemic patients (p=0.012). No significant association was found between hypoxemia and age, gender, nutritional status, severity of anemia or severity of pneumonia classification.
Conclusions: Clinical signs such as nasal flaring, chest indrawing and cyanosis are reliable bedside predictors of hypoxemia in children with LRTI. While pulse oximetry remains the gold standard for detection, these clinical signs warrant immediate attention, especially in resource-limited settings.

Keywords: Clinical signs, Hypoxemia, Lower respiratory tract infection, Pneumonia, Pediatrics, SpO2

INTRODUCTION

LRTI encompass a range of conditions affecting the airways and lung parenchyma. Pneumonia, defined as acute inflammation of the lung parenchyma, remains the single largest infectious cause of death in children worldwide.[1] According to UNICEF, pneumonia kills approximately one child every 35 seconds, accounting for 16% of all deaths of children under five years old.

In developing countries, the burden is particularly high due to risk factors such as malnutrition, overcrowding and lack of exclusive breastfeeding.[2] The World Health Organization (WHO) classifies pneumonia into non-

severe, severe and very severe categories based on clinical presentation.[3] Regardless of classification, hypoxemia (low blood oxygen levels) is a critical complication that significantly increases the risk of mortality. The median prevalence of hypoxemia in children with severe to very severe pneumonia is approximately 13%, though this varies by setting.[4] While arterial blood gas analysis is the gold standard for measuring oxygenation, it is invasive and impractical for continuous monitoring. Pulse oximetry (SpO2) offers a non-invasive, reliable alternative.[5]

Despite the high burden of disease, early detection of hypoxemia remains a challenge in resource-limited settings where pulse oximeters may not always be available. Therefore, understanding the correlation between clinical signs such as nasal flaring, chest indrawing and cyanosis and objective hypoxemia is crucial for timely triage and management.

This study aimed to determine the immediate outcome of community-acquired pneumonia in children aged 2 months to 5 years, with a specific focus on correlating SpO2 levels with clinical signs and laboratory markers.

METHODS

Study design and setting

This prospective observational study was conducted in the PICU of Dhiraj Hospital Piparia. The study population consisted of children admitted with a diagnosis of community-acquired pneumonia. The study was conducted from period of 2017-2019

Inclusion criteria

Children aged between 2 months and 5 years with acute lower respiratory tract infection whose parents provided informed consent were enrolled.

Exclusion criteria

The study excluded children with congenital heart disease, known chronic respiratory diseases (e.g., bronchial asthma, cystic fibrosis), immunocompromised states (HIV, long-term steroids), foreign body aspiration, nosocomial pneumonia or shock.

Data collection and procedures

All enrolled subjects underwent detailed history taking and clinical examination. Patients were classified according to the WHO classification of pneumonia. Routine investigations included complete blood count (CBC), C-reactive protein (CRP) and chest X-ray. Oxygen saturation (SpO2) was measured using a multi-parameter monitor (L&T, N series). SpO2 readings were recorded every 6 hours in the PICU and every 12 hours for 48 hours after transfer to the ward.

Statistical analysis

The sample size was calculated based on a prevalence of 20%, resulting in a target of 67 patients; a total of 61 patients were enrolled. Data were analyzed to determine associations between hypoxemia (defined as SpO2≤90%) and various clinical and demographic variables. P values were calculated to assess statistical significance, with $p<0.05$ considered significant.

RESULTS

Demographic characteristics

A total of 61 patients participated in the study. The majority of patients were infants; 46 (75.41%) were aged 2–12 months, while 15 (24.59%) were older than 12 months. There was a male predominance, with 45 (73.77%) males and 16 (26.23%) females.

Regarding nutritional status, 35 (57.38%) children had severe acute malnutrition (SAM), 16 (26.23%) had moderate acute malnutrition (MAM) and 10 (16.39%) had normal nutrition.

Clinical presentation

The most common symptoms reported were cough (98.36%) and difficulty in breathing (93.44%), followed by fever (73.77%) and inability to feed (39.34%). Clinical signs observed on admission included chest indrawing in 51 (83.61%) patients, nasal flaring in 33 (54.10%) and cyanosis in 7 (11.48%).

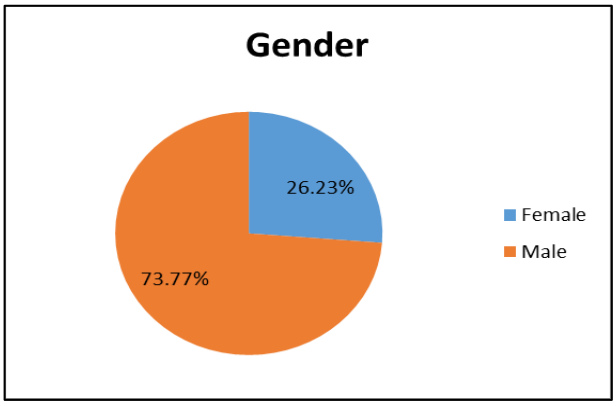

Figure 1: Demographic data.

Association of clinical signs with hypoxemia

Hypoxemia (SpO2≤90%) was present in 36 (59.02%) of the study participants. Statistical analysis revealed significant associations between specific clinical signs and hypoxemia. While nasal flaring, chest indrawing and cyanosis were strongly predictive of hypoxemia, no significant association was found between hypoxemia and demographic factors such as age (p=0.929), gender (p=0.393) or nutritional status (p=0.866 for SAM).

Laboratory and radiological findings

Laboratory analysis showed a significant correlation between inflammatory markers and oxygen saturation. Higher total leukocyte counts (TLC) were associated with lower SpO2 levels (p=0.029). Similarly, elevated C-reactive protein (CRP) levels significantly correlated with the severity of hypoxemia (p=0.006).

On chest X-ray, consolidation was present in 36 (59.02%) patients. There was a statistically significant association between the presence of consolidation and hypoxemia (p=0.003), with 75% of patients with consolidation exhibiting SpO2≤90%.

Severity and outcomes

According to WHO classification, 32 (52%) patients had severe pneumonia and 27 (44%) had very severe pneumonia. Surprisingly, there was no statistically significant association between the WHO severity classification and the presence of hypoxemia (p=0.480 for severe, p=0.083 for very severe). Regarding outcomes, no deaths occurred in the study population. There was no significant association between outcome (discharge vs. DAMA) and hypoxemia. However, the duration of oxygen support was significantly longer in hypoxemic patients (p=0.012 for the 96-144 hours duration group).

Table 1: Age wise distribution.

Age group (in months)	n=61	%
2-12	46	75.41
>12	15	24.59
Total	61	100.00

Table 2: Distribution according to nutrition status.

Nutrition	Male	%	Female	%	Total
SAM	25	71.43	10	28.57	35
MAM	12	75.00	4	25.00	16
Normal	8	80.00	2	20.00	10
Total	45	73.77	16	26.23	61

Table 3: Association of clinical signs with hypoxemia.

Clinical sign	Total cases (N)	Hypoxemic (SpO2 ≤ 90%)	P value
Nasal flaring	33	24 (72.73)	0.022
Chest indrawing	51	33 (64.71)	0.011
Combined (flaring+indrawing)	28	24 (85.71)	0.001
Cyanosis	7	7 (100)	-
Grunting	7	6 (85.71)	0.223

DISCUSSION

This prospective study highlights the burden of hypoxemia in children hospitalized with acute LRTI. With a hypoxemia prevalence of 59.02%, the findings underscore the critical need for oxygen therapy in this population. The study reaffirmed that specific clinical signs are valuable indicators of compromised oxygenation.

The significant association of nasal flaring (p=0.022) and chest indrawing (p=0.011) with hypoxemia aligns with existing literature suggesting that increased work of breathing is a direct physiological response to hypoxia. Notably, the study found that 100% of children with cyanosis were hypoxemic, confirming it as a specific but late sign of severe illness. The combination of nasal flaring and chest indrawing proved to be a highly significant predictor (p=0.001), suggesting that clinicians should have a high index of suspicion for hypoxemia when these signs coexist, which was similar to other studies.[6,7] Interestingly, the study did not find a significant correlation between nutritional status and hypoxemia, despite a high prevalence of malnutrition (SAM and MAM) in the cohort. This suggests that the physiological mechanism of hypoxemia in pneumonia operates independently of the child's baseline nutritional state in the acute phase.[8]

Laboratory markers (TLC, CRP) and radiological consolidation showed strong correlations with hypoxemia, indicating that the extent of inflammation and parenchymal involvement directly impacts gas exchange similar results were seen in certain other

studies.[9,10] The lack of significant association between WHO pneumonia severity classification and hypoxemia suggests that while the classification is useful for management triage, it may not perfectly surrogate for oxygenation status, reinforcing the need for pulse oximetry or careful observation of specific respiratory signs.[11] Similar study was conducted in 2015 by Malik et al found that there was significant correlation of clinical signs with hypoxemia.[12]

CONCLUSION

Acute lower respiratory tract infection remains a major cause of hospitalization in infants and young children. This study concludes that clinical signs—specifically nasal flaring, chest indrawing and cyanosis—are strongly associated with hypoxemia. Furthermore, laboratory evidence of severe inflammation (high TLC, CRP) and radiological consolidation are significant predictors of low oxygen saturation. In settings where pulse oximetry is unavailable, these clinical and investigative parameters should guide the aggressive management of oxygen therapy.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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