

# Childhood Community-acquired Pneumonia at the Wesley Guild Hospital, Ilesa: Prevalence, Pattern, and Outcome Determinants

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## ABSTRACT

**Background:** Pneumonia remains a leading cause of childhood morbidity and mortality despite the presence of effective preventive and curative management. The factors at presentation that determine prognosis particularly mortality among children with pneumonia have not been fully characterised in resource-poor centres.

**Objectives:** This study set out to determine the hospital prevalence, pattern of presentation, associated risk factors, and determinants of deaths among children admitted with community-acquired pneumonia in Ilesa.

**Methods:** We carried out a retrospective review of 352 children managed for pneumonia at the Wesley Guild Hospital, Ilesa, Nigeria over a three year period (2011 to 2013) by analysing hospital records. History, clinical features and laboratory findings at presentation were compared in children who survived and those who died. Binary logistic regression analysis was used to determine the independent predictors of mortality.

**Results:** Pneumonia accounted for 23.5% of the 1470 total admission among children one month - 15 years during the period with a male preponderance of 1.4:1 and 84.9% of the children being less than two years. Sixty (17.0%) of the children were undernourished with 12 (3.4%) being severely wasted. Radiological pneumonia was observed in 44.0% of the children, 116 (33.3%) presented with heart failure while 18 (5.1%) had underlying cardiac lesions. Thirty-five (9.9%) of the children died. Children with pneumonia who in addition had concurrent measles infection, heart failure, cyanosis, head nodding and severe undernutrition were at increased risk of death. ( $p < 0.05$ ) Severe wasting independently predicts mortality among the children. (RR = 5.86; 95% CI = 1.34 – 12.11;  $p = 0.01$ ).

**Conclusion:** Children with pneumonia who in addition had measles, heart failure, cyanosis and severe protein energy malnutrition should be aggressively managed because they are at increased of dying

**Key words:** Childhood pneumonia, determinants, mortality, outcome

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## INTRODUCTION

Pneumonia is a leading cause of morbidity and mortality in children responsible for approximately one out of every five under-five deaths globally.<sup>1</sup> The burden of childhood pneumonia is highest in developing countries with Nigeria having the highest burden in Africa, second only to India globally.<sup>1-3</sup> Recent estimates by the World Health Organization (WHO) revealed that about 6 million cases of childhood pneumonia occur annually with associated over 140,000 under-five deaths in Nigeria.<sup>3</sup> Pneumonia is also a significant cause of household and governmental spending on health and together with malaria puts tremendous pressure on the health system at all levels.<sup>4,5</sup>

There have been a lot of efforts geared toward reducing the burden of childhood pneumonia locally, regionally, and globally.<sup>6</sup> These

include identifying and reducing the major risk factors such as household air pollution, overcrowding, lack of breastfeeding, immunization, particularly against the leading causes of fatal pneumonia in children, i.e., *Streptococcus pneumoniae* and *Haemophilus influenzae* Type B and effective case management of pneumonia in children.<sup>6,7</sup> Regrettably, these efforts seem to be suboptimal, yielding little or no significant results in Nigeria as routine immunization uptake is still low,<sup>8</sup> many children who ought to be on antibiotic therapy for pneumonia are still misdiagnosed and thereby denied appropriate treatment<sup>8</sup> and children are still being continually exposed to both indoor and outdoor air pollution.<sup>9,10</sup> Consequently, pneumonia continues to be a significant cause of ill-health and deaths among Nigerian children.

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Case management of childhood community-acquired pneumonia is one of the pillars of pneumonia control and management.<sup>6,7</sup> Here, health workers, particularly at the primary level, are expected to be able to recognize children with pneumonia and classify the severity and treat/or refer those with serious illness to higher centers appropriately.<sup>7</sup> Prompt recognition of the factors at presentation that determine outcome, particularly mortality, is important to reduce the burden of childhood pneumonia and save life,<sup>6,7</sup> although there have been a lot of studies on childhood pneumonia in Nigeria<sup>11-13</sup> and other developing countries.<sup>14</sup> Few studies had looked at the determinants of pneumonia-related mortality in children. This study sets out to determine the hospital prevalence, pattern of presentation, associated risk factors, and determinants of deaths among children admitted with community-acquired pneumonia at the Wesley Guild Hospital (WGH), Ilesa.

## METHODS

This was a retrospective review of all admitted cases of childhood pneumonia at the pediatric wards of the WGH, Ilesa, over a 3-year period (January 2011–December 2013). The WGH is one of the Tertiary Units of the Obafemi Awolowo University Teaching Hospitals Complex (OAUTHC), Ile-Ife, Nigeria. It serves the health needs of the urban and rural communities of the Osun, Ondo, and Ekiti States of South-West Nigeria. It is a major referral health facility providing both general and specialist pediatric care for these communities. The Paediatric Department of the hospital admits about 1400 children per annum. The hospital has four pediatric wards with total beds/cots of 80; 32 of which are for newborns. Children with pneumonia and its complications are managed at the isolation children ward with seven cubicles each with 4 beds/cots.

Data from all children aged 1 month to 15 years admitted and managed for pneumonia over the study period were analyzed. Community-acquired pneumonia in the recruited children was defined as age-specific tachypnea, cough, and evidence of respiratory distress, reduced or absent breath sounds, bronchial breath sound, or coarse crepitation with or without significant radiological findings.<sup>7</sup> These symptoms must be present at home before presenting or admission in the hospital. Children with pneumonia were adjudged to have pleural effusion when there is radiological evidence of fluid collection in the pleural cavity coupled with free flowing of fluid from the pleural space on percutaneous pleural tap.<sup>15</sup> Heart failure for this study was recorded as the presence of significant age-specific tachypnea, tachycardia, and tenderly enlarged liver.<sup>16</sup> Children with chronic cough (>3 weeks), hospital-acquired pneumonia as well as those with tachypnea and wheeze reversible with bronchodilator therapy were excluded.

The data retrieved from the clinical notes of the recruited children included socio-demographic variables such as age and sex of the children, maternal age and parity, and the socio-economic classes of the parents. The parental socioeconomic classes were obtained based on the rank assessment of parental occupation and highest educational attainments as described by Oyedeji.<sup>17</sup> According to Oyedeji's

classification, gainfully employed professionals such as doctors and lawyers were classified as social class I whereas the unemployed parents with no formal education were classified as V.<sup>17</sup> This was further graded as upper (Classes I and II), middle (Class III), and lower (Classes IV and V) social classes. Also retrieved from the clinical notes of the study participants were the immunization status of the children and the number of persons living in the same room with the children. Overcrowding for this study was defined as having three or more persons living together in a standard room.<sup>18</sup> Other associated conditions such as gastroenteritis and concurrent measles infection as recorded in the clinical notes were noted.

Examination findings retrieved from the clinical notes of the children at presentation included features of respiratory distress such as grunting and cyanosis. Results of investigations retrieved from the clinical notes of the recruited children included chest radiographic findings, blood culture, and packed cell volume results. In addition, the results of echocardiography done to detect and characterize the underlying cardiac lesions in children with abnormal heart sounds were also noted. The outcome of hospitalization was recorded as discharged home, discharged against medical advice, and died.

Ethical clearance for this study was obtained from the Ethics and Research Committee of the OAUTHC, Ile-Ife, with protocol number ERC/2014/08/04.

## Data analysis

This was done using Statistical Program for Social Sciences (SPSS) software Version 17.0 (SPSS Inc., Chicago 2008). The prevalence of community-acquired pneumonia during the study period was calculated from the proportion of children with pneumonia over the total childhood admission during the period. Continuous variables such as children and maternal ages were summarized using mean and standard deviations (SD) for normally distributed variables and median and interquartile range (IQR) for non-normally distributed ones. Proportions and percentages were determined for categorical variables such as sex and age categories. Differences between the means of continuous variables were analyzed using Student's *t*-test, whereas categorical variables were analyzed using Pearson's Chi-square test and Fisher's exact test, as appropriate (with Yate's correction where applicable). Level of significance at 95% confidence interval (CI) was taken at  $P < 0.05$ .

Association between dependent (mortality-recorded) and independent variables (study variables) that gave significant results in the univariate analysis was used in binary logistic regression analysis to adjust for possible confounders and determine the independent predictors of mortality among the children with pneumonia. Results were interpreted with relative risk and 95% CI. Statistical significance for the regression analysis was also taken at  $P < 0.05$  at 95% CI.

## RESULTS

Over the study period, a total of 1470 children aged 1 month to

**Table I: Association between socio-demographic characteristics of the children and mortality**

Socio-demographic	Died <i>n</i> =35 (%)	Survive <i>n</i> =317 (%)	Total <i>n</i> =352	$\chi^2$	<i>P</i>
Sex					
Male	20 (57.1)	194 (61.2)	214	0.22	0.64
Female	15 (43.9)	123 (38.8)	138		
Age (in months)					
1-12	20 (57.1)	194 (61.2)	214	0.22	0.64
13-59	14 (40.0)	96 (30.3)	110	2.31	0.24
≥60	1 (2.8)	27 (8.5)	28	3.04	0.40
Maternal age					
<20	1 (2.9)	9 (2.8)	10	0.00	1.00*
20-35	34 (97.1)	308 (97.2)	242	0.00	1.00
Parental socio-economic class					
Upper social class	1 (2.9)	34 (10.7)	35	2.87	0.10*
Middle social class	19 (54.3)	184 (58.0)	203	0.41	0.52
Lower social class	15 (42.9)	99 (31.3)	114	1.95	0.16
Parity					
Primipara	2 (5.7)	58 (18.3)	60	2.70	0.10*
Multipara	20 (57.2)	169 (53.3)	189	0.19	0.67
Grand multipara	13 (37.1)	90 (28.4)	103	1.17	0.28
Maternal highest level of education					
No formal education	1 (2.9)	6 (1.9)	7	0.00	1.00*
Primary	3 (8.6)	40 (12.6)	43	0.53	0.47*
Secondary	19 (54.3)	223 (70.3)	242	2.79	0.05
Postsecondary	3 (8.6)	57 (18.0)	60	2.30	0.13*
Overcrowding	9 (25.7)	87 (27.4)	96	0.05	0.83
Not exclusively breastfed	16 (45.7)	186 (58.7)	202	2.17	0.14
Not appropriately immunized	9 (25.7)	76 (24.0)	85	0.05	0.76
No measles vaccine	10 (28.6)	87 (27.4)	97	0.00	1.00
Previous hospital admission	5 (14.3)	44 (13.9)	49	0.00	1.00

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

15 years were admitted and managed in the pediatric wards, out of which 352 (23.9%) children had community-acquired pneumonia.

Table I shows the socio-demographic features and general information about the 352 children admitted and managed for pneumonia at the WGH, Ilesa, during the study period.

### Age and sex distribution

The age of the children with pneumonia ranged from 1 to 168 months with median and IQR of 9.0 (4.0–18.0) months. Majority (299) of the children with pneumonia were <2 years representing 84.9%. Only 28 (8.0%) were school age children. There were 214 (60.8%) males and 138 (39.2%) females with a male: female ratio of 1.6:1.

### Maternal age

The ages of the mothers ranged from 17 to 50 years with a mean (SD) age of 29.5 (5.9) years. Ten (2.8%) of the mothers whose children had pneumonia were teenagers.

### Parental socio-economic class

Majority (90.0%) of the children were from middle and low social class. Only 35 (10.0%) of the children were from high social class [Table I].

### Other risks factors associated with childhood pneumonia

Ninety-six (27.3%) children admitted with pneumonia

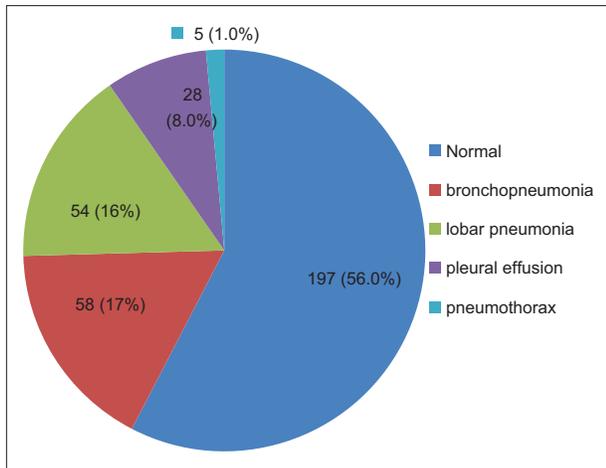
lived in overcrowded houses, whereas 24.1% were not appropriately immunized including 53 (15.1%) who did not receive measles vaccine. About one-quarter of the children (91) were not exclusively breastfed for the first 4–6 months of life [Table I].

### Clinical features and laboratory findings of the children managed for community-acquired pneumonia

Table II and Figure 1 highlight the clinical features at presentation and the laboratory as well as radiologic findings in the children with community-acquired pneumonia.

Fever was the predominant feature at presentation observed in 263 (74.7%) children; however, 78 (22.2%) had no fever at presentation including 7 (2.0%) with subnormal temperature and 1 (0.3%) with hypothermia. The other manifestations included grunting respiration (20.2%), head nodding (5.7%), and cyanosis (4.3%). Sixty (17.0%) children had undernutrition which was severe in 12 (3.4%) [Table II].

One hundred and ninety-seven (56.0%) children had normal chest radiograph, whereas the rest (44.0%) had abnormalities in the chest radiograph which included lobar consolidation in 54 (16.0%), patchy opacities in 58 (17.0%), evidences of parapneumonic effusions in 28 (8.0%), and pneumothorax in 5 (1.0%) [Figure 1].



**Figure 1:** Pie chart showing the radiological findings among the children with pneumonia.

**Table II: Association between clinical features at presentation and mortality**

Clinical features	Died n=35 (%)	Survive n=317 (%)	Total n=352	$\chi^2$	P
Duration of symptoms (week)					
<1	23 (65.7)	233 (73.5)	256	0.96	0.33
>1	12 (34.3)	84 (26.5)	96	0.96	0.33
Clinical features					
Fever	11 (31.4)	134 (42.3)	145	0.09	0.77
Hyperpyrexia	1 (2.9)	10 (3.2)	11	0.00	1.00**
Grunting	9 (25.7)	62 (19.6)	71	0.74	0.39
Head nodding	6 (17.1)	14 (4.4)	20	6.76	0.01
Cyanosis	5 (14.3)	10 (3.2)	15	6.50	0.01*
Underweight <sup>^</sup>	6 (17.1)	42 (13.2)	48	0.41	0.52
Severe wasting <sup>^</sup>	6 (17.1)	6 (1.9)	12	17.87	<0.001*
Associated problems					
Measles	3 (8.6)	8 (2.5)	11	4.47	0.04*
Heart failure	17 (48.6)	99 (31.2)	116	4.29	0.04
Gastroenteritis	6 (17.1)	36 (11.4)	41	0.53	0.47

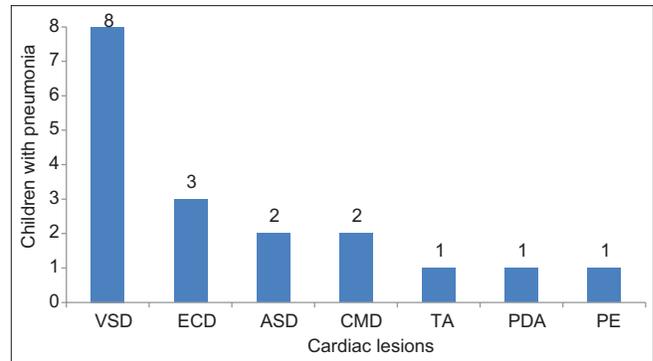
<sup>^</sup>WHO/NCHS classification underweight: Weight for age <-2SD; While severe wasting: Weight for height <-3SD from the mean.\*Yates correction applied; \*\*Fisher's exact test applied. SD: Standard deviation, WHO: World Health Organization, NCHS: National Center for Health Statistics

### Complications and associated problems seen in the children with pneumonia

Table II and Figure 2 show the complications and associated problems seen in the children managed for pneumonia during the study period.

Eighty (22.2%) children with pneumonia had anemia at presentation which was severe enough to warrant blood transfusion in 11 (3.1%). There was concurrent measles infection in 11 (3.1%) children. One-third of the children had features of heart failure at presentation and 42 (12.0%) had associated gastroenteritis [Table II].

Eighteen (5.1%) children had abnormal heart sounds at presentation and the predominant echocardiographic findings



**Figure 2:** Distribution of the echocardiographic-confirmed cardiac lesions seen among the children with pneumonia. VSD = Ventricular septal defect; ECD = Endocardial cushion defect; ASD = Atrial septal defect; CMD = Cardiomyopathies; TA = Truncus arteriosus; PDA = Patent ductus arteriosus; PE = Pericardial effusions.

in them were isolated ventricular septal defects (VSDs) in 8 (61.5%). Others included endocardial cushion defects in 3 (16.7%), cardiomyopathies, and pericardial effusions [Figure 2].

### Association between socio-demographic features and mortality among the children with pneumonia

There was no significant association between age of the children, gender, and other socio-demographic variables and pneumonia-related mortality among the study participants. [Table I].

### Association between clinical and laboratory findings at presentation and pneumonia-related death

Tables II and III highlight the association between clinical and laboratory findings at presentation among the children with pneumonia as related to mortality.

Head nodding at presentation was significantly associated with mortality as 6 (30.0%) of the 20 children who presented with head nodding, compared to 29 (8.7%) of the 332 children who did not head nod at presentation died ( $\chi^2 = 6.76$ ;  $df = 1$ ;  $P = 0.01$ ). Similarly, cyanosis was significantly associated with mortality in childhood pneumonia as 5 (33.3%) of the 15 children with cyanosis, compared to 30 (8.9%) of the 337 children without cyanosis at presentation died ( $\chi^2 = 6.51$ ;  $df = 1$ ;  $P = 0.01$ ). In addition, concurrent measles infection (27.3% vs. 2.3%;  $\chi^2 = 4.47$ ;  $P = 0.04$ ), heart failure (14.7% vs. 7.6%;  $\chi^2 = 4.29$ ;  $P = 0.04$ ), severe wasting (50.0% vs. 1.8%;  $\chi^2 = 17.87$ ;  $P < 0.001$ ), and patchy opacities on chest radiograph (17.2% vs. 8.5%;  $\chi^2 = 4.13$ ;  $P = 0.04$ ) were significantly associated with mortality in childhood pneumonia. Conversely, normal chest radiographic findings were significantly associated with survival ( $\chi^2 = 22.40$ ;  $P < 0.001$ ).

### Predictors of mortality in childhood pneumonia

The variables found to be significantly associated with mortality [Tables I-III] were analysed using binary logistic regression [Table IV], only severe wasting at presentation was an independent predictor of mortality among the children with pneumonia. (RR = 5.86; 95% CI = 1.34 – 12.11;  $P = 0.01$ ).

**Table III: Association between laboratory findings at presentation and mortality**

Investigations	Died n=35 (%)	Survive n=317 (%)	Total n=352	$\chi^2$	P
Normal chest radiograph	7 (20.0)	190 (59.9)	197	20.40	<0.001
Patchy opacity	10 (28.6)	48 (15.1)	58	4.13	0.04
Lobar consolidation	3 (8.6)	51 (16.1)	54	1.37	0.33*
Pneumothorax	1 (2.9)	4 (1.3)	5	0.57	0.50*
Effusions	4 (11.4)	24 (7.8)	28	0.64	0.50*
Cardiac lesions	4 (11.4)	14 (4.4)	18	3.19	0.09*
Anemia					
Mild to moderate	5 (14.3)	64 (20.2)	69	0.37	0.54
Severe	1 (2.9)	10 (3.2)	11	0.00	1.00*
Convulsion	5 (14.3)	25 (7.9)	30	0.94	0.33

\*Fisher's exact test applied

**Table IV: Predictors of mortality among children with community-acquired pneumonia at the Wesley Guild Hospital, Ilesa**

Variable	Coefficient of regression	SE	95% CI		P
			Lower	Upper	
Head nodding	1.57	1.08	0.03	1.73	0.15
Cyanosis	1.21	1.29	0.02	3.74	0.35
Heart failure	0.37	0.66	0.19	2.52	0.57
Patchy opacities	0.64	0.70	0.14	2.07	0.36
Measles infection	0.13	0.38	0.42	1.85	0.73
Severe wasting	2.04	1.22	1.34	12.11	0.01*

\*Relative risk=5.86. CI: Confident interval, SE: Standard error

## DISCUSSION

This study has presented data on the pattern of presentation of childhood pneumonia at the WGH, Ilesa, highlighting the risk factors, complication, and comorbidities associated with it, as well as the determinants of mortality among the children with pneumonia.

Community-acquired pneumonia accounted for 23.9% of the total childhood admission outside the neonatal period, which is similar to the reports of 24.7% from Enugu, Nigeria, by Oguonu *et al.*<sup>11</sup> Pneumonia and other respiratory infections are the common causes of childhood morbidity and mortality because of high prevalence of indoor and outdoor air pollution,<sup>9,10</sup> undernutrition,<sup>8</sup> and other major risks factors to developing childhood pneumonia in Nigeria and other developing countries.<sup>1,2,6</sup>

Majority of the children with community-acquired pneumonia from this study were <2 years. These findings agree with reports from other centers in Nigeria<sup>11,12</sup> and other developing countries.<sup>14,19</sup> This may be related to their relatively immature specific and nonspecific immune responses to infections making infants and young children susceptible to a wide variety of infectious diseases including pneumonia.<sup>20</sup>

Many of the risk factors to childhood pneumonia were recognized in the study participants. These included lack of

immunization, failure to breastfeed, and living in overcrowded homes.<sup>1-3,6</sup> The recognition of these factors among children with pneumonia underscores the need for aggressive campaign, awareness creation, and enlightenment of mothers in particular on the need to give their children a good head start in life with adequate breastfeeding and immunization to ensure their protection from vaccine preventable diseases including community-acquired pneumonia.

Worthy of note is that only about one-half of children with community-acquired pneumonia had radiologic pneumonia; this is in keeping with the reports from rural Gambia where like the present study about one-half of the under-five children with community-acquired pneumonia had no radiological evidence of pneumonia.<sup>21</sup> This may be due to the fact that early pathologic phase of pneumonia (congestion) may manifest with clinical features without the formation of the classical consolidation or infiltrates on chest radiography. When treatment is commenced at this stage, inflammatory processes are often arrested and radiologic pneumonia may not occur.<sup>20</sup> Furthermore, viral causes of pneumonia may often present more with clinical manifestation without associated radiologic features.<sup>1</sup>

About 5% of the children with community-acquired pneumonia had underlying cardiac lesions; this is much <11.5% prevalence of congenital heart lesions reported by Sadoh and Osarogiagbon<sup>22</sup> in Benin among children managed for pneumonia. The variation noted from the present study compared to the latter may be due to the fact that Sadoh and Osarogiagbon<sup>22</sup> screened all their study participants for cardiac lesions using an echocardiography, irrespective of whether there is clinical suspicion of cardiac lesion or not. Conversely, in the present study, only the children with clinical suspicion of underlying cardiac lesions were referred for echocardiography. Expectedly, VSD like in Sadoh study was the most prevalence cardiac lesion being the most reported congenital heart diseases in children.<sup>23</sup> The higher incidence of cardiac lesions including congenital heart lesions among cohort of children with community-acquired pneumonia than those reported in the general population makes careful evaluation of the cardiovascular system, a necessity in children being managed for pneumonia.

About 10% of the children with pneumonia from this study died which is similar to the mortality rate reported by Johnson *et al.*<sup>13</sup> at a Tertiary Health Facility in Ibadan, Nigeria, and by Tiewsoh *et al.*<sup>14</sup> at a similar facility in Indian, where mortality rates in childhood pneumonia were reported as 10.8% and 10.4%, respectively. This is, however, higher than the reported mortality of 3% to 4% reported from Primary Health Centre in rural Gambia.<sup>19</sup> The higher mortality rate observed in this study and that of Johnson *et al.* and Tiewsoh *et al.* may be due to the fact that these studies were conducted in tertiary health facilities in developing countries where complicated cases are more likely to be referred to, hence the higher mortality rates recorded.

Severe undernutrition was found in this study to be an independent predictor of mortality among children with community-acquired pneumonia. This was in agreement with reports from Ibadan, Nigeria,<sup>13</sup> rural Gambia,<sup>19</sup> and India.<sup>14</sup> Undernutrition has been reported to predispose children to infections including pneumonia, prolong their recovery from infections, and make them more likely to succumb to it.<sup>24</sup> Severe undernutrition causes impaired cellular and humoral immune responses to infectious agents.<sup>24</sup> These not only predispose these children to infections, but also make infections difficult to recognize in them,<sup>25</sup> which often delay presentation ultimately leading to poor prognosis.

Concurrent measles infections predispose children to undernutrition, impair immune response to infections, and may be associated with other complications such as myocarditis.<sup>26</sup> These worsen prognosis, hence concurrent measles infections among the study participants in this study was significantly associated with mortality. This agrees with reports by Johnson *et al.*<sup>13</sup> Association between pneumonia and measles is a two-way cause and effect type.<sup>27</sup> Measles virus itself is a cause of childhood pneumonia just as children with measles are at an increased risk of superimposed bacterial pneumonia.<sup>27</sup> Pneumonia as a complication of measles was reported to contribute to 56–86% of all deaths attributable to measles.<sup>27</sup> This underscores the need to scale up coverage of both routine and supplemental childhood immunization to reduce morbidity and mortality attributable to vaccine preventable diseases.

The presence of cyanosis, head nodding in infancy, and features of heart failure in childhood pneumonia have been classified as “danger signs” and features of very severe pneumonia by the WHO.<sup>7</sup> These features often found in the presence of widespread patchy opacities of the lung leading to increased anatomical death space. This increases the work of breathing and necessitates the employment of accessory muscle of respiration including the sternocleidomastoid muscles. These muscles being attached to the base of the skull causes head nodding in infants and young children with severe respiratory distress, hence its association with pneumonia-related mortality.<sup>20</sup> This is corroborated by the reports of Johnson *et al.*<sup>13</sup> in Ibadan, Nigeria, and Tiewsoh *et al.*<sup>14</sup> in Indian, where patchy opacity and head nodding in children with pneumonia are significantly associated with mortality.

Presence of cyanosis in children with pneumonia connotes increasingly worsening impairment of ventilation-perfusion, which overwhelms the compensatory mechanisms of the respiratory system, hence the build-up of deoxygenated hemoglobin which when are in excess of 5 g/dl manifest clinically as cyanosis.<sup>20</sup> In children with increased death space such as widespread patchy opacity, there is an increased work of breathing, intrapulmonary shunting, and elevated right ventricular pressure. These coupled with the possibility of the causative organisms also causing myocarditis eventually results in cardiac de-compensation and failure,<sup>16,20</sup> hence the poor prognosis associated with the presence of cyanosis and heart failure in childhood pneumonia. Heart failure, cyanosis,

and other associated complication in childhood pneumonia should be carefully looked for and appropriately managed in children with pneumonia to improve survival.

We appreciate the fact that this study may be limited by its retrospective nature in that the etiological diagnosis of pneumonia through blood culture, lung aspirate, and antigen studies were not done in a large majority of the children for financial and logistic reasons, hence were not reported in this study. Nonetheless, this study has been able to highlight clinical and simple laboratory determinants of pneumonia-related mortality among children in a resource-constraint center and recommending the need for early recognition and prompt aggressive management of these determinants to ensure survival.

## CONCLUSION

Pneumonia is a leading cause of childhood morbidity and mortality. Children with concurrent measles infection, heart failure, cyanosis, patchy opacities on chest radiograph, and severe undernutrition are at an increased risk of death. These features should be meticulously looked for and aggressively managed in children presenting with pneumonia to ensure survival.

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## Conflicts of interest

There are no conflicts of interest.

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