

High prevalence of hypoxia in children with severe pneumonia in rural tertiary hospital in Nigeria

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Abstract

Introduction: Hypoxia is one of the strongest predictors of these deaths in children with pneumonia. This study aimed to document the prevalence and outcome of pneumonia in children with pneumonia.

Methodology: Children between 1 month to 14 years with diagnosis of severe pneumonia admitted during the study period were included in this study. Hypoxemia was defined as an arterial oxygen saturation (SpO₂) of <92% at the point of admission.

Results: Fifty-four of the 94 hospitalized children with severe pneumonia had hypoxia, giving a prevalence of 57.4%. The mean SpO₂ in children with hypoxia was 77.2±11.3% while it was 94.4±1.9% in non-hypoxic children. The case fatality rate of children with hypoxemia in this study is 40.7%, with the relative risk of death of 2 among hypoxic children compared to those without.

Conclusion: Hypoxia is prevalent in children with pneumonia and increases the risk of mortality.

Keywords: Pneumonia; Hypoxia; Prevalence; children; mortality; outcome; Nigeria; Jigawa

1. Introduction

Hypoxemia, defined as low oxygen saturation in arterial blood (i.e. SpO₂ <90%), is common among children with pneumonia and other acute lower respiratory infections, and is one of their strongest predictors of mortality.⁽¹⁻⁴⁾ In 2019, an estimated 7 million hospitalization for children in the middle and lower income countries were due hypoxemic pneumonia.⁽⁵⁾

Hypoxemia can be diagnosed using an inexpensive and non-invasive pulse oximeters, however this low-cost technology is not readily available in some sub-Saharan African countries^(3,6) and its systematic use to monitor and treat children in resource-poor developing countries, when coupled with a reliable oxygen supply, has been shown to improve quality of care and reduces mortality in children with pneumonia by approximately 35%.⁽⁷⁾

About 28-41.5% of Nigerian Children hospitalized for pneumonia were reported to have hypoxemia.⁽⁸⁻¹⁰⁾ however these reports were mainly from the southern part of the country with very scanty reports from the north-western region which disproportionately have high morbidity and mortality due to pneumonia.⁽¹¹⁾ Therefore, this study was conducted to document the prevalence of hypoxemia in children with severe pneumonia and its association with mortality. It also hopes that, the evidence generated will assist policymakers to effectively prioritize relevant interventions at all levels to improve clinical outcome of pneumonia in children.

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2. Materials and Method

This was a retrospective study of children aged 6-months to 14 years admitted and managed for pneumonia from January 2020 to December 2021, in the emergency pediatrics unit (EPU) of Federal medical center Birnin-kudu (FMCBKD), Jigawa State. The hospital is a tertiary facility located in Birnin Kudu, North west, Nigeria. The EPU has a 14-bed capacity with an average of annual 600 admissions. The protocol of management of community acquired pneumonia in our setting included resuscitation, antibiotic treatment, oxygen therapy and other supportive treatment. There was no Pediatrics Intensive Care Unit at the time of conducting this study. Birnin Kudu. The average elevation of the town is 437m.⁽¹²⁾

2.1. Eligibility Criteria

All consecutive records of children managed for severe pneumonia during the study period were retrieved. The diagnosis was based on WHO classification and treatment guidelines for pneumonia treatment in children.⁽¹³⁾ Children with bronchial asthma and those with incomplete records were excluded.

2.2. Exposure variables

The age, gender, immunization status, duration of admission, oxygen saturation and outcome of admission were noted in the patients' hospital records.

2.3. Outcome variables

The primary outcome of interest was hypoxemia defined as SPO₂ less than or equal to 92% and the secondary outcome measure was in-hospital mortality.

2.4. Data Extraction

The data was extracted from the files using a specifically designed case report form for the study and subsequently entered into Statistical Package for Social Science software (version 17.0; SPSS Inc, Chicago) for analysis.

2.5. Ethical consideration

The study was approved by the hospital ethical research committee of FMCBKD FMC/HREC/APP/CLN/001/1/213.

2.6. Sample size consideration

All the consecutive admissions for children with severe pneumonia over the 24 months period were included.

2.7. Data analysis

Data were transferred to the SPSS (version 17.0; SPSS Inc, Chicago). The prevalence of hypoxia during the study period was calculated from the proportion of children with hypoxia in children pneumonia. Continuous data were represented as mean or median as appropriate while categorical data were presented as percentages. The χ^2 and Student's t-tests were used to identify significant differences for categorical and continuous variables, respectively. A p-value of <0.05 was considered significant.

3. Results and discussion

3.1. General Patients Characteristics

Ninety-four children with severe pneumonia were admitted during the study period of which 53 (56.4%) were boys and 41(43.6%) were girls. The median age was 13.5 months and IQR of 17 months. Forty-five (47.9%) of the participants were less than 12 months old, 38 (40.4%) 12-59 months old while 11(11.7%) were 60-months and above. About two-third of the children was from low socio-economic status, only 21.3% (20/94) were fully vaccinated for age. Eighteen (19.1%) of the 63 participants were documented to have been exclusively breastfed. Majority (80.8%) of the children had clinically diagnosed bronchopneumonia.

3.2. Prevalence of hypoxia

Fifty-four of the 94 hospitalized children with severe pneumonia had hypoxia, giving a prevalence of 57.4%. The mean SPO₂ in children with hypoxia was 77.211.3% while it was 94.4=1.9% in non-hypoxic children. Table 1 showed the level

of oxygen saturation in the study participants. Hypoxia was more prevalent among boys and those less than one year of age as shown in Table 2. The mean (standard deviation) hospital duration of children with hypoxia was 5.7 ± 4.9 days compared to 5.1 ± 2.7 days in those without hypoxia.

Table 1 Oxygen saturation of hospitalized children with Pneumonia

Level of SPO ₂	Frequency	Percent
<85	41	43.6
85-90	13	13.8
91-92	7	7.4
93-95	21	22.3
95	12	12.8
Total	94	100.0

Table 2 Association between hypoxia and some variables

Variable	Hypoxia		P -value
	Present n=54	Absent n=40	
Males	30	23	0.85
Females	24	17	
Age group			
Less than 1-year	32	13	0.71
1-5 years	18	23	
More than 5 years	4	4	
Vaccination status			
Not fully immunized	40	33	0.41
Fully immunized	14	7	

3.3. Outcome of children with hypoxia

Thirty-two (59.3%) of the 54 children with hypoxia survived (29 were discharged, 3 were referred to other facilities) and 22 (40.7%) died. The case fatality rate of children with hypoxemia in this study is 40.7%, with the relative risk of death of 2 among hypoxic children compared to those without.

Table 3 Outcome based on Hypoxia and level of SPO₂

	Survived n (%)	Died n (%)	Total	p-value
Hypoxia				
Present	32(59.3)	22(40.7)	54	0.04
Absent	34(85)	6(15)	40	
Level of SPO ₂				
<85	22 (53.7)	19 (46.3)	41	0.10
86-90	10(76.9)	3 (23.1)	13	
91-92	6(85.7)	1(14.3)	7	

93-95	19(90.5)	2(9.5)	21	
95	12(100)	0(0)	12	

Hypoxemia is a life-threatening condition that requires early detection and treatment, as oxygen deficiency is often associated with severe adverse events. Hypoxemia was reported among 57.4% of the studied population. Hypoxemia was more prevalent among boys and those under one-year of age. Twenty-two of the hypoxemic children died giving a case fatality rate of 40.7%. Children with hypoxia had longer median duration of hospital stay.

This study found a high prevalence of hypoxemia among children hospitalized for severe pneumonia. The documented prevalence of hypoxemia in this study is higher than 41.5% - 49.2% among hospitalized children with pneumonia in Nigeria.^(8,10,13) The high prevalence in this study may be due to inclusion of children with severe pneumonia unlike other studies which included all forms of pneumonia and or other forms of ALRI. Furthermore, Study setting (out-patient or Emergency unit) is reported by Lozano ⁽⁴⁾ Rahman and colleagues ⁽⁵⁾ in their recent systematic review reported that hypoxemia is more prevalent in the emergency setting. Additionally, viral pneumonias were observed to be associated with increased risk of hypoxemia, probably due to its propensity to induced diffuse, bilateral, pulmonary damage,⁽¹⁵⁾ compared with bacterial pneumonia. Also, delay in seeking care has also been shown to be associated with severe disease and invariably hypoxemia in this setting.⁽¹⁶⁾ In addition, the microbial etiology of respiratory disease (especially viral versus bacterial), co-morbidities, host and environmental factors, care-seeking behavior, availability of effective antibiotics in primary-care facilities, and referral patterns might be important in explaining regional differences in reported hypoxemia prevalence.

Infants were found to be more likely to be hypoxemic than older children, this is in keeping with the reports from Ilorin,⁽³⁾ ⁽¹⁰⁾ and Kenya⁽⁴⁾. Relatively smaller functional residual capacity, tidal volume and bigger dead space and increased basal metabolic rate in infants put them at a greater risk of hypoxemia.

Children with hypoxemia had a longer hospital stay compared to those without, a finding that is corroborated by authors from Nigeria^(8,17) and India.⁽¹⁸⁾ The need for oxygen therapy and frequent monitoring of children with hypoxia may have possibly caused the prolong hospital stay. Furthermore, presence of complications may be contributory.

This study found that 2 out of every 5 children with hypoxemia died, and the mortality increases as the level of spo2 decreases further. The case fatality rate of severe pneumonia in this study (40.7%) is higher compared to the 8.5 -26.2% reported from Nigeria ^(10,19), 15% from Zambia⁽²⁰⁾, and 8% from Bangladesh⁽²¹⁾, varied methodology, different settings, geographical location, and sample size, may make comparison across these studies difficult. Rural residency, pre-hospital antibiotic treatment and poor health seeking behavior were reported among other factors to be contributory to the poor clinical outcome in children with pneumonia.⁽¹⁶⁾ Presence of co-morbidities may have significantly increased the death among children with hypoxia. Additionally, cultural, physical and resource-related barriers to accessing care may have increased the risk of death as previously documented.²² Delayed presentation, poor health seeking behavior and low immunization uptake may have contributed to the high prevalence of hypoxemia and mortality in this cohort. Additionally, lack of ventilatory support and intensive care unit played a role in the adverse outcomes in these children.

This study may be limited by its retrospective nature and small sample size but it was able to highlight the clinical burden of hypoxemic pneumonia in our facility and the attendant increased risk of death. It is therefore, imperative for the policy makers to reevaluate the interventions aimed at controlling pneumonia like the promoting exclusive breastfeeding, improving immunization uptake, and knowledge attitude and practices related to pneumonia. Health system strengthening and adequate training of the personnel may improve the treat outcome of pneumonia, which is crucial to attaining the ambitious UN Sustainable Development Goal target of reducing the mortality rate of children younger than 5 years to less than or equal to 25 per 1000 live births by 2030.⁽²³⁾

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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