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Complications of pneumonia and its associated factors in a pediatric population in Osogbo, Nigeria

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Abstract: *Introduction:* Pneumonia is one of the leading causes of morbidity and mortality in under-five children. Nigeria still has a high burden of child death due to pneumonia. Many of these deaths result from the development of complications. This study was done to determine the pattern of pneumonia complications and its associated factors amongst under-five children with pneumonia.

Methods: It was a hospital-based cross-sectional observational study involving 129 children aged 1 - 60 months with a diagnosis of pneumonia. The participants were recruited over a nine-month period. Clinical signs were recorded, and a confirmatory chest radiograph was obtained within 24 hours of admission.

Result: Of the 129 subjects studied, 70 (54.3%) had complica-

tions. Children less than 24 months had a higher frequency of complications at presentation. Heart failure and anemia occurred more commonly. Other complications were pleural effusion, empyema, pneumatocele and pneumothorax. More than half (57.1%) of those with complication were hypoxaemic at presentation. Complicated pneumonia was significantly associated with prolonged hospital stay and risk of mortality.

Conclusion: Complication is common among children hospitalized for pneumonia in Osogbo. Heart failure was the most common complication. Presence of pneumonia complications and hypoxaemia are important contributors to mortality in this environment.

Keywords: Pneumonia, complication, under-fives, Nigeria.

Introduction

Pneumonia is the inflammation of the lung parenchyma caused by pathogenic micro-organisms.¹⁻³ It is one of the most common illnesses affecting children globally. The incidence and mortality of pneumonia are highest in children under five years of age, especially in developing countries.^{4,5} Most cases of pneumonia could be self-limiting, however, a percentage of children; particularly those younger than five years may develop complication due to virulence of the pathogen and/or host susceptibility.^{6,7} Complications have been notably increasing in all ages, and many of these complications often worsen pneumonia outcome.⁸ There are very few data highlighting pneumonia complications and the associated factors particularly among children in south-western Nigeria. This study, therefore, aims to determine the pattern of pneumonia complications and its associated factors among children aged 1 - 60 months with clinical and radiologically confirmed pneumonia in Osogbo, south-western Nigeria.

Materials and Methods

Ethics: Study was in conformity with the Helsinki Declaration of 1975 (as amended). Institutional ethical clearance was obtained from the Ethics and Research Committee with protocol number LTH/REC/2015/08/13/211. Written informed consent was obtained from the parent/caregiver of each participant after providing necessary details about the research. All the patients' information was handled confidentially. All principles governing ethical conducts were adhered to. Subjects did not experience any harm by virtue of their participation in the study.

Study design

This is a prospective observational study conducted at the children emergency unit (CEU) of Ladoke Akintola University of Technology (LAUTECH) Teaching Hospital Osogbo, Osun state, Nigeria. Subjects were consecutive children aged between 1 - 60 months with both clinical and radiological pneumonia, admitted to the CEU and whose caregiver gave informed consent.

Children with wheeze and cough suggestive of bronchial asthma or bronchiolitis, a cough lasting more than two weeks or any feature suggestive of pulmonary tuberculosis, heart murmurs or cyanosis suggestive of heart disease and severe anaemia (venous haematocrit ≥ 15 percent) were excluded from the study.

Sample size determination

Since the total population of children admitted at the CEU is less than 10,000, the sample size for the study was obtained using the formula:^{19]}

$$n = \frac{Z^2 P Q}{D^2}$$

nf (minimum sample size) = $n / 1 + (n / N)$

The minimum sample size was determined to be 110, at 95 percent confidence level using a prevalence of 8.7% percent,¹⁰ obtained from a previous study.

A total of 129 participants were recruited for this study over a nine month period (February 2017 to October 2017). The demographic characteristics, clinical presentation, examination findings and complications were documented. The clinical diagnosis of pneumonia was made based on history of cough and/or difficult breathing, fast breathing and/ or chest wall in-drawing with or without fever.⁴ Additional signs sought for include auscultatory findings of at least one of the followings: reduced breath sound intensity, bronchial breath sound or crepitation.⁷ Plain chest radiographs (anteroposterior view) were obtained within 24 hours of admission after stabilizing the patients. Plain chest radiograph was done to confirm the diagnosis of pneumonia and to detect associated complications. Radiologic findings were appropriately interpreted and reports were validated by a consultant radiologist.¹¹ The demographic characteristics, clinical presentation, examination findings and complications were documented. Socioeconomic classification of the participants was done according to the method described by Oyediji.¹² The hemoglobin oxygen saturation (SPO₂) of all the participants were recorded at admission. The SPO₂ was measured with a Paediatrics finger pulse oximeter (Merlin M-pulse, N100471, UK). The index finger of the patient's right hand was used to take the SPO₂ measurement. Hypoxaemia was defined as SPO₂ value < 90 percent in line with standard recommendation.⁶ Anemia was defined as hematocrit value < 30 percent.¹³ Pleural (parapneumonic) effusion or empyema appears as a generalized homogenous density obliterating the normal markings of the underlying lung on chest radiograph.¹⁴ The diagnosis of heart failure was made clinically when at least three out of the four diagnostic criteria outlined below was present.¹⁵

1. Significant tachycardia (>160 beats/ minute in those aged < 1 year, >140 beats/ minute in those aged 1- 2 years, >120 beats/ minute in those aged 3- 4 years, > 100 beats/ minute in those aged 5 years.)
2. Significant tachypnoea for age (> 60 cycles/ minute for children aged 1 month, > 50 cycles/ minute in those aged 2 - 11 months, > 40 cycles/ minute in those aged 12 - 60 months).
3. Cardiomegaly (defined in children less than five

years as apex beat located lateral to the fourth left intercostal space in the mid-clavicular line while the trachea is central) or cardio-thoracic ratio > 0.6 in infants and > 0.5 in older children).

4. Soft tender hepatomegaly of at least three centimeters below the right costal margin

The results of laboratory investigations were also recorded. Patients with complications were appropriately managed. Antibiotics were given according to the hospital protocol. Antibiotics were changed to oral and patient considered for discharge when there was no complication, no fever for at least 48 hours, no tachypnea, and oxygen saturation was 95 percent and above.

Statistical analysis

The data was analyzed using Statistical Package for Social Sciences (SPSS) version 20.0 (SPSS Chicago Inc., IL, U.S.A). Means and standard deviations (SD) were determined for continuous variables. The association between pneumonia complications and independent variables such as age and gender were determined using Chi-square test. The effect of pneumonia complication on the outcome of illness was also tested using chi-square test. Level of significance for all tests was set at $p < 0.05$ at 95% confidence interval.

Results

Subjects' age, gender and parental social class

Of the 129 subjects, 78 (60.5%) were males and 51 (39.5%) were females, giving a male to female ratio (M: F) of 1.5: 1. Their mean (SD) age was 21.6 (16.5) months. Median (IQR) age was 17.0 (23.0) months. Fifty-nine (45.7%) subjects belong to the middle class (class III). (Table 1)

Table 1: Socio-demographic distribution of the subjects by age grouping, gender and social class

Socio-demographic characteristics	Frequency (n) = 129	Percentages (%)
<i>Age (in month)</i>		
1 – 24	81	62.8
25 – 60	48	37.2
<i>Gender</i>		
Male	78	60.5
Female	51	39.5
<i>Social Class</i>		
I	8	6.2
II	25	19.4
III	59	45.7
IV	35	27.1
V	2	1.6

Presenting symptoms in the participants

The respiratory symptoms among the subjects were predominantly cough, difficulty with breathing, fever and nasal discharge. One hundred and twenty-five subjects (96.9%) had cough, followed by difficulty with breath-

ing which was reported in 115 (89.1%), fever in 107 (82.9%), nasal discharge in 53 (41.9%), and chest pain in 10 (7.8%).

Complications of Pneumonia in the participants

Seventy (54.3%) of the subjects had complications. Commonest complications at presentation were congestive heart failure in 54 (41.9%), anemia in 25 (19.4%) and pleural effusion in 10 (7.8%). (Table 2)

Forty-nine (38.0%) of the 129 subjects were hypoxaemic ($\text{SPO}_2 < 90$ percent) at presentation.

Table 2: Complications of pneumonia, presence of hypoxaemia, duration of hospital stay and outcome of illness in the participants

Variables	Frequency (n)	Percentages (%)
n = 129		
<i>Complication*</i>		
1. Heart failure	54	41.9
2. Anaemia	25	19.4
3. Pleural (parapneumonic) effusion	10	7.8
4. Empyema thoracis	4	5.7
5. Pneumatocele	3	3.1
6. Pneumothorax	1	0.8
7. Meningitis	2	1.6
8. Febrile convulsion	2	1.6
<i>Presence of hypoxaemia</i>		
Yes	49	38.0
No	80	62.0
<i>Duration of stay</i>		
5 days	90	69.8
>5 days	39	30.2
<i>Outcome</i>		
Survived	116	89.9
Dead	13	10.1

*Some subjects had multiple complications

Association between age and gender of patients and the presence of complication

Fifty-one (72.9%) of the 70 participants with complications were less than 24 months. This relationship was statistically significant ($X^2 = 6.638$, $p = 0.010$). Forty-one (58.6%) of the 70 subjects with complications were male, though this was not at statistical significant level ($X^2 = 0.230$, $p = 0.632$).

Association between pneumonia complication and presence of hypoxaemia

Forty (57.1%) of the 70 patients with complications had associated hypoxaemia at presentation compared to 9 (15.3%) of 59 patients without complication ($X^2 = 23.848$, $p < 0.001$). Among the pneumonia complications, heart failure and anemia were significantly associated with hypoxaemia ($p < 0.001$ and 0.039 respectively). (Table 3)

Table 3: Pneumonia complications and presence of hypoxaemia

Complications*	Presence of hypoxaemia		Test statistics	p-value
	Yes n= 49	No n= 80		
Heart failure	30 (55.6)	24 (44.4)	2 = 12.173	<0.001
Parapneumonic effusion	5 (50.0)	5 (50.0)	Fisher's Exact Test	0.312
Empyema thoracis	3 (75.0)	1 (25.0)	Fisher's Exact Test	0.153
Pneumatocele	3 (6.1)	0 (0.0)	Fisher's Exact Test	0.053
Pneumothorax	0 (0.0)	1 (100.0)	Fisher's Exact Test	0.620
Anaemia	14 (56.0)	11 (44.0)	2 = 4.273	0.039
Meningitis	1 (50.0)	1 (50.0)	Fisher's Exact Test	0.617
Convulsion	2 (100.0)	0 (0.0)	Fisher's Exact Test	0.142

*Multiple complications apply $X^2 = \text{chi-square}$

Pneumonia complication and duration of hospital stay and outcome of illness

Majority (87.2%) of the participants who stayed beyond 5 days on admission were those with complications. There was a statistically significant association between complication and duration of hospital stay ($X^2 = 24.404$, $p < 0.001$).

Fifty-seven (81.4%) of the 70 subjects with complicated pneumonia were discharged. All the subjects who died had complications. There was a statistical significant association between pneumonia complication and outcome of illness ($X^2 = 24.404$, $p < 0.001$). (Table 4)

Table 4: Complication and duration of hospital stay and outcome of illness

	With complication n= 70 n (%)	Without complication n= 59 n (%)	Total n (%)	Test statistics	p-value
<i>Hospital stay</i>					
5 days	36 (40.0)	54 (60.0)	90 (100)	2 =	<0.001
>5 days	34 (87.2)	5 (12.8)	39 (100)	24.404	
<i>Outcome</i>					
Discharge	57 (81.4)	59 (100.0)	116 (100.0)	2 =	<0.001
Death	13 (18.6)	0 (0.0)	0 (0.0)	12.185	

Discussion

Pneumonia continues to be a significant cause of morbidity in hospitalized children. More than half of the study participants presented with pneumonia complications. This is a reflection that many children with pneumonia still present with complication in the developing countries. This could be an evidence of poor/ delayed utilization of health facilities and/or host susceptibility. Social factors have been identified as a reason why children with pneumonia present with complication.¹⁶ Factor such as low family income increases the risk of developing severe pneumonia.¹⁶ Although this present study did not look out for the factors responsible for

development of complication, an earlier study had shown that factors such as age of the child, access to adequate health care and socioeconomic status (low maternal education and low family income) have an influence on the development of complicated pneumonia.¹⁶ In this study, more boys had pneumonia. This is in agreement with previous studies.^{5,17,18} There was no significant difference regarding gender and the development of complicated pneumonia. The reason for this observation may not be known with certainty. Children less than 24 months had higher frequency of complication (63.0%). This age group also represent majority with community acquired pneumonia. This finding is consistent with other studies in Nigeria.^{17,18} There was a statistical significant association between age and presence of complication ($p = 0.010$). This relationship may be because younger children have narrower airway or due to immaturity of the defense mechanism of the airway which increases their susceptibility to infection.

Heart failure was the commonest acute complication observed in this study. Pleural (parapneumonic) effusion, empyema, pneumatoceles and pneumothorax were recorded in few subjects. Co-existence of heart failure and pneumonia has been reported commonly among children.^{19,20} The frequency of heart failure in this study is 41.9% comparable to previous Nigerian study by Sadoh *et al*¹⁹ who obtained estimates of 39.4%. Our value is slightly higher than kuti *et al*¹⁷ who reported a frequency of 33.3%. The high frequency of heart failure in the present study may be a reflection of the severe pneumonia seen in our participants. In pneumonia, heart failure often develops as a result of hypoxaemia and/ or hypoxia at the tissue level. This results to peripheral vasodilation and tachycardia. There is an increase in myocardial oxygen demand despite low oxygenation, and this eventually leads to cardiac failure due to the stress placed on the heart by hypoxia.^{21,22} The possibility of the direct spread of the infective organism from the lungs to the heart resulting into myocarditis with eventual cardiac decompensation and failure have also been reported.²² Heart failure has been noted by previous researchers as the most common non-respiratory complication of acute lower respiratory tract infection.^{15,19,22} Some subjects with heart failure also had anemia. The co-existing anemia may further worsen the effect of hypoxaemia on the myocardium thereby worsening the heart failure.

In this study, anemia was observed frequently even in those without obvious risk factor, this was present in 19.4% of the subjects. This finding is comparable to a frequency of 22.2% reported by Kuti *et al*,¹⁷ in an earlier study among children with pneumonia. Similarly, Yagou Ide,²³ reported the frequency of anemia as 22.4%, among children with pneumonia in south-east Nigeria. The cause of the anemia in these subjects with pneumonia may be multifactorial; may therefore not be explained by pneumonia alone. Generally, anemia is common among children in developing countries, the baseline hematocrits of the patients before the development of pneumonia were not known. The role of nutritional

status and other infections including parasitic infections could not be completely ruled out to create a borderline hematocrit (anemia). The borderline anemia may be worsened by the effect of inflammatory cytokines and/ or red cell destruction by the infective organism causing pneumonia.²⁴

Parapneumonic effusion was reported in 7.8% of the children with pneumonia in this study. This value compares with 8.0% reported by kuti *et al*,¹⁷ in Ilesa, south west Nigeria. The value obtained in the present study is however higher than 3% reported by Abdulkarim *et al*¹⁸ among children with pneumonia in Ilorin, North Central Nigeria. These disparities may be due to the difference in the study population. The present study was conducted among children aged less than five years while the latter included children up to age 14 years. Previous reports have shown that highest percentage of parapneumonic effusion were in children younger than five years.^{25,26} Pleural effusion in pneumonia usually result from the spread of infection and inflammation to the pleural, with subsequent leakage of proteinaceous fluid into the pleural space.¹⁴ Empyema thoracis, pneumothorax and pneumatoceles are also not frequently observed complications. This is in agreement with earlier studies.^{17,18,21} The convulsion observed in a patient in this study may be due to acute encephalopathy from hypoxaemia and/or fever. The low prevalence reported is similar to findings of Mustapha *et al*.²⁰

More than half (57.1%) of the children who presented with complicated pneumonia were hypoxaemic at presentation. This may be because the patients presented with severe disease. The deranged or worsening pathological disturbances seen in pneumonia could result into decrease lung compliance and ventilation-perfusion mismatch (V/ Q) which may result in hypoxaemia.²⁷ Air-flow obstruction from respiratory tract secretions, and respiratory muscle fatigue also contributes to the hypoxaemic state. There is a statistical significant association between presence of complication and hypoxaemia and outcome of illness.

Previous reports estimate an average duration of 5-7 days for pneumonia treatment in children.^{29,30} Hospitalization is therefore regarded as prolonged when the duration of hospital stay exceed five days.³⁰ Presence of complications among other factors have been reported by previous researchers as a factor for prolonged hospitalization.^{28,29,31} The present study observed that children with pneumonia complications stayed longer in the hospital (>5 days). Complication represents deranged pathophysiologic process which may lower rate of clinical improvement as a result of alveolar hypoventilation, impaired gaseous exchange and ventilation-perfusion mismatch. We observed that hypoxaemia at presentation was significantly associated with prolonged hospital stay. This observation is comparable to reports from Abdulkarim *et al*.¹⁸ The reason for the prolonged hospital stay in our subjects were multifactorial; need for prolonged use of parenteral antibiotics and supplemental oxygen. Also, some of them required surgical

intervention (chest tube thoracotomy drainage).

In this study, despite presence of complications by majority at presentation, 81.4% of the children were discharged. Nevertheless, subjects with complication accounted for the high mortality recorded in childhood pneumonia.^{18,23} In this present study, case fatality rate of 10.1% was obtained, majority of whom died within 24 hours of hospitalization. Our case fatality rate compares with the rate of 10.0% reported by Kuti *et al*¹⁷ in Ilesa, 10.8% by Johnson *et al*²⁸ in Ilorin, Nigeria and 10.5% by Tiewsoh *et al*,²⁹ in Indian among children with pneumonia. The high mortality rate observed in the present study may be attributed to the fact that the study was conducted in a tertiary health facility where complicated cases are mostly seen. The present study demonstrated a

significant association between complicated pneumonia and death. This finding correlates with report from previous studies.^{5,20}

It is concluded that complications are common in childhood pneumonia at the time of presentation, with heart failure as the leading complication. Anemia also occurred frequently in the participants. Children with complication often present with hypoxaemia and these are common contributors to mortality in this environment. Particular attention should be given to the younger age group as they are at higher risk of having complications and death. Prompt identification and treatment of pneumonia complications at presentation in hospitalized patients may be one of the most pragmatic approaches to reducing the mortality rate.

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