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Kuti BP
Adetola HH
Aladekomo TA
Kuti DK

Prevalence and predictors of hypoxaemia in hospitalised children at the emergency unit of a resource constrained centre

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Kuti BP (✉)
Aladekomo TA
Department of Paediatrics and Child Health
Obafemi Awolowo University, Ile-Ife, Nigeria
Email: kutitherapy@yahoo.com

Adetola HH, Kuti DK
Department of Paediatrics,
Wesley Guild Hospital, Ilesa, Nigeria

Abstract*: Background:* Hypoxaemia is often poorly detected and treated in emergently-ill children in resource-poor centres because of the non-availability of pulse oximeters and similar facilities to detect it. This study sets out to determine the prevalence and simple predictors of hypoxaemia among children with or without respiratory features at the emergency unit of the Wesley Guild Hospital, Ilesa, Nigeria

Methods: Children aged one month to 14 years were consecutively recruited and prospectively studied over an eight month period. All the children had their peripheral oxygen saturation (SpO_2) measured at presentation using a portable pulse oximeter (Nellcor$^{(R)}$ N-200, USA) and hypoxaemia was defined as $SpO_2 <$ 90%. Relevant history and examination findings were compared among hypoxaemic and non-hypoxaemic children. Multivariate analysis was used to predict the presence of hypoxaemia.

Results: Four hundred and two children were recruited with male to female ratio of 1.3:1 and105 (26.1) presented with respiratory features. Eighty three (20.6%) were hypoxaemic including 40 (38.1%) of those with respiratory features at admission. Infancy, chest in-drawing, cyanosis and grunting were associated with hypoxaemia ($p < 0.05$) among those with respiratory features, while infancy, pallor and tachycardia were significant among those with no respiratory features. Grunting (OR = 7.875; 95% CI=1.029-15.797; p = 0.045) and Cyanosis (OR =13.579; 95% CI = 1.360-14.379; p = 0.009) independently predict hypoxaemia among the children with respiratory features.

Conclusion: Hypoxaemia occurred in approximately one out of five ill children admitted to the emergency unit of the WGH, Ilesa and was significantly associated with mortality. Emergently ill children with cyanosis and grunting especially infants should preferentially be placed on oxygen therapy even when hypoxaemia cannot be confirmed.

Key words: Emergently ill children, hypoxaemia, predictors, resource-poor.

Introduction

Hypoxaemia has been recognised as a sign of serious ill-health in children because it often denotes poor ventilation and or perfusion and an urgent need for oxygen therapy.[1-2] Oxygen supply in busy emergency units of resource constrained developing countries is not always available and or affordable.[3] Sometimes oxygen supply is rationed among children who need it because demands often outweigh supply.[3-4] Ill children are often not well screened for need for oxygen therapy because of the non-availability of pulse oximeters and similar facilities.[4] These often lead to denial of oxygen therapy to children whose survival depends on this life-saving therapy.[3-4]

The burden of hypoxaemia in developing countries is huge because a large proportion of children are brought into the hospital in serious condition requiring emergency care.[5] Subhi and his group[6] in a systematic review estimated that 13% (1.5 - 2.7 million) children with pneumonia in developing countries who presented to health facilities annually are hypoxaemic.[6] Emordi *et al*[7] also reported that 13% of children aged 2 to 59 months admitted to the children emergency unit of a tertiary centre in South East Nigeria were hypoxaemic.[7] Orimadegun *et al*[8] however reported a much higher prevalence of 28.6% among emergently ill neonates and children at another tertiary facility in Nigeria and a much higher prevalence of 49.2% among those with respiratory tract infections.[8] Other studies from develop-

ing countries including the west African sub region also reported a huge burden of hypoxaemia among ill children.[9-12] Unfortunately oxygen supply to meet this huge demand is not always available in most of the centres .[3-4]A large proportion of emergently ill children in developing countries particularly those with non-respiratory symptoms may however remain unrecognised and thus untreated as most reported studies on hypoxaemia among ill children were done on those with respiratory symptoms at presentation.[6]

Many centres in resource –poor countries still administer oxygen to emergently ill children without diagnosing hypoxaemiaobjectively.[3-4] This is often due to non-availability of pulse oximeters and other facilities to make this diagnosis.[3-4] This brings to the fore a need for simple, easily measureable parameters that could guide clinicians in resource-poor centres in prompt recognition of hypoxaemia in emergently ill children with or without respiratory symptoms to improve survival. This study therefore sets out to determine the prevalence and predictors of hypoxaemia among emergently ill children at the Wesley Guild Hospital (WGH), Ilesa, Nigeria.

Patients and Methods

This was a prospective cross sectional study of children aged 1 month to 14 years admitted over an eight month period (January to August, 2015) at the Children Emergency Ward (CEW) of the WGH, Ilesa, Nigeria. The WGH is a tertiary annexe of the Obafemi Awolowo University Teaching Hospitals Complex (OAUTHC), Ile-Ife. The hospital is one of the main referral centers providing specialized pediatric care for the communities of Osun, Ondo, and Ekiti States of the South-West Nigeria. The children emergency ward of the hospital operates a 24-h service and admits about 600 children per annum. The hospital has functional biochemical, microbiological and hematological laboratory services as well as well-equipped and staffed radiological services which also operate on a 24 h basis.

Ilesa, the largest town in Ijesaland is situated on latitude 7°35'N and longitude 4°51'E and is about 200 km North-East of Lagos a major commercial nerve center of Nigeria.[13] Ilesa is home to about 620,000 people with about 25% of the population being children <5 years and up to 40% children <15 years.[13]The people in Ilesa called Ijesa are mainly traders, peasant farmers, artisans, and civil servants.[13]

Study size

The minimum sample size for this study was estimated using Fisher's formula. [14]With reference 49.2% prevalence of hypoxaemia among emergently ill children from a previous study,[8] a minimum total of 384 study participants was estimated. Adding attrition rate of about five percent, total of 402 children were recruited for the study

Subject recruitment

Consecutive admissions into the CEW whose parents/ caregivers gave consent were recruited for the study. Children admitted with all forms of shock were excluded because their peripheral oxygen saturation (SPO_2) could not be measured with pulse oximetry due to systemic hypo perfusion.[15] The (SPO_2) of the recruited children were recorded using a portable pulse oximeter (Nellcor N-200, USA) by a study assistant who did not take part in the history taking and subsequent management of the patients. The SPO_2 was taken using an appropriately sized paediatric probe attached to the finger or toes for at least 30 seconds till the reading of the oximeter is stabilised. Hypoxaemia which is the outcome variable was defined in this study as SPO_2< 90%.[2, 5]

The study variables included age of the patients, sex, and parental socioeconomic class derived using rank assessment of the parents' highest level of educational attainment and occupation as described by Oyedeji.[16]Also of interest were the clinical features at presentation including axillary temperature taken using a low reading clinical thermometer. Hypothermia was recorded as temperature less than 35^0C; subnormal as 35 – 36.5^0C; normal as 36.5 to 37.5^0C; fever as 37.5 to 38.5^0C, and hyperpyrexia as >38.5^0C.[5,17]Other features at presentation considered included convulsion, diarrhoea, cyanosis, pallor and prostration. The study participants were categorised into those with respiratory features and those without respiratory features at presentation. The respiratory features looked for in these children included fast breathing defined using the WHO cut off thus (respiratory rate >50 cycles per minute in children less than 12 months; > 40cpm in children 1-5 years and > 30cpm in those > 5 years); noisy breathing including grunting, wheezing and stridor, nasal flaring and chest in-drawing.[17] Tachycardia was defined as pulse rate> 150 beats per minute in children 1-3 years and > 140 beats per minute for children > 3 years.[17] The nutritional status of the children was assessed using Wellcome classification.[18] The children were investigated appropriately based on the presentation. Diagnoses was made based on the unit standard protocol and these were in line with the WHO guidelines for the management of common childhood illnesses.[17] The outcomes of hospitalisation were recorded as discharged home, died, discharged against medical advice (DAMA) and referred to another health facility.

Ethical clearance for this study was obtained from the Ethics and Research Committee of the Obafemi Awolowo University Teaching Hospitals Complex (OAUTHC), Ile-Ife, Nigeria with protocol number ERC/2014/08/05. Informed consent and assent (as appropriate) were also obtained from the study participants.

Data analysis

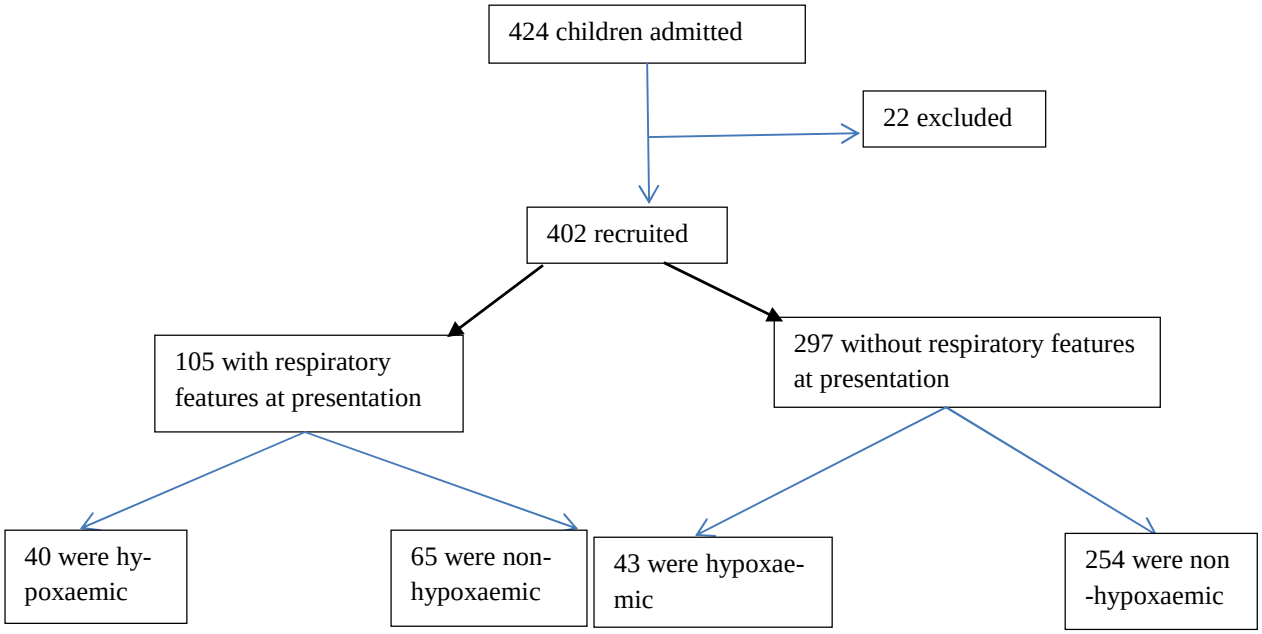
Data were analyzed using SPSS for Windows software version 17.0 (SPSS Inc. Chicago 2008). Differences between the means (SD) or median (IQR) values of con-

tinuous variables were determined using Student's t-test or Mann–Whitney U-test; while the differences between proportions of categorical variables were determined using Pearson's Chi-squared or Fisher's exact tests. The level of significance at a 95% confidence interval was set at P <0.05. Associations between the presence or absence of hypoxaemia and the study variables that gave significant results were further analyzed with binary logistic regression to determine the independent predictors of hypoxaemia among the children with or without respiratory features at presentation. Results were interpreted with Odds ratios (OR) and 95 percent confidence interval (CI). Statistical significance was established when CI does not embrace unity.

Results

Over an eight month study period, a total of 424 children were admitted to the CEW, 22 children were excluded including 19 who presented with shock and 3 children whose parents did not consent to participate in the study. A total of 402 children were recruited for the study and form the basis of further analysis. 105 (26.1%) of the children had respiratory features at presentation. Eighty three (20.6%) of the children were hypoxaemic at presentation, this included 40 (38.1%) of the 105 children with respiratory features and 43 (14.5%) of 297 with no respiratory features at presentation. Figure 1 highlights the study participants and subgroups in a flow chart.

Fig 1: Flow chart of the recruitment of the study participants



Socio-demographic and general characteristics of the study participants

Age and Sex: The ages of the children ranged from one to 168 months with a median interquartile (IQR) age of 24 (15 - 42) months. Majority (72.1%) of the children were under-fives including 84 (20.8%) infants. Of the 402 study participants, 226 (56.2%) were males with a male to female ratio of 1.3:1.Table one highlights the socio-demographic characteristics of the study participants as related to the presence or absence of respiratory features at presentation.

Parental socio-economic class: Majority (77.4%) of the emergently ill children were from middle social class, while only 31 (7.7%) were from upper social class.

Clinical features at presentation

Fever was the most prominent feature at presentation reported in 352 (87.6%) of the children. Others presenting features included convulsions 152 (37.8%) pallor 138 (34.3%), cough (19.2), vomiting 48 (11.9%) and loss of consciousness 52 (12.9%).Among the 105 children with respiratory features, tachypnoea 90 (85.7%); grunting respiration 12 (11.4); wheezing 10 (9.5%); nasal flaring 50 (47.6%)and chest in-drawing 42 (40.0) were more commonly observed. Table 2 highlights the clinical presentation of the emergently ill children with or without respiratory features at presentation. Majority (82.3%) of the children had normal nutritional status. The spectrum of malnutrition observed in the children is also highlighted in table 2.

The duration of illness before presentation in the 402 recruited children ranged from one to 28 days with a median (IQR) of 2 (1-3) days. No significant difference in the Median (IQR) duration of illness before presentation between the children with respiratory features and those without respiratory features. (Mann Whitney U =14973.500; p = 0.716) Majority (74.9%) of the children presented within three days of illness.

Table 1: Socio-demographic and general characteristics of the study participants as related to the presence or absence of respiratory symptoms at presentation

Socio-demographic features	Children with respiratory symptoms n = 105 (%)	Children with no respiratory features n= 297 (%)	Total n = 402
Age range (in years)			
< 1 (infants)	38 (36.1)	46 (15.5)	84
1 -5	55 (52.4)	191 (64.3)	246
6- 14	12 (11.4)	60 (20.2)	72
Sex			
Male	63 (63.9)	163 (54.2)	226
Female	42 (36.1)	134 (45.8)	176
Parental social class			
Upper class	2 (2.4)	29 (9.1)	31
Middle class	65 (78.3)	246 (77.1)	311
Lower class	16 (19.3)	42 (13.2)	58
Place of residence			
Within Ilesa	70 (66.7)	120 (40.4)	190
Outside Ilesa	35 (33.3)	177 (59.6)	212

The figures in parentheses are percentages of the total in each column

Table 2: Clinical features at presentation as related to the presence or absence of respiratory features

Clinical features at presentation	Children with respiratory features n = 105	Children with no respiratory features n = 297	Total n = 402
Temp at admission			
Hypothermia	1 (1.0)	4 (1.4)	5
Subnormal	6 (5.7)	11 (3.7)	17
Normal	7 (6.7)	12 (4.0)	19
Fever	84 (80.0)	268 (90.2)	352
Hyperpyrexia	7 (6.7)	2 (0.7)	9
Clinical features			
DOI median (IQR)	2.0 (1.0 – 4.0)	3.0 (1.0 – 3.0)	
Convulsion	20 (19.1)	135 (45.5)	155
Pallor	36 (34.3)	102 (34.3)	138
Cough	98 (93.3)	57 (19.2)	77
Tachycardia	31 (29.5)	44 (14.8)	75
Diarrhoea	4 (3.8)	12 (4.0)	16
Coma	2 (1.9)	50 (16.8)	52
Vomiting	10 (9.5)	38 (12.8)	48
Dehydration	5 (4.8)	17 (5.7)	22
Prostration	2 (1.9)	23 (7.7)	25
Tachypnoea	90 (85.7)	0 (0.0)	100
Nasal flaring	50 (47.6)	0 (0.0)	50
Chest in-drawing	42 (40.0)	0 (0.0)	42
Stridor	6 (5.7)	0 (0.0)	6
Grunting	12 (11.4)	0 (0.0)	12
Cyanosis	6 (5.7)	2 (0.6)	8
Wheezing	10 (9.5)	0 (0.0)	10
Nutritional status			
Normal	80 (76.2)	251 (85.6)	331
Underweight	17 (16.2)	33 (11.9)	50
Marasmus	5 (4.8)	10 (2.8)	15
Kwashiorkor	0 (0.0)	1 (0.0)	1
Overweight/Obese	3 (2.9)	2 (0.9)	5

The figures in parentheses are percentages of the total in each column. Temp = temperature; DOI = Duration of illness before presentation; IQR = interquartile range

Factors associated with hypoxaemia among the children

Among the children with respiratory features: Infancy was significantly associated with the presence of hypoxaemia, as 21 (55.3%) of the 38 infants with respiratory features compared to 19 (28.4%) of 67 children> one year were hypoxaemic at presentation ($x^2 = 7.443$; $p < 0.006$). Table III. Conversely, older children (> one year) were less likely to be hypoxaemic at presentation. The presence of chest in-drawing (52.4% vs. 31.7%;$x^2 = 6.058$; $p = 0.014$), grunting respiration (80.0% vs. 58.2%; $x^2 = 8.148$; $p = 0.004$) and Cyanosis (87.5% vs. 57.9%; $x^2 = 9.135$; $p = 0.003$) were significantly associated with hypoxaemia among emergently ill children with respiratory features at presentation. (Table 3)

Among the children with no respiratory features at presentation: Infancy was also significantly associated with hypoxaemia among the emergently ill children with no respiratory features at presentation ($x^2 = 5.924$; $p = 0.015$). Also, pallor (20.6% vs. 14.5%; $x^2 = 4.684$; $p = 0.030$) and tachycardia (27.3% vs. 14.8%; $x^2 = 6.829$; $p = 0.009$) at presentation were significantly associated with hypoxaemia among the children. (Table 3)

Nutritional status and the presence of hypoxaemia at presentation

No significant association was observed between the nutritional status of the children and the presence of hypoxaemia at presentation. Table 4 highlights the nutritional status of the children with or without respiratory features and the presence of hypoxaemia at presentation.

Outcome of hospitalisation as related to hypoxaemia at presentation

Outcome of hospitalisation: Majority (93.0%) of the children were discharged home, while 13 (3.2%) of the children died. (Table 4). The duration of hospitalisation ranged from few hours to 33 days with a median (IQR) duration of 3.0 (2.0 – 4.0) days.

Length of hospitalisation: Emergently ill children with hypoxaemia at presentation significantly stayed longer in the hospital compared to non-hypoxaemic children. (Median (IQR) 4.0 (2.0 – 6.0) days vs. 3.0 (2.0 – 4.0) days, Mann Whitney U = 9.911, $p < 0.001$).

Mortality: Significantly more emergently ill children with hypoxaemia at presentation compared to non-hypoxaemic children died as 8 (9.6%) of the 83 hypoxaemic children compared to 5 (1.5%)of the 329 non-hypoxaemic children, died. The association between hypoxaemia and mortality is significant irrespective of the presence or absence of respiratory symptoms at presentation as highlighted in table 5.

Predictors of hypoxaemia among emergently ill children

The variables found to be significantly associated with hypoxaemia among the emergently ill children with or without respiratory features at presentation (tables 3 and 4) were further subjected to binary logistic regression analysis to determine the independent predictors of

hypoxaemia. Grunting respiration (OR = 7.875; 95%CI = 1.029– 15.797; p = 0.045) and Cyanosis at presentation (OR = 13.576; 95%CI 1.360–14.279; p = 0.009) were independent predictors of hypoxaemia among emergently ill children with respiratory features at the WGH, Ilesa. However, among the children with no respiratory features, none of the variables independently predict hypoxaemia (Table 6)

Table 3: Socio-demographic characteristics and clinical features of the children as related to the presence of hypoxaemia at presentation

Variables	Children with respiratory features n = 105		p-value	Children with no respiratory features n = 297		p -value
	Hypoxaemic n = 40 (%)	Non-hypoxaemic n = 65 (%)		Hypoxaemic n = 43 (%)	Non-hypoxaemic n = 254 (%)	
Sex						
Male	26 (65.0)	37 (56.9)	0.412	27 (62.8)	136 (53.5)	0.260
Female	14 (35.0)	28 (43.1)		16 (37.2)	118 (46.5)	
Age range (years)						
< 1	21 (52.5)	17 (26.2)	0.006	12 (27.9)	34 (13.4)	0.015
1 - 5	15 (37.5)	40 (61.5)	<0.001	24 (55.8)	167 (65.7)	0.209
6- 14	4 (10.0)	8 (12.3)	0.716*	7 (16.3)	53 (20.9)	0.479
Social class						
Upper class	1 (2.5)	6 (9.2)	0.151*	1 (2.3)	23 (9.1)	0.087*
Middle class	32 (80.0)	53 (81.5)	0.845	33 (76.7)	195 (76.8)	0.997
Lower class	7 (17.5)	6 (9.2)	0.212	9 (20.9)	36 (14.2)	0.253
Place of residence						
Within Ilesa	24 (60.0)	31 (47.7)	0.219	21 (48.8)	133 (52.4)	0.669
Outside Ilesa	16 (40.0)	34 (52.3)		22 (51.2)	121 (47.6)	
Clinical features						
Temperature						
Hypothermia	0 (0.0)	1 (1.5)	0.326*	1 (2.3)	3 (1.2)	0.578*
Subnormal	2 (5.0)	4 (6.2)	0.803*	1 (2.3)	10 (3.9)	0.583*
Normal	2 (5.0)	5 (7.7)	0.584*	3 (7.0)	9 (3.5)	0.327*
Fever	33 (75.0)	51 (86.2)	0.615	38 (88.4)	230 (90.6)	0.656
Hyperpyrexia	3 (7.5)	4 (4.6)	0.790*	0 (0.0)	2 (0.8)	0.428
Other features						
Convulsion	4 (10.0)	16 (24.6)	0.064*	14 (32.6)	111 (45.7)	0.171
Pallor	12 (30.0)	24 (36.9)	0.468	21 (48.8)	81 (31.8)	0.030
Tachycardia	13 (32.5)	18 (27.7)	0.600	12 (27.9)	32 (12.6)	0.009
Diarrhoea	3 (7.5)	10 (15.4)	0.219*	4 (1.6)	14 (5.5)	0.363*
Coma	2 (5.0)	3 (4.6)	0.929*	2 (4.7)	13 (5.1)	0.896*
Vomiting	5 (12.5)	12 (18.5)	0.242	8 (18.6)	57 (22.4)	0.574
Dehydration	3 (7.5)	2 (3.1)	0.412*	3 (7.0)	14 (5.5)	0.710*
Prostration	1 (2.5)	1 (1.5)	0.730*	1 (2.3)	22 (8.7)	0.102*
Nasal flaring	20 (50.0)	30 (46.2)	0.702	0 (0.0)	0 (0.0)	NA
Chest in-drawing	22 (55.0)	20 (30.7)	0.014	0 (0.0)	0 (0.0)	NA
Tachypnoea	32 (80.0)	58 (89.2)	0.189	0 (0.0)	0 (0.0)	NA
Stridor	2 (5.0)	4 (6.2)	0.803*	0 (0.0)	0 (0.0)	NA
Grunting	8 (20.0)	2 (3.1)	0.004*	0 (0.0)	0 (0.0)	NA
Wheezing	4 (10.0)	4 (6.2)	0.477*	0 (0.0)	0 (0.0)	NA
Cyanosis	7 (17.5)	1 (1.5)	0.003*	0 (0.0)	0 (0.0)	NA

The figures in parentheses are percentages of the total in each column.* Fisher's exact test applied. NA = not applicable

Table 4: Nutritional status of the study participants in relation to the presence of hypoxaemia at presentation

Variables	Children with respiratory features n = 105		p-value	Children with no respiratory features n =297		p -value
	Hypoxaemic n = 40 (%)	Non-hypoxaemic n = 65 (%)		Hypoxaemic n = 43 (%)	Non-hypoxaemic n = 254 (%)	
Normal	32 (80.0)	48 (73.8)	0.472	36 (83.7)	219 (86.2)	0.664
Underweight	5 (12.5)	12 (18.5)	0.421	4 (9.3)	29 (11.4)	0.737
Marasmus	2 (5.0)	3 (4.6)	0.929	1 (2.3)	5 (2.0)	0.891
Kwashiorkor	0 (0.0)	0 (0.0)	NA	1 (2.3)	0 (0.0)	0.401
Overweight/Obese	1 (2.5)	2 (3.1)	0.663	1 (2.3)	1 (0.4)	0.245

The figures in parentheses are percentages of the total in each column.* Fisher's exact test applied

Table 5: Outcome of hospitalisation as related to the presence of hypoxaemia at presentation

Outcome	Children with respiratory features n = 105		p-value	Children with no respiratory features n = 297		p -value
	Hypoxaemic n = 40 (%)	Non-hypoxaemic n = 65 (%)		Hypoxaemic n = 43 (%)	Non-hypoxaemic n = 254 (%)	
Discharged	36 (90.0)	61 (93.8)	0.473	38 (88.4)	239 (94.1)	0.101
DAMA	0 (0.0)	2 (3.1)	0.163*	1 (2.3)	10 (3.9)	0.583*
Died	4 (10.0)	1 (1.5)	0.049*	4 (9.3)	2 (1.2)	0.003*
Referred	0 (0.0)	0 (0.0)	NA	0 (0.0)	1 (0.4)	0.576*

The figures in parentheses are percentages of the total in each column; DAMA = discharged against medical advice. * Fisher's exact test applied

Table 6: Predictors of hypoxaemia among emergently ill children with or without respiratory features at presentation using multiple regression analysis

Variables	Coefficient of regression	Standard error	Odds ratio	95% confident interval	*P* value
Respiratory features					
Infancy	0.801	0.495	3.121	0.845 - 5.871	0.105
Grunting respiration	1.394	0.697	7.875	1.029 - 15.797	0.045
Cyanosis	1.211	0.461	13.576	1.360 - 14.279	0.009
Chest in-drawing	0.955	0.476	2.750	0.768 - 4.778	0.098
No respiratory features					
Infancy	0.741	0.613	2.179	0.631 - 6.971	0.227
Pallor	1.059	0.560	2.360	0.146 - 7.167	0.054
Tachycardia	0.136	0.610	2.973	0.347 - 3.787	0.824

Diagnostic accuracy of predictors: Grunting respiration among children with respiratory features has a sensitivity of 20.0%; specificity of 96.9%; positive and negative predictive values of 44.4% and 66.3% respectively. Cyanosis among children with respiratory features has a sensitivity of 17.5%, specificity of 98.5%, positive and negative predictive values of 87.5% and 66.0% respectively.

Discussion

This study has highlighted the prevalence and simple measurable predictors of hypoxaemia among ill children at the emergency unit of a resource poor centre. The 20.6% prevalence of hypoxaemia reported in this study is similar to reported prevalence of 19.0% in the Gambia by Junge *et al*[19] using the same criteria. This is however, much higher than 13.3% reported by Emodi *et al*[7] from a tertiary centre in Nigeria. This difference between the prevalence of hypoxaemia in this study compared to that of Emodi *et al*[7] may be explaint by relative smaller sample size (92 children) studied by the latter compared to 402 children recruited in this study. The prevalence of 20.6% observed in this study is much less than 52.0% reported by Dukes *et al*[19] in Papua New Guinea. The higher prevalence reported from Papua New Guinea may be due to fact that it is located in a high altitude region (1600m above sea level) with expected relative ambient hypoxia compared to the present study which was conducted at sea level.

Cyanosis and grunting respiration were observed to predict hypoxaemia among children with respiratory features in this study. This is similar to reported observations in other studies in developing countries among children with pneumonia and respiratory tract infections[9-12]Grunting is an inspiratory sound produced by inspiring against a partially closed glottis.[2] It is a form of positive pressure ventilation employed by ill children to overcome ventilation perfusion mismatch caused by conditions that can result in increased lung dead space. [2]Inability of the compensatory mechanisms like grunting and use of accessory respiratory muscles to improve oxygenation often results in the build-up of deoxygenated haemoglobin in the circulation.[2] This often manifests clinically as cyanosis hence grunting respiration and cyanosis are important predictors of hypoxaemia in sick children with high specificity. However the absence of grunting and cyanosis in sick children does not exclude hypoxaemia as their sensitivity to detect hypoxaemia is low as observed in this study.

Sick Infants were observed in this study to be at increased risk of having hypoxaemia compared to older children. These findings were corroborated by studies within[8] and outside Nigeria.[9-12] This may be due to the fact that infants have low tidal volume and relative inefficient compensatory mechanisms (like use of accessory respiration muscles) to improve ventilation. In situations of increased dead space and ventilation perfusion mismatch, infants are poorly equipped to compensate for this, thus they easily succumb to hypoxaemia.[2-3] Consequently, ill infants should particularly be carefully assessed for hypoxaemia at presentation and promptly treated to ensure survival.

In addition to infancy, pallorand tachycardia were also observed to be associated with hypoxaemia among the children with no respiratory features at presentation. This observation was corroborated by Emordi *et al*[7]who reported higher frequency of anaemia among hypoxaemic children in Enugu, Nigeria. Severe anaemia is the most common cause of pallor among emergently ill children in malaria endemic region like our study site.[5] Severely anaemic children may often be hypoxaemic due to inability of the depleted haemoglobin to carry enough

oxygen to meet the tissue requirements. (Anaemic hypoxia) [2] Anaemic heart failure can also ensue in these children leading to pulmonary congestion and poor ventilation and perfusion. [2]This explains why tachycardia and pallor were significantly associated with the presence of hypoxaemia among the emergently ill children.

Hypoxaemia was observed in this study to be associated with mortality irrespective of the presenting features. This finding was also reported by other researchers in children with or without respiratory symptoms.[7-12, 19-20] Hypoxaemia often connote poor tissue oxygenation with consequent impair aerobic respiration and cellular energy utilisation.[2]This impaired cellular functions including sodium/potassium ATP pump ultimately leading to cellular damage and death.[2] This implies that hypoxaemia should be promptly recognised and managed efficiently particular in sick children to improve survival.

We appreciate the limitation that oxygen saturation (SPO_2) was assessed once at presentation in the study participants and preferred continuous oxygen monitoring in sick children was not done due to unavailability of facilities to do so. Nonetheless, this study has highlighted simple easily observable factors that can guide clinicians in resource poor in prompt detection of hypoxaemia among emergently ill children with or without respiratory features at presentation even in the absence of facilities to detect and monitor hypoxaemia.

Conclusion

In conclusion, at the emergency room, hypoxaemia was present in one of every two to three children with respiratory features at presentation and one in every seven children with no respiratory features at presentation in Ilesa, Nigeria. The presence of hypoxaemia was significantly associated with mortality irrespective of the presenting features. Emergently ill children in resource-poor settings who presented with respiratory features and cyanosis, grunting respiration and chest in-drawing and those with no respiratory features but presented with pallor and tachycardia especially infants should preferentially be placed on oxygen therapy even when hypoxaemia had not been confirmed.

Author's contributions

Kuti BP: Conceptualised the study, collected, analysed the data and wrote the manuscript

Adetola HH: Collected the data and revised the manuscript

Kuti DK: Participated in data collection and analysis. Also revised the manuscript

Aladekomo TA: Supervised the conduct of the study and revised the manuscript.

All the authors approved the final manuscript.

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References

1. Duke T, Graham SM, Cherian MN, Ginsburg AS, English M, Howie S, et al. The Union Oxygen Systems Working Group. Oxygen is an essential medicine: a call for international action *Int J Tuberc Lung Dis. 2010; 14(11): 1362–8.*
2. Qureshi SA. Measurement of respiratory function: an update on gas exchange. *Anaesthesia & Intensive Care Medicine 2011; 12: 490 – 5.*
3. Wandi F, Peel D, Duke T. Hypoxaemia among children in rural hospitals in Papua New Guinea: epidemiology and resource availability—a study to support a national oxygen program. *Ann Trop Paediatr 2006; 26:277–284.*
4. Schneider G. Oxygen supply in rural Africa: a personal experience. *Int J Tuberc Lung Dis 2003; 5: 524–6.*
5. Management of the child with a serious infection or severe malnutrition. World Health Organization, Geneva, 2000.
6. Subhi R, Adamson M, Campbell H, Weber M, Smith K, Duke T, for the Hypoxaemia in Developing Countries Study Group. The prevalence of hypoxaemia among ill children in developingcountries: a systematic review.*The Lancet 2009; 9: 221-227.*
7. Emodi J, Ikefuna AN, Ubesie AC, Chukwu BF, Chinawa JM. Assessment of clinical features andhaematocrit levels in detection ofhypoxaemia in sick children. *AJRM 2011; 7(1): 11-13.*
8. Orimadegun AE, Ogunbosi BO, Carson SS.Laman M, Ripa P, Vince J, Tefuarani N. Prevalence and predictors of hypoxaemia in respiratory and non-respiratory primary diagnoses among emergently ill children at a tertiary hospital in south western Nigeria. *Trans R Soc Trop Med Hyg. 2013; 107:699-705.*
9. Basnet S, Adhikari R, Gurung C. Hypoxemia in children with pneumonia and its clinical predictors. *Indian J Pediatr. 2006; 73:777–81.*
10. Laman M, Ripa P, Vince J, Tefuarani N. Can clinical signs predict hypoxaemia in Papua New Guinean children with moderate and severe pneumonia? *Ann Trop Pediatr. 2005; 25: 23–7.*

11. Usen S, Webert M. Clinical signs of hypoxaemia in children with acute lower respiratory infection: indicators of oxygen therapy. *Int J Tuberc Lung Dis.2001; 5: 505–10.*
12. Kuti BP, Adegoke SA, Ebruke BE, Howie S, Oyelami OA, Ota M. Determinants of Oxygen Therapy in Childhood Pneumonia in a Resource-Constrained Region. *ISRN Pediatrics.*2013; Article ID 435976, 6 pages
13. Ilesa West Local Government Area. Available from: http:// www.info@ilesawestlg.os.gov.ng. [Last accessed 23rd September, 2015].
14. Araoye MO. Subjects Selection. In: Araoye MO, editor. Research methodology with statistics for health and social sciences. 1st ed. Ilorin: *Natadex 2003:115-21*.
15. Bohnhorst B, Peter CS, Poets CF. Pulse oximeters' reliability in detecting hypoxaemia and bradycardia: comparison between a conventional and two new generation oximeters. *Crit Care Med 2000; 28:1565-8.*
16. Oyedeji GA. Socioeconomic and cultural background of hospitalized children in Ilesa. *Niger J Paediatr 1985; 13:111 -8.*
17. WHO. Pocket book of hospital care for children: guidelines for the management of common illnesses with limited resources. *World Health Organization,* Geneva; 2005
18. Well come Trust Working Party. Classification of infantile malnutrition. *Lancet 1970; 2:302- 3.*
19. Junge S, Palmer A, Greenword BM, Mulholland EK, Weber MW. The spectrum of hypoxemia in children admitted to hospital in Gambia, West Africa. *Trop Med Int Health 2006; 11: 367–72.*
20. Duke T, Blaschke AJ, Sialis S, Bonkowsky JL. Hypoxaemia in acute respiratory and non-respiratory illnesses in neonates and children in a developing country. *Arch Dis Child 2002; 86:108-112.*