



Hypoxaemia in Hospitalised Children at the Emergency Unit of a Specialist Hospital in Gusau, North- Western Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Authors BIG and ASM designed the study, performed the statistical analysis, wrote the protocol and drafted the manuscript. Authors AOA and AABW obtained data and carried out literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Introduction: Hypoxaemia is a common complication in hospitalised children, which can be detected using pulse oximeter, a valuable non-invasive and cost- effective tool. Indeed, in most developing countries, hypoxaemia is usually identified by clinical signs alone, and this has been shown to be insensitive.

Objective: To determine the prevalence of hypoxaemia, socio-demographic and clinical predictors associated with hypoxaemia among hospitalised children in a Specialist Hospital in Gusau, Zamfara State, North-Western Nigeria.

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Methodology: A prospective, cross-sectional study of admissions into the Emergency Paediatric Unit of Ahmad Sani Yariman Bakura Specialist Hospital (ASYBSH), Gusau over a three (3) month period. Relevant information was recorded in a proforma and analysed accordingly. Hypoxaemia is defined as oxygen saturation <90% and all hypoxaemic children were provided with oxygen.

Results: 217 children were studied of which 141(65.0%) were males with a M:F ratio of 1.9:1. Majority were diagnosed with severe malaria 59(27.2%), followed by Severe Acute Malnutrition (SAM) 39(18.0%) and Pneumonia 24(11.0%). Hypoxaemia was present in 26(12.0%) children, equally seen in both sexes.

Predictors of hypoxaemia were tachypnoea ($p=0.012$, 95%CI 0.430-0.680) and chest indrawing ($p=0.008$, 95% CI 0.380-0.615). A total of 194 children (89.4%) were discharged while 18 (8.3%) died. Seven (38.9%) of the mortality had hypoxaemia. Case fatality rate for hypoxaemic children was high (i.e. 7/26=26.9%), and this was significant (Fischer's exact=0.001).

Conclusion: Hypoxaemia was common among children admitted to the emergency unit and found to be common in children with severe malaria. Tachypnoea and chest indrawing were associated with hypoxaemia. It was found to be associated with death irrespective of the diagnosis. –Pulse oximetry and blood gas analysis for diagnosis are highly recommended to reduce morbidity and mortality.

Keywords: Hypoxaemia; oxygen saturation; predictor; pulse oximeter.

1. INTRODUCTION

Hypoxaemia is a common complication in hospitalised children, different cut-off values of peripheral oxygen saturation have been used to define hypoxaemia with <90% acceptable at sea level [1-3]. Hypoxaemia can be detected using the pulse oximeter, which is a valuable non-invasive and cost-effective tool [4,5]. Indeed, in most developing countries hypoxaemia is usually identified by clinical signs alone, and this has been shown to be insensitive [6].

Hypoxaemia is commonly associated with acute lower respiratory infections (ALRI) [4,7]. However it can also occur in other non-respiratory illnesses like severe sepsis, meningitis, neonatal problems and other conditions that impair ventilation and gas exchange or increase oxygen demand [7,8].

Studies have been reported on the burden and predictors of hypoxaemia among hospitalised children in resource-poor settings [1,7,9,10] but were mostly conducted on children with ALRI or respiratory conditions [9,10]. Few studies have been conducted on prevalence and outcome of hypoxaemia in hospitalised children [11,12]. This has led to little information known about hypoxaemia in childhood diseases other than pneumonia [1]. There is no reported study on hypoxaemia in hospitalised children in North-Western Nigeria which forms the justification for this work.

1.1 Objectives

The study aims to determine the prevalence of hypoxaemia, socio-demographic and clinical predictors associated with hypoxaemia among hospitalised children in a Specialist Hospital in Gusau, Zamfara State, North-Western Nigeria.

2. MATERIALS AND METHODS

This was a hospital-based, prospective, cross-sectional study of admissions into the Emergency Paediatric Unit of Ahmad Sani Yariman Bakura Specialist Hospital (ASYBSH), Gusau over a 3 month period between June to August 2017.

Information on age, gender, clinical features, primary admission diagnoses and outcome were recorded in a proforma. The diagnosis was based on the departmental standard protocol in line with the World Health Organisation (WHO) guideline and other guidelines accordingly. The WHO Z score charts were used to classify malnutrition.

Acute lower respiratory infection (ALRI) is defined as acute onset of respiratory symptoms such as a cough, fast/difficult breathing and chest wall indrawing of less than 14 days duration with radiological evidence of lower respiratory infection. The socio-economic class (SEC) of the parents was assessed using Oyediji's classification [13]. The social class of each child was determined from the occupational and educational level of both parents using

standard scoring scales. The social class allocated for the family was the mean of the four scores (two for the father and two for the mother) to the nearest whole number.

Peripheral oxygen saturation was measured non-invasively with an M70 Biolight Co Ltd China, fingertip pulse oximeter immediately after admission and after obtaining a quality signal with the child breathing room air. Hypoxaemia is defined as oxygen saturation <90% and all hypoxaemic children received oxygen except unavailability or power- Cut. Oxygen saturation was monitored at intervals which is a routine for all children on oxygen.

2.1 Data Analysis

Normally distributed variables were reported as mean ± SD and categorical variables represented as frequencies and percentages. Categorical variables were compared using either Pearson's χ^2 tests or Fisher's exact tests.

Study variables that were significantly associated with hypoxaemia were further analysed using binary logistic regression to determine their independent effect on the outcome (presence or absence of hypoxaemia). Results were interpreted with odds ratios at 95% confidence interval. The statistical significance level was established at $p = 0.05$. All statistical analyses were performed using SPSS 17.0 (SPSS Inc., Chicago 2008, IL, USA)

3. RESULTS

A total of 217 children were enrolled over the study period, of which 141 (65.0%) were males while 76 (35.0%) were females, with a M: F ratio of 1.9:1. The mean age was 49.33 ± 39.17

months, with a range of 1 month to 12 years. Most of the children belonged to 1-5 years age group as shown in Table 1.

Table 1. Age distribution of the study population

Age (years)	Frequency	Percentage
< 1	26	12.0
1-5	134	61.8
6-10	39	18.0
>10	18	8.3
Total	217	100.0

Eleven (5.1%) belonged to the upper socio-economic class (SEC), while 32 (14.7%) belonged to the middle SEC and 174 (80.2%) belonged to the lower SEC. Fifty- seven (26.3%) of the children were fully immunised while 160 (73.7%) were partly or not immunised at all.

Respiratory symptoms and signs at presentation are shown in Table 2.

Table 2. Respiratory symptoms and signs at presentation

Symptom	Frequency	Percentage
Cough	71	32.7
Tachypnoea	71	32.7
Crepitations	38	17.5
Chest in drawing	23	10.6
Cyanosis	5	2.3

Majority (59) of the children were diagnosed to have severe malaria (27.2%), followed by 39 patients of Severe Acute Malnutrition (SAM) (18.0%) and 24 patients of pneumonia (11.0%) as shown in Table 3.

Table 3. Diagnoses of the study population

Diagnosis	Frequency	Percentage
Severe malaria	59	27.2
Severe acute malnutrition	39	17.9
Pneumonia	24	11.1
Typhoid fever	16	7.4
Sickle cell anaemia	16	7.4
Meningitis	12	5.5
Sepsis	12	5.5
Acute diarrhoeal disease	8	3.7
Pharyngotonsillitis	6	2.8
Congenital heart disease	3	1.4
Urinary tract infection	3	1.4
Others	19	8.7
Total	217	100.0

Majority of the children had normal oxygen saturation as shown in Table 4.

Table 4. Level of oxygen saturation

Oxygen saturation	Frequency	Percentage
≥95	170	78.3
90-94	21	9.7
<90	26	12.0
Total	217	100.0

Hypoxaemia was present in 26 (12.0%) children, equally seen in both sexes.

Oxygen was administered to 25 (96.2%) hypoxaemic children and 8 (4.2%) non-hypoxaemic children which was significant (Fisher's exact=0.000). Majority of the hypoxaemic children were under the age of 5 years, however this was not statistically significant as shown in Table 5.

Diagnosis of acute lower respiratory tract infection (ALRI) was made in 26 (12.0%), of which 7/26 (26.9%) had hypoxaemia compared

to 19/191 (11.5%) with non- ALRI, which was significant as shown in Table 6. Table 6 shows an association between hypoxaemia and some variables. Of the 26 hypoxaemic children, 20 (76.9%) belonged to the low SEC, which was not statistically significant, while 19 (73.1%) were not fully immunised which was significant.

Tachypnoea and chest indrawing predicted hypoxaemia using binary logistic regression as shown in Table 7. Children with tachypnoea were 4 times more likely to have hypoxaemia while children with a chest indrawing were 6 times more likely to be hypoxaemic.

Most of the children 194 (89.4%) were discharged, while 18 of them (8.3%) died, and 3 (1.4%) signed against medical advice while 2 (0.9%) absconded. Seven (38.9%) of the mortality had hypoxaemia, case fatality rate for hypoxaemic children was high (i.e. 7/26 = 26.9%) compared with non- hypoxaemic children (i.e. 11/191=5.8%) and this was statistically significant (Fischer's exact t= 0.001). The overall presence of hypoxaemia was significantly associated with death ($p = 0.000$).

Table 5. Association of hypoxaemia with age group

Age (years)	Hypoxaemic no (%)	Non hypoxaemic no (%)	Total
< 5	22(10.1)	128(59.0)	150(69.1)
5-10	3(1.4)	42(19.4)	45(20.8)
>10	1(0.5)	21(9.6)	22(10.1)
Total	26(12.0)	191(88.0)	217(100.0)

Fischer's exact =0.184 no= number, %=percentage

Table 6. Association of hypoxaemia with some variables

Variable	Number (%) hypoxaemic	χ^2 or Fishers' exact	P value
Gender			
M	13(50.0)	2.912	0.080
F	13(50.0)		
Social class		0.007	0.810*
High	2(7.7)		
Middle	4(15.4)		
Low	20(76.9)		
Immunisation status			0.015
Full	7(26.9)		
Poor	19(73.1)		
Cough	15(57.7)	8.369	0.004
Cyanosis	5(19.2)		0.000*
Crepitations	12(46.2)	16.776	0.000
Chest Indrawing	13(50.0)	48.395	0.000
Tachypnoea	21(80.8)	30.931	0.000
ALRI	7(26.9)	6.253	0.012

**Fisher's exact ALRI- Acute lower respiratory infection*

Table 7. Binary logistic regression analysis of some variables

Variable	aOR	P value	CI
Gender	1.838	0.320	0.190-2.562
Cough	0.698	0.590	0.190-2.562
Tachypnoea	0.170	0.012	0.430-0.680
Chest in drawing	0.152	0.008	0.380-0.615
Cyanosis	0.000	0.990	0.000-0.000
ALRI	1.345	0.710	0.279-6.489

aOR= adjusted odds ratio, CI= Confidence interval, ALRI acute lower respiratory tract infection

4. DISCUSSION

This study highlights the prevalence of hypoxaemia in hospitalised children at the EPU of a Specialist Hospital in Gusau, North-western Nigeria. The prevalence obtained in this study is lower than 28.6% from Ibadan [7], 52.0% from Papua New Guinea [10], 20.6% reported from Ilesha [11] and 13.3% reported from Enugu [14]. It is, however, higher than 5.8% reported from Gambia [1] and 5.3% from Malawi [12]. The reason for the differences can be due to the methodology regarding sample size, cut off point of SPO₂ and study location, for example, Papua New Guinea is located in a high altitude region compared to Gusau which is located at sea level.

There were more males similar to the findings in Ilesha [11,12,15]. Most of the children were admitted for non- ALRI infections of which malaria tops the list, which is similar to the findings from Gambia [1] and Malawi [12], but differs from Ibadan [7] where most of the children had ALRI.

Majority of the hypoxaemic children were under the age of 5 years, which was also reported by Junge et al. from Gambia [1] and McCollum et al. from Malawi [12].

Hypoxaemia was more common in children with ALRI similar to the report by Junge et al. [1]. It is a common finding in children with pneumonia [16-21].

Full immunisation, cough, cyanosis, tachypnoea, crepitations, chest indrawing and presence of ALRI were associated with the presence of hypoxaemia. The finding of an association between poor immunisation status and hypoxaemia in the present study was similar to the findings from Ilorin in children with pneumonia [22]. They found out that unvaccinated children were at increased risk of having hypoxaemia. Full immunisation has been shown to protect children against microbes that

cause infections including those causing severe pneumonia with subsequent risk of developing hypoxaemia [22,23].

Cough, cyanosis, tachypnoea and chest indrawing which are cardinal symptoms and signs of respiratory illness have also been identified to be predictors of hypoxaemia in hospitalised children by different researchers [6,7,10-12,15]. However, in Ilesha, tachypnoea was not significantly associated with hypoxaemia in sick babies [15].

Low SEC was found to be associated with hypoxaemia, similar to the findings by Ibrahim et al. [22] in children with Pneumonia, and this may be due to the delay in seeking health care by the parents due to cost implications and ignorance.

It is worthy of note that only tachypnoea and chest indrawing were predictors of hypoxaemia, this may be because, both if prolonged, may lead to respiratory fatigue and failure which can lead to hypoxaemia. Increased work of breathing also manifests as chest indrawing which can lead to ventilation- perfusion mismatch and eventual hypoxaemia. However, Weber et al. [6] have shown that tachypnoea and chest indrawing are not very sensitive to detect hypoxaemia Hence children with tachypnoea and chest in drawing should have pulse oximetry to assess those who may require oxygen therapy.

Only one hypoxaemic child did not receive oxygen due to his demise before oxygen was commenced, which contrasts findings from Malawi [12] where only 22.5% received oxygen. Oxygen therapy is recommended to all hypoxaemic children to relieve hypoxaemia. However this is not readily available in developing countries.

Mortality has been associated with hypoxaemia which is similar to the findings from other studies [1,7,11]. The reason is hypoxaemia has been shown to reflect poor tissue oxygenation,

impaired aerobic respiration and cellular energy utilisation [24,25]. Hence, all children found to be hypoxaemic, should be promptly identified and managed as an emergency to improve chances of survival.

5. CONCLUSION

Hypoxaemia is a common finding among children admitted to an emergency unit in Gusau, North-Western Nigeria and was found to be common in children and severe malaria. tachypnoea and chest indrawing were associated with hypoxaemia. It was found to be associated with death irrespective of the diagnosis. Availability of pulse oximeters and facilities for blood gas analysis to diagnose hypoxaemia and provision of oxygen supply are highly recommended to reduce morbidity and mortality.

CONSENT

Informed consent was obtained from parents/guardians and assent from children > 7 years of age.

ETHICAL APPROVAL

Ethical approval was obtained from the hospital research and ethical committee.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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