Title: Hypoxaemia in Nigerian Children Presenting to the Children Emergency Ward (CHEW) of a Tertiary Hospital.

Abstract:

Aim of this study is to determine the prevalence of hypoxaemia and predictors of signs of hypoxaemia in children with various disease conditions admitted into the CHEW of a tertiary health facility.

Study Design: Descriptive, Cross sectional study

Place and Duration: Department of Paediatrics (Children Emergency Ward). Study was done from 1st February to 30th April 2015

Methods: We included 129 children. Seventy two (55.8%) males and 57(44.2%) females and age range 0.08 to 17 years admitted into the CHEW with various disease conditions. Biodata and clinical examination was done in all patients. Oxygen saturation (SpO2) was determined on admission using pulse oximeter for every sick child admitted. Hypoxaemia is defined as SpO2 less than 90%.

Results: One hundred and twenty nine children were studied. Ages ranged from 0.08 to 17 years with a mean age of 3.06 ± 3.65 years. Modal age was 4 years. The mean age of 3.34 ± 3.97 years for males was higher than 2.70 ± 3.22 years for females. Thirty one (24%) children had hypoxaemia on admission with 20(64.5%) with respiratory diseases. Infants (p=0.004) and children with respiratory disease (p=0.047) had a significantly higher prevalence of hypoxaemia among the study group.

Chest in drawing is a common feature but grunting (100%) and wheezing (50%) have the best positive predictive values.

Conclusion: Hypoxaemia is prevalent in children who are ill and need emergency care. Respiratory diseases and infants account for a major proportion of hypoxaemic children seen in emergency wards. Chest in drawing is a common feature from different studies; presence of grunting was highly predictive in this study.

Keywords: Children, Hypoxaemia, Emergency care

Introduction

Hypoxaemia is defined as reduced oxygen content of blood specifically in arterial blood or the reduced percentage of saturation of haemoglobin with oxygen. It is an under recognized complication of most severe illnesses in neonates and children in developing countries and a common predictor of death. [1, 2, 3]

Hypoxaemia can be determined by measuring the level of oxygen in a sample of arterial blood or by determination of oxygen saturation in the blood using the pulse oximeter. Hypoxaemia can be

defined as arterial oxygen concentration of less than 75 mmHg or blood oxygen saturation of less than 90%. [1, 3] Hypoxaemia is a common manifestation of severe illnesses in children and a major contributor to mortality. Several clinical signs and symptoms have been found to predict hypoxaemia in sick children with or without acute lower respiratory tract infection, this include inability to feed, fast breathing, grunting, lower chest wall in drawing, nodding and convulsion.[4,5]

Hypoxaemia is known to correlate well with disease severity and occurs mainly in diseases that impair ventilation, gaseous exchange or increase oxygen demand in the body. [6] A disease of the respiratory tract such as pneumonia which accounts for more than 2million deaths in children worldwide is commonly complicated by hypoxaemia.[6]The prevalence of hypoxaemia in children varies with disease condition and severity of illness. Prevalence of hypoxaemia in ill children range from 11 to 52% and can be as high as 73 % in children with acute lower respiratory tract illnesses.[3,5] In a study on hypoxaemia as a measure of disease severity in young hospitalized Nigerian children with pneumonia, 41.5% had hypoxaemia with hypoxaemic children 48 times more likely to die.[2]

The blood gas analysis is the gold standard for detecting hypoxemia. Other methods include pulse oximetry and less objectively clinical signs.[3] The use of the pulse oximeter is a reliable, safe, non-invasive and reproducible tool which compares well with the results from the blood gas analysis.[7,8] Its use ensures early detection and commencement of efficient treatment of hypoxaemia in sick children in resource limited setting.

There is a persisting high rate of childhood mortality in Nigeria from various disease conditions. The objective of this study is to determine the prevalence of hypoxaemia and predictors of signs

of hypoxaemia in children with various disease conditions admitted into the CHEW of a tertiary health facility.

Methods

The study was a descriptive cross sectional study conducted at the Paediatric Emergency Department of the University of Port Harcourt Teaching Hospital, Nigeria. The study comprised of all children presenting to the Paediatric Emergency Ward, from 1st February to 30th April 2015 whose parents gave consent. The University of Port Harcourt Teaching Hospital is a tertiary health care facility in Port Harcourt, Rivers State in Southern Nigeria. It is the largest health care facility in the State and offers health care to people living in the State and its environs.

The study was approved by the Ethics and Research Committee of the University of Port Harcourt Teaching Hospital and written informed consent was obtained from all caregivers that participated. A detailed history was taken and physical examination conducted on all children admitted into the Paediatric Emergency Ward and a clinical diagnosis made. Presence or absence of symptoms and signs of respiratory distress were particularly sought for and recorded using a study proforma. Pulse oximetry was done for all patients at presentation using a pulse oximeter (Contec CMS0DL) with appropriate probe size placed on the finger and peripheral capillary oxygen saturation (SpO2) was recorded while breathing room air. Recordings were taken after stabilization of the pulse oximetry reading for one minute. Hypoxaemia was defined as SpO2 of less than 90% recorded by pulse oximetry.

All subjects were treated by the children emergency ward managing team with appropriate medications and interventions based on their individual diagnoses. They were followed up to monitor the outcome of their admission.

Data was analyzed using the Epi info version 7.1.3.3 software. The Chi square and Student's t tests were used to test for statistically significant differences in proportions and means respectively. A p value of less than or equal to 0.05 was considered as statistically significant.

Results

A total of 129 children participated in the study, Seventy two (55.8%) males and 57(44.2%) females giving a male to female ratio of 1.3:1. Ages ranged from 0.08 to 17 years with a mean age of 3.06 ± 3.65 years. Modal age was 4 years. The mean age of 3.34 ± 3.97 years for males was higher than 2.70 ± 3.22 years for females. The difference was not statistically significant (t=0.98, df=1, p=0.327). The primary diagnosis in 66 (51.2%) of the children was a respiratory disease and otherwise in the remaining 63 (48.9%).

The SpO2 ranged from 54% to 99% with a mean of 91.53 ± 8.57%, mode of 98% and median of 95%. Thirty one (24%) of the children had hypoxaemia with 20(64.5%) having primary respiratory disease. The mean SpO2 for the hypoxaemic children was 78.13 ± 6.90% while the mean SpO2 for the non-hypoxaemic children was 95.78 ± 2.55% (t=21.27, df=1, p<0.001). **Table 1** shows the levels of SpO2 measured among the patients.

Table 1: Levels of SpO2 measured

SpO2 (%)	Frequency (N)	Percent (%)

≥95	69	53.5
90-94	29	22.5
75-89	27	20.9
<75	4	3.1
Total	**129**	**100.00%**

Table 2 shows the relationship between presence of hypoxaemia and some variables among the study group. Infants (p=0.004) and children with respiratory disease (p=0.047) had a significantly higher prevalence of hypoxaemia among the study group.

Table 2: Relationship between some variables and presence of hypoxaemia

Variable		Hypoxaemia	No hypoxaemia	Total	p
Age group	Infants	19 (35.8)	34 (64.2)	53 (42.1)	0.004*
	Children	11 (15.1)	62 (84.9)	73 (57.9)	
Gender	Males	18 (25.0)	54 (75.0)	72 (55.8)	0.390
	Females	13 (22.8)	44 (77.2)	57 (44.2)	
Primary diagnosis	Respiratory disease	20 (30.3)	46 (69.7)	66 (51.2)	0.047*
	Non-respiratory disease	11 (17.5)	52 (82.5)	63 (48.8)	

*significant

Table 3 shows the predictive value of some clinical signs of hypoxaemia. Tachypnoea was the most sensitive (sensitivity=61%) for hypoxaemia, followed by intercostals recession (sensitivity=58%) and subcostal recession (sensitivity=55%). Grunting (specificity=100%), wheezing (specificity=99%) and suprasternal recession (specificity=99%) were the most specific for hypoxaemia. The best predictors of hypoxaemia were grunting (100%) and wheezing (50%).

Table 3: Predictive value of some clinical signs of hypoxaemia

	Hypoxaemic patients (n=31)	Non-hypoxaemic patients (n=98)	p value	Sensitivity	Specificity	Positive predictive value	Negative predictive value
Flaring	13	29	0.107	42	70	31	79
Intercostal recession	18	40	0.05	58	59	31	82
Subcostal recession	17	30	0.009	55	69	36	83
Suprasternal recession	0	1	0.76	0	99	0	76
Grunting	1	0	0.24	3	100	100	77

Wheezing	1	1	0.424	3	99	50	76
Tachypnoea	19	47	0.102	61	52	29	81

One of the 31 cases with hypoxaemia died giving a case fatality rate of 3.2%.

Discussion

The prevalence of hypoxaemia of 24% in this study was similar to that of 20.6% in a study in Ife, Nigeria[9] and 23.8% in Kanpur, India.[10] It is however higher than the 5.8%, 11.9% and 13% found in studies done in The Gambia,[11] Chandigarh, India[12] and Enugu, Nigeria[13] respectively, and lower than 41.5% and 73% seen in Ilorin, Nigeria[2] and Papua New Guinea respectively.[3] Various factors including altitude, health care settings, diagnoses in subjects, age group of subjects, cut off values for hypoxaemia could have contributed to the differences seen among the various studies. Differences may also be due to prevalence of respiratory illnesses which can be affected by incidence of viral illnesses which may be seasonal.

The significantly higher prevalence of hypoxaemia among infants (35.8%) compared to children above one year in this study is corroborated by similar studies among children in Enugu,[13] Ife,[9] The Gambia[11] and India.[12] This may be due to the fact that infants have a lower tidal volume and relative inefficient compensatory mechanisms to improve ventilation. Infants are also less unable to compensate for ventilation perfusion mismatch in situations of increased dead

space.[14] Emodi et al[13] showed an equal occurrence of hypoxia in both genders in their study as was also seen in the present study.

Hypoxaemia was significantly higher among patients with a respiratory disease compared to other diseases in this study. This is similar to findings in other studies.[2,3,11,12] While this was the finding in studies [3,11] among ill children with respiratory and non-respiratory illnesses, studies [2,12] among children with respiratory illnesses all revealed a higher prevalence of hypoxaemia in children with severe pneumonia. Pneumonia results in airway obstruction from swelling, abnormal secretions, and cellular debris. Atelectasis, interstitial edema, and ventilation-perfusion mismatch causing significant hypoxemia often accompany airway obstruction.[15]

The present study showed tachypnoea and chest wall retractions (intercostals and subcostal) to be the most sensitive clinical features of hypoxaemia, and grunting, wheezing and suprasternal recession to be the most specific clinical features of hypoxaemia. In a study by Rao, et al [10] the sensitivity for hypoxaemia was highest with chest wall retraction which is similar to finding in this study. He also reported flaring of alar nasi, inability to feed as other strong indicators of hypoxaemia with sensitivity of 84% and 81% respectively especially in children with pneumonia. Chest in drawing was also significantly associated with presence of hypoxaemia in the study by Kuti and colleagues in Ile Ife, Nigeria.[9] In this study, grunting and wheezing had the highest positive predictive value in occurrence of hypoxaemia, also a study in Ibadan, Nigeria by Adebola and colleagues [16] showed that flaring and chest in drawing were predictive of hypoxaemia. The use of clinical signs in determination of hypoxaemia in ill children has met diverse views. A systematic review and meta-analysis of prospective diagnostic studies that evaluated the accuracy of individual or combined clinical symptoms and signs in predicting hypoxemia among children aged <5 years with ARI, revealed that cyanosis, inability to feed,

head nodding, respiratory rate >70/min and unresponsiveness/impaired arousability had high specificity but low sensitivity.[17] This report was supported by Lodha *et al*.[18] and Dyke *et al*.[19] who concluded that clinical symptoms and sings alone or in combination do not have sufficient sensitivity and specificity to predict hypoxemia in children with ALRI. Using clinical symptoms, about 20% of hypoxemic children would be missed, and 17–50% of children given supplemental oxygen would not need it in high sensitivity models based on clinical signs.[3] Pulse oximetry when used correctly provides a reliable bedside standard for detecting hypoxaemia even in developing countries. Pulse oximetry can correctly identify 20–30% more children with hypoxemias than using clinical signs alone and will ensure judicious and efficient use of oxygen therapy in resource limited setting where oxygen is not readily available.[2,20,21]

Although pulse oximetry remains the reliable means of determining oxygen saturation in children, using of clinical symptoms may be very helpful in deciding presence of hypoxaemia in ill children where pulse oximeter is not available in resource limited settings.

Conclusion: Hypoxaemia is prevalent in children who are ill and need emergency care. Respiratory diseases and infants account for a major proportion of hypoxaemic children seen in emergency wards. Chest in drawing is a common feature from different studies; presence of grunting was highly predictive in this study.

Consent: As per international standard or University standards, the patient written consent has been collected and preserved by authors

Ethical Approval: As per international standards or University standards, a written ethical approval has been collected and preserved by authors.

Competing Interest: Authors have declared that no competing interest exist.

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