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ABSTRACT

***Objective*: To evaluate heart failure in patients with pneumonia.**
***Setting*: The paediatric wards of a tertiary hospital in Nigeria.**
***Subjects:* One hundred and four patients were studied.**
***Results*: The mean age was 10.3 ± 11.0 months and 53(51.0%) were males. Of the 104, 41(39.4%) also had Congestive Cardiac Failure (CCF). All 41(100%) patients with CCF compared to 38 of 63(60.3%) with pneumonia only had cardiomegaly (p = 0.0001). Ten of 61(16.4%) patients with chest X ray had a cardiothoracic ratio (CTR) >60%. Ten children had dilated ventricular chambers, eight (80.0%) had dilated inferior vena cavae and seven (70%) had myocarditis.**
***Conclusion*: The prevalence of CCF complicating pneumonia was high. Tender hepatomegaly, increased CTR and myocarditis were pointers to CCF complicating pneumonia.**

INTRODUCTION

Pneumonia is one of the leading causes of childhood morbidity and mortality especially among children under five years of age globally (1). The World Health Organisation (WHO) estimates that pneumonia is responsible for 3.5 million deaths among under five years annually (2). In Nigeria, pneumonia is estimated to accounts for 20% of the under-five mortality (3). Pneumonia could be complicated by congestive heart failure (CCF), which is a major cause of childhood mortality and it is responsible for 5.3 – 11.5% of hospital admissions in Nigeria (4-6). Pneumonia is reported to be a significant cause of CCF in Nigerian children. The risk of mortality may increase when CCF complicates pneumonia.

Childhood pneumonia could be bronchopneumonia or lobar pneumonia. Bronchopneumonia is more common in the under five years of age. In pneumonia the inflammation of the alveoli and interalveolar septum causes exudation of fluid into the alveoli and oedema of the inter-alveolar septum. The resulting ventilation perfusion mismatch leads to hypoxia. Hypoxia causes pulmonary vascular vasoconstriction which raises the pulmonary arterial vascular pressure. The right side of the heart eventually fails when it cannot adequately pump against the pulmonary pressure (7). The resulting CCF worsens the illness, may lead to supplemental oxygen therapy and increased hospital stay and cost of treatment. CCF is even more likely to occur when there is underlying congenital heart disease with increased pulmonary blood flow such as ventricular septal defect (8). Pneumonia and pulmonary hypertension may also occur in children with the acquired immunodefficicency syndrome (AIDS) (9). AIDS is a common cause of immune deficiency in children south of the Sahara.

This study was carried out to describe the prevalence, clinico-radiologic characteristics of children with pneumonia complicated with CCF in comparison with children who had pneumonia without CCF.

MATERIALS AND METHODS

Consecutive patients presenting to the children's emergency room of a tertiary centre in Nigeria with pneumonia between March 2011 and February 2012 were recruited for the study. Pneumonia was diagnosed on typical history (fever, cough and difficult

breathing) physical findings and confirmed on chest radiographic findings of pneumonic infiltrates in either or both lung fields. The age, gender and socio-economic class (SEC) were documented. The SEC was determined using the method described by Olusanya *et al* (10). Each patient was clinically evaluated and the findings noted. The duration of admission and outcome were also noted. Ethical approval was given by the Ethics Committee of the UBTH

All the children were evaluated for heart failure by a senior registrar which was diagnosed when the patient fulfilled the clinical diagnostic criteria of heart failure outlined below (11).

1. Significant tachycardia for age (>160 beats/ minute in infancy, >140/minute at 2 years, >120/ minute at four years and >100/minute above six years.) Where fever was present, a 10/ minute for every 10° C rise in temperature was allowed for.
2. Significant tachypnoea for age(>60 cycles/ minute in the newborn, >40 cycles/ minute <24 months, 30 cycles/ minute in two to five years, >28 cycles/ minute in five to ten years and >25 cycles/ minute in >ten years)
3. Cardiomegaly (defined in <five years as apex beat located lateral to the fourth left intercostal space in the mid-clavicular line while the trachea is central. In five years, it was defined as apex beat located lateral to the fifth left intercostal space in the mid-clavicular line or cardiothoracic ratio >50%).
4. Tender hepatomegaly of at least three centimetres size below the right costal margin.

The fulfillment of at least three of the four criteria above was diagnostic of congestive heart failure.

The oxygen saturation was determined at presentation with a Konica Minolta, Pulsox 300 pulse oximeter. A full blood count and chest radiograph were done for each patient. The radiograph was read by the radiologist and the paediatric pulmonologist (WOO). Pneumonia was confirmed when both reports were positive. The cardiothoracic ratio was determined for each chest radiograph, any other abnormality was noted.

Children with congenital heart diseases and HIV infection/AIDS were excluded from the study. Congenital heart disease was diagnosed by echo-cardiographic screening of all the children with pneumonia, using an Aloka Prosound SSD 4000SV. All the echo-cardiograms were done by one of the authors WES. HIV infection was diagnosed by DNA PCR in children <18 months and by serology in those >18 months. HIV test was done for children with suggestive history and in children of mothers with positive HIV infection status. The patients with pneumonia were treated with antibiotics, those with heart failure had diuretics (frusemide). Digoxin was included when signs of heart failure did not resolve in forty eight hours.

Statistical analysis: The data were coded and entered into and analysed using SPSS 16 (Chicago IL). Simple proportions were represented in percentage. The means of continous variables were presented in mean standard deviation. The difference in means was tested by student t-test, comparison between proportions were done with $\chi 2$ or Fischer's exact test as appropriate. The level of significance was set at $p < 0.05$.

RESULTS

Characteristics of the study population: Over the study period, 121 patients had pneumonia, of these, 14 had underlying congenital heart disease and three had paediatric AIDS. The data of the remaining 104 children were analysed for the study. Of the 104 patients, there were 53 male (51.0%) and 51 female (49.0%). The patients' ages ranged from 1–48 months with a mean of 10.3 ± 11.0 months; median was six months. The mean age of the male patients 11.6 ± 12.1 months was not significantly higher than that of their female counterparts 9.1 ± 9.7 months, $p = 0.25$. Most of the patients, 77 of the 104(74.38%) were less than one year, the age group distribution of the patients is shown in Table 1. There were 47(45.2%) in the low socio-economic class (SEC), 32(30.8%) were in the middle SEC and 25(24.0%) in the high SEC. All the 104 patients had broncho-pneumonia.

Table 1
Age group distribution of the study population

Age group (mo)	Pneumonia (%)	Pneumonia + CCF (%)	Total (%)
<11	45(71.4)	32(78.0)	77(74.0)
12 – 23	10(15.9)	3(7.3)	13(12.5)
24 – 35	1(1.6)	4(9.8)	5(4.8)
≥36	7(1.1)	2(4.9)	9(8.7)
	63(60.6)	41(39.4)	104(100.00)

mo = months

Patients with pneumonia and congestive cardiac failure: Of the 104 children with pneumonia, 41 (39.4%) had congestive heart failure as well. The 41 children consisted of 22(53.7 %) male and 19(46.3 %) female. The mean age of the children with pneumonia and CCF was 9.4 ± 10.6 (range 1 – 42) months lower than the mean age of children with pneumonia only 10.9 ± 11.3 (range 1 – 48) months. P = 0.50 (Confidence interval (CI) = -5.94, 2.92).

Table 2

Gender and socio-economic class of the children with pneumonia and congestive heart failure

Characteristic	Pneumonia only (%)	Pneumonia + CCF (%)	P-value
Gender			
Males	31(49.2)	22(53.7)	0.197
Females	32(50.8)	19(46.3)	
Socioe-conomic class			
High	17(27.0)	8(19.5)	
Middle	18(28.6)	14(34.2)	0.655
Low	28(44.4)	19(46.3)	

Of the 41 patients 32(78.0%) were <12 months (Table I). Nineteen of the 41(46.3%) children with pneumonia and CCF were from the low SEC, the SEC distribution of the patients is shown in Table 2.

Clinical features of the study population: All the children in the study population, 104(100) had a cough, 88(84.6%) had fever. All the patients with pneumonia and CCF, 41(100.0) had tender hepatomegaly and crepitations in the lung fields compared to 38(60.3%) and 59(93.7%) respectively for hepatomegaly and crepitiations in children with pneumonia only, p = 0.0001 and 0.15. Only two out of forty one (4.9%) of children with pneumonia and CCF were clinically cyanosed while none of the children with pneumonia only were cyanosed.

Table 3

Some clinical features of the study population

Feature	Pneumonia (n=63) (%)	CCF(n=41) (%)	P-value	Confidence Interval
Cough	63(100.0)	41(100)		
Fever	53(84.1)	35(85.4)	1.00	-0.24 – 0.28
Cyanosis	0(0.0)	2(4.9)	0.15	0.51 – 0.71
Crepitations	59(93.7)	41(100.0)	<0.15	0.48 – 0.69
Hepatomegaly	38(60.3)	40(97.6)	<0.0001	0.40 – 0.64

The distribution of the other clinical features is shown in Table 3. The mean oxygen saturation of the patients with pneumonia only 95.6 ± 4.3(range; 85 -99) % was significantly higher than the p-value obtained from children with pneumonia and CCF 91.9 ± 8.1(range; 74 – 99) %, p = 0.003 (CI = -6.12, –1.28)

Laboratory and imaging findings of the study population: The mean PCV of patients with pneumonia only was 30.8 ± 6.1% was not significantly different from the 31.5 ± 6.5% in the patients with CCF and pneumonia, p = 0.518 (CI = -3.24, 1.64). The mean total white cell count in children with pneumonia only was 13,100 ± 6900 (range 4800 – 29,000) cell/u3 was lower than the value of 15,300 ± 14,520 (6800 – 50,300) cell/u3 obtained in patients with pneumonia and CCF, p = 0.603 (CI = -6749.0, 11349)

Of the 104 children studied, the cardio-thoracic ratio (CTR) was determined in 61(58.7%) patients. It was not measured in the others because of the presence of thymic shadow obscuring the cardiac silhouette. The mean CTR in the children with pneumonia only was 52.1 ± 5.6% was significantly lower than the p-value 57.4 ± 6.1 % obtained in children with pneumonia and CCF, p = 0.0002 (CI = 2.60, 7.89). There were ten (16.4%) patients with CTR >60%, of which nine (90%) had pneumonia and CCF while one (10%) had pneumonia only, p = 0.014.

The mean fractional shortening on echo-cardiography of the children with pneumonia only was 37.3 ± 2.5 (range; 31 – 41.2) % was significantly higher than the 34.0 ± 3.6 (range; 28.4 – 40) % obtained in children with pneumonia and CCF, p = 0.0001 (CI = -4.52, –2.16). Ten (9.6%) children (Nine with

pneumonia and CCF and one with pneumonia only) had dilated biventricular chambers and eight (80.0%) of the ten had dilated inferior vena cavae as well, the diagnosis of myocarditis was made in seven (70.0%) of the ten children who also had tachycardia ≥200 beats per minute and typical electro-cardiographic changes. Of the 41 patients with pneumonia and CCF, the CCF resolved in 39(95.1%) patients with diuretic only while two (4.9%) required addition of digoxin to manage their CCF. All the patients had antibiotics.

Duration of hospitalisation and outcome: The mean duration of admission for patients with pneumonia only was 7.28±5.62 (2–22) days it was shorter than the mean value in children with pneumonia and CCF 8.43 ±5.49 (2–28) days. The difference was not significant, p = 0.267 (CI = -0.89, 3.19). There were nine (8.7%) mortality recorded amongst the study population. The mortality among children with pneumonia and CCF 6/35 (17.1%) was not significantly higher than the value of 3/60 (0.05%) observed among those with pneumonia only, p = 0.15.

DISCUSSION

The proportion of children with pneumonia complicated by CCF (39.4%) in this study was high; this might be due to the fact that CCF was actively sought for in the study. It, however, underpins the importance of CCF as a complication of pneumonia. The proportion of children with pneumonia and CCF in this study was lower than the value of 72% obtained by Reshadat (12) in Iran, but higher than the 14% reported by a Turkish study (13). The higher value in the Iranian study may have been due to the study design in which pneumonia was diagnosed using clinical parameters only. It is possible that the similarity in clinical presentation of pneumonia and CCF may have led to the high number of children with CCF and pneumonia. The higher figure obtained in our study compared to the Turkish study may reflect a more severe illness occasioned by the late presentation. CCF is more likely to complicate a more severe pneumonia. Late presentation of our patients to orthodox health facilities have earlier been reported by other workers(14).

Pneumonia alone and pneumonia complicated by CCF was highest amongst infants in this study. This is consistent with previous reports on pneumonia and CCF studies (12,13,15). In the Iranian study the prevalence of CCF and pneumonia decreased with declining age (12). The higher proportion of infants with pneumonia complicated by CCF may reflect the greater susceptibility of their hearts to succumb to heart failure(16).

In the present study, pneumonia presented without fever clinically, the absence of fever should not exclude pneumonia, since most settings in developing countries may not have access to X ray facilities and would thus have to rely on clinical diagnosis as recommended by WHO (17). The absence of fever in this study may be due to prior antibiotic administration before presentation, indiscriminate purchase over the counter of antibiotics is a common practice in the study locale (18). It is important to note also that the presence of tender hepatomegaly was almost a consistent finding in children with pneumonia and CCF in this study. The systemic congestion in CCF that manifests in children as hepatic congestion may have led to this finding. The significantly lower oxygen saturation in children with pneumonia and CCF compared to children with pneumonia only may be due to the effects of pneumonia and pulmonary oedema arising from CCF on the ventilation perfusion mismatch and resulting in reduced levels of saturation (19). It is worthy of note that the use of pulse oximeters in identifying significant hypoxaemia is very important as only two children were identified to be clinically cyanosed whereas, oxygen saturation readings suggest many more children had hypoxaemia. Hypoxaemia is a risk for mortality in children with pneumonia (20).

It is not clear why the mean WBC of the children with pneumonia and CCF was higher than in those with pneumonia only. It is possible that infection contributes to the causation of CCF in patients with pneumonia as has earlier been alluded to (21). Thus children with more severe infection may be more prone to having CCF. The higher CTR in children who had pneumonia and CCF compared to those with pneumonia only suggests the development of cardiac dilatation in children with CCF. However, in a previous study on pneumonia and CCF amongst Papua New Guinean children, mostly right ventricular hypertrophy was observed in some children (22). The cardiomegaly in the present study represents ventricular failure due to possible myocarditis, which has been reported to occur in children with pneumonia (13). This may also be the reason why more patients in the pneumonia and CCF group were observed to have CTR >60% compared to the pneumonia only group.

The failing heart is unable to pump well resulting in significantly lower fractional shortening obtained on echo-cardiography among children with pneumonia and heart failure when compared to the children with pneumonia only. Reduced fractional shortening is known to be associated with heart failure (23). However, none of the patients in the study had reduced contractility as has earlier been noted in the New Guinean study (22). The mortality recorded in this study was mostly among children with pneumonia and CCF, buttressing the contribution of CCF to mortality when it complicates pneumonia.

In this study, there was no significant difference in SEC between the two groups. We had expected

that more children from the low SEC would have pneumonia and CCF because they are more likely to present late and, therefore, have more severe pneumonia that may be complicated with CCF. We acknowledge limitation in this study; the diagnosis of heart failure was made on clinical grounds only. There is a tendency to over-diagnose heart failure in children with pneumonia clinically because of the similarity in presentation of the two conditions.

In conclusion, the prevalence of CCF complicating pneumonia in this study is high, tender hepatomegaly, elevated total WBC counts and CTR may be important features more commonly seen in children with pneumonia complicated by CCF. Myocaridits may also play an important role in development of CCF in children with pneumonia. We, therefore, recommend that in children with pneumonia, the presence of hepatomegaly and cardiomegaly strongly suggest heart failure.

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