Risk factors for parapneumonic effusions among children admitted with community-acquired pneumonia at a tertiary hospital in south-west Nigeria

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Abstract

Parapneumonic effusions in children with community-acquired pneumonia (CAP) often prolong the period of ill-health and may be associated with increased mortality. This study set out to determine the patterns, risk factors, aetiology, and outcome of parapneumonic effusions among children admitted with CAP at a tertiary health facility in south-west Nigeria.

All cases of childhood pneumonia, including those with parapneumonic effusions, were retrospectively studied over a 3-year period by looking at hospital records. Relevant study variables were compared in the children with and without parapneumonic effusions. Multivariate regression analysis was used to determine the independent determinants of the presence of effusions among the children and the diagnostic accuracy of these determinants was assessed.

The hospital incidence of parapneumonic effusions during the study period was 19 per 1000 admissions; with parapneumonic effusions seen in 8.0% of the cases of childhood pneumonia. The majority (85.7%) of these children were infants and Staphylococcus aureus was the predominate isolate from the pleural fluid. Infancy, late presentation, inadequate immunisation, pre-admission antibiotic use, signs of severe disease (grunting, head nodding, heart failure, and cyanosis) as well as concurrent measles infection, were significantly associated with parapneumonic effusions ($p<0.05$). Only late presentation independently predicts the presence of effusions (odds ratio (OR) = 3.821; 95% confidence interval (CI) = 1.614–6.925; $p=0.007$, area under the curve (AUC) = 0.635). Late presentation and delayed treatment of childhood CAP is an important risk factor for the development of parapneumonic effusions.

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Introduction

Childhood pneumonia is a leading cause of ill-health and death among children under 5 years of age, particularly in resource-constrained parts of the world.1 It has been estimated that about 10% of children with community-acquired pneumonia (CAP) will require hospitalisation, often because of complications requiring specific treatment and close monitoring.[1] One of these complications is parapneumonic effusion.[2]

Parapneumonic pleural effusions occur when an inflammatory response to pneumonia causes an increase in the permeability of the pleurae with accumulation of fluid in the pleural space.[3] This often occurs as a consequence of increased capillary permeability associated with parenchymal injury which favours the migration of inflammatory cells into the pleural space. Three stages of evolution have been described for parapneumonic pleural effusions. The early exudative stage (stage I) usually lasts 3–5 days and is characterised by the presence of sterile effusions. The fibrinopurulent stage (stage II) occurs 7–10 days after the outset of the illness with eventual pus formation and deposition of fibrin on both visceral and parietal pleurae. The last (organising) stage takes place after about 2–3 weeks of illness and is characterised by thickened and non-elastic intrapleural membranes and poor lung compliance.[3]

In developed countries, small often clinically insignificant pleural effusions have been reported in up to 10–40% of bacterial pneumonia cases while empyema develops as a complication of bacterial pneumonia in 0.6–3% of hospital admissions.[4,5] In developing countries however, there is a dearth of data on both the occurrence of parapneumonic effusions among children with CAP and the actors that predispose them to developing parapneumonic effusions. The failure to recognise the presence of parapneumonic effusions in children with pneumonia may delay recovery, prolong length of hospital stay, and even result in fatal outcomes.[6] The situation may be even worse in centres without adequately trained personnel and basic investigative facilities.[7] This study therefore set out to determine the pattern of presentation and the factors that predispose children with pneumonia to developing parapneumonic pleural effusions, as well

as the hospital outcome for these children managed at the Wesley Guild Hospital, Ilesa, south-west Nigeria. These factors may assist health workers in resource-constrained centres in recognising children who are more likely to have parapneumonic effusions, so that they can receive more appropriate management and/or referral.

Method

The currents study was a retrospective observational study conducted in the paediatric wards of the Wesley Guild Hospital (WGH), Ilesa. 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 paediatric care for these communities. The paediatric department of the hospital admits about 1200 children per annum.

The hospital has four paediatric wards with total beds/cots of 80; 32 of these are for newborns. Children with pneumonia and its complications are managed at the children's isolation ward which has 7 cubicles, each with 4 beds/cots. The case notes of the children managed for parapneumonic effusions are kept in the unit's medical records department and are filed using the International Classifications of Diseases (ICD 10) coding system to facilitate file retrieval when the need arises.

The study participants were children aged 1 month–15 years, managed for pneumonia over a 3-year period from January 2011 to December 2013. A diagnosis of pneumonia was based on clinical findings of age-specific tachypnoea, cough, and evidence of respiratory distress, reduced or absent breath sounds, bronchial breath sound or coarse crepitations with or without significant radiological findings to suggest radiologic pneumonia.

Parapneumonic effusion was defined based on radiological evidence of fluid collection in the pleural space (i.e. obliteration of the costophrenic angles or as a layer of fluid adjacent to the lateral chest wall)[8] with positive free-flowing yield on percutaneous pleural aspiration. Children with pleural effusions from malignancy, renal pathology, and other non-pneumonic causes including tuberculous effusions were excluded.

The study variables of interest included the sex, age, maternal age, and parental socio-economic class calculated based on average of parental occupation and highest educational qualification (as described by Oyedeji[9]). The number of persons co-habiting with the child was recorded and overcrowding was defined as having three or more persons sleeping in the same room with the child.[10] The immunisation status of the child as well as the presenting symptoms and their duration were noted. Other associated illnesses such as gastroenteritis and measles were documented. The treatment received before presentation was also noted. The relevant examination findings such as grunting and cyanosis, as well as the nutritional status of the study participants, were also noted. Heart failure was defined as the presence of tachypnoea, tachycardia with a third heart sound (gallop rhythm), and enlarged tender liver. Presentation after 7 days of illness was termed 'late presentation'.

All the children had a chest radiograph at admission which was read by the hospital radiologist. Results of the packed cell volume (PCV) and blood culture and sensitivity, as well as pleural aspirate culture and sensitivity, were noted. Anaemia was defined in this study as a PCV of less than 30%.[11] The children were managed as per the unit's protocol. All the children had antibiotics and fluid, and calorie maintenance was ensured. Thoracocentesis was carried out and/or a thoracostomy tube was inserted in patients for whom it was indicated; other complications such as heart failure and hypoxaemia were appropriately treated. The outcome and duration of hospitalisation was noted.

The outcome variable for this study was the presence of parapneumonic effusions among the children admitted with CAP.

Ethical clearance to carry out this work was obtained from the physician in charge of the Wesley Guild Hospital, Ilesa.

Data analysis was performed using the Statistical Programme for Social Sciences (SPSS) software, version 17.0 (SPSS Inc standard version 2010). Means, standard deviations (SD), median, and interquartile range (IQR) were calculated for normally and non-normally distributed continuous variables respectively. Categorical variables were summarised using proportions and percentages.

The differences between categorical variables were analysed using Pearson's χ^2 test and Fisher's exact test as appropriate (with Yate's correction where applicable), while differences between continuous variables were analysed using Student's t-test (for normally distributed continuous variables) and the Mann–Whitney U-test (for non-normally distributed variables). The level of significance at 95% confidence interval (CI) was taken as $p<0.05$.

The association between dependent (parapneumonic effusions) and independent variables (study variables) was assessed using multivariate logistic analysis to determine their independent effect on the outcome. The diagnostic accuracy of the study variables in detecting parapneumonic effusions was further assessed using sensitivity, specificity, and determination of the area under the receiver operating characteristic (ROC) curve (AUC). Results were interpreted with odds ratios (OR) and 95% CI. Statistical significance was established when the CI did not include unity.

Results

Over a 3-year study period (January 2011 to December 2013), a total of 1470 children outside the neonatal period were admitted; of these, 352 (23.9%) had pneumonia. Of the 352 children with pneumonia, 28 (8.0%) had parapneumonic effusions and 324 (92.0%) had no effusion.

Socio-demographic and general characteristics of the children with parapneumonic effusions

The ages of the children with effusions ranged from 5.0 to 144 months with a median (IQR) of 16 (12.0–36.0) months. The majority (85.7%) of the children with effusions were infants. There was a male preponderance, with a male to female ratio of 1.8:1 (Table 1).

Socio-demographic variables	Pneumonia with effusion n=28 (%)	Pneumonia without effusion n=324 (%)	Total	χ^2	*p*-value
Sex					
Male	18 (64.3)	194 (60.2)	212	0.176	0.675
Female	10 (35.7)	128 (39.8)	138	0.176	0.675
Age range (months)					
1-12	24 (85.7)	204 (63.0)	228	4.892	0.027
13 - 59	4 (14.3)	93 (28.7)	97	2.010	0.156*
> 60	0 (0.0)	27 (8.3)	27	1.487	0.223*
Median (IQR) age	16 (12.0-36.0)	12 (12.0-24.0)		846.500^	0.178
Maternal age (years)					
Less than 20	1 (3.6)	9 (2.8)	10	0.000	1.000*
20 -35	22 (78.5)	217 (67.0)	239	1.590	0.207
Greater than 35	5 (17.9)	98 (30.2)	103	1.368	0.244
Mean (SD) age	30 (5.9)	29.6 (5.4)		0.370#	0.709
Maternal education					
No formal education	2 (7.1)	7 (2.2)	9	2.568	0.109*
Primary	3 (10.7)	40 (12.3)	43	0.000	1.000*
Secondary	21 (75.0)	215 (66.4)	236	0.871	0.351
Post secondary	2 (7.1)	62 (17.9)	64	1.751	0.186*
Parental social class					
Upper (Class I and II)	1 (3.6)	34 (10.7)	35	0.714	0.398*
Middle (Class 3)	18 (64.3)	156 (48.1)	174	2.685	0.101
Lower (Class IV and V)	9 (32.1)	134 (44.2)	143	0.907	0.341
Parity					
Primipara	4 (14.3)	56 (17.3)	60	0.020	0.886*
Multipara	20 (71.4)	220 (62.5)	240	0.148	0.701
Grand multipara	4 (14.3)	48 (13.8)	52	0.000	1.000*
Overcrowding	10 (35.7)	106 (30.1)	116	0.105	0.746
Not appropriately immunised	12 (42.9)	73 (25.8)	85	5.813	0.016
Not exclusively breastfed	9 (32.1)	82 (25.3)	91	0.478	0.489
Pre-admission antibiotic use	8 (28.6)	39 (12.3)	47	6.090	0.014

*Fisher test applied; ^ Mann Whitney U test applied; # independent t-test applied;
The figures in parentheses are percentages of the total in each column.

Table 1 Socio-demographic characteristics and general information of the children with pneumonia with or without effusions

The mean (SD) age of the mothers with children having parapneumonic effusions was 30 (5.9) years. This ranged from 17 to 50 years. The majority (75.0%) of the mothers of these children were formally educated up to secondary school level, while only two (7.1%) of the mothers had no formal education.

Eighteen (64.3%) of the children with effusion were from the middle social class, with their parents being artisans or traders. Only one child (3.6%) was from the upper socioeconomic class. Ten (35.7%) of the children with effusion lived in overcrowded homes, while about one-third of the children were not exclusively breastfed. Other characteristics of the children are highlighted in Table 1.

Clinical manifestations of the children with parapneumonic effusions

About two-thirds of the children with parapneumonic effusions had fever at presentation, including two children (7.1%) with hyperpyrexia; 28.5% of the children had no fever at presentation.

The effusions were located on the right pleural space in 19 (67.8%), on the left in 7 (25.0%) and were bilateral in 2 (7.1%) of the children. The effusions were purulent (empyema thoracis) in 15 (53.6%) and serous or sero-sanguinous in 10 (35.7%) of the children; there was pyopneumothorax in 3 (10.7%) of the children.

About two-thirds of the children with parapneumonic effusions presented with grunting respiration (64.3%) and features of congestive cardiac failure (67.9%), while 21.4% of them had underlying measles infection. The other presenting features and associated problems are presented in Table 2. *Staphylococcus aureus* was the predominant organism isolated from the pleural aspirate samples of the children with effusions (19 (67.9%) children). The other organisms isolated included *Streptococcus pneumoniae* and *Klebsiella* spp. The organisms isolated from the cultures of the pleural aspirates as well as the antibiotic sensitivities are highlighted in Table 3. Three (10.7%) of the 28 children with parapneumonic effusions had a bacterial isolate from a blood culture and all yielded *Staphylococcus aureus* with a sensitivity pattern shown in Table 3; 25 (89.3%) of the children were managed with chest tube drainage, while 3 (10.7%) had thoracocentesis to drain the fluid.

The mean (SD) hospital stay of the children with effusions was 9.5 (5.5) days (range, 1–27 days). The majority (85.7%) of the children were discharged home well while 4 (14.3%) of the children with parapneumonic effusions died (Table 4).

Risk factors for developing parapneumonic effusions among children with pneumonia

There was no significant difference in the median ages of the children with or without parapneumonic effusions (Mann–Whitney U test=846.500; p=0.178). However, more infants were admitted with parapneumonic effusions compared with the other age groups (24 (10.5%) of the 228 infants had parapneumonic effusions compared with 4 (3.5%) of the remaining 114 children older than 1 year (χ^2=4.892; p=0.027; df=1)). In addition, inappropriate immunisation among the children with pneumonia (14.1% vs. 6.0%; χ^2=5.813; p=0.016; df=1) as well as pre-admission use of antibiotics (17.0% vs. 6.6%; χ^2=6.090; p=0.014; df=1) were significantly associated with the occurrence of parapneumonic effusions.

Although a greater proportion of male children admitted with pneumonia had effusions compared with their female counterparts, the difference was not significant (p=0.675). Likewise, there was no significant association between maternal age, parity, level of education, and parental socioeconomic class and the presence of parapneumonic effusions among the children admitted with pneumonia (Table 1).

Late presentation was significantly associated with parapneumonic effusions: 7 (21.2%) of the 33 children who presented after 1 week of illness had effusions, compared to 21 (6.6%) of the remaining 319 children who presented at less than 1 week of illness (χ^2=8.741; p=0.003; df=1). In addition, the mean (SD) duration of symptoms before hospital admission was significantly higher among children with pneumonia who had effusions compared with those without effusions (7.0 (5.2) vs. 4.4 (3.2) days; t-test=3.890; p<0.001; Table 2).

Grunting respiration at presented was more often associated with the presence of parapneumonic effusions: 18 (21.7%) of the 83 children with grunting had parapneumonic effusions compared with 23 (7.0%) of the remaining 328 children with no grunting (χ^2 =27.972; p<0.001). Likewise, head nodding (20.8% vs. 7.0%; χ^2=4.314; p=0.038; df=1) and cyanosis at presentation (33.3% vs. 6.4%; χ^2=10.400; p=0.001; df=1) as well as concurrent measles infection (33.3% vs. 6.6%; χ^2=16.688; p<0.001) and heart failure (16.4% vs. 3.7%; χ^2=16.772; p<0.001) were more frequently associated with the presence of parapneumonic effusions. Although a higher proportion of the children with parapneumonic effusions had anaemia, gastroenteritis, and bacteraemia compared with those without effusions, the difference was not significant (p>0.05; Table 2).

The children whose pneumonia was complicated with parapneumonic pleural effusions stayed longer in the hospital compared with those without effusions (9.1 (5.5) vs. 4.6 (3.8) days; t-test=5.770; p<0.001). A higher proportion of children with parapneumonic effusions died compared with those without effusions. The difference, however, was not statistically significant (14.3% vs. 10.8%; χ^2=0.062; p=0.803; Table 4).

The factors found to be significantly associated with the presence of parapneumonic effusions using univariate analysis (Tables 3 to 5) were subjected to stepwise multivariate regression analysis. Only late presentation (OR=3.820; 95% CI 1.614–2.925; p=0.007) was an independent predictor of parapneumonic effu-

Clinical features	Pneumonia with effusion n=28 (%)	Pneumonia without effusion n=324 (%)	Total	χ^2	*p*-value
Duration of symptoms before presentation					
< 1 week	21 (75.0)	298 (92.0)	319	8.741	**0.003**
> 1 week	7 (25.0)	26 (8.0)	33	8.741	**0.003**
Mean (SD) duration	7.0 (5.2)	4.4 (3.2)		3.890#	**0.000**
Temperature at presentation					
Hypothermia	0 (0.0)	1 (0.3)	1	0.000	1.000*
Subnormal	1 (3.5)	6 (1.9)	7	0.051	0.822*
Normal	7 (25.0)	63 (19.4)	70	0.499	0.480
Fever	18 (64.3)	245 (75.6)	263	1.752	0.186
Hyperpyrexia	2 (7.1)	9 (2.7)	11	1.622	0.203*
Other features					
Grunting	18 (64.3)	65 (20.1)	83	27.972	**0.000**
Head nodding	5 (17.8)	19 (5.9)	24	4.314	**0.038**
Cyanosis	5 (17.8)	10 (3.1)	15	10.400	**0.001****
Oedema	0 (0.0)	4 (1.2)	4	0.000	1.000*
Associated problems					
Measles	6 (21.4)	12 (3.7)	18	16.688	**0.000****
Anaemia	9 (32.1)	71 (21.9)	80	1.538	0.215
Heart failure	19 (67.9)	97 (29.9)	116	16.772	**0.000**
Gastroenteritis	4 (14.3)	38 (11.7)	42	0.001	0.971
Pneumothorax	1 (3.6)	4 (1.2)	5	0.029	0.865*
Cardiomegaly	2 (7.1)	10 (3.1)	12	0.351	0.554*
Bacteraemia	3 (10.7)	17 (5.2)	20	0.598	0.438*
Mean (SD) hospital stay	9.1 (5.5) days	4.6 (3.8) days		5.770	**0.000#**

Independent t test applied; * Fisher test applied; ** Yates correction applied. The figures in parentheses are percentages of the total in each column; figures in bold indicate statisical significant

Table 2 Clinical features of the children admitted with pneumonia with or without effusions

sions among the children with pneumonia (Table 5).

The sensitivity and specificity of duration of symptoms before presentation in excess of 1 week in predicting the presence of parapneumonic effusions among the children admitted with pneumonia were 25.0% and 92.0% respectively; while the predictive values were 21.3% and 93.4% for positive and negative values. The AUC was 0.635 (95% CI 0.508– 0.763) (see Table 6 and Figure 1).

Organism	No.	PEN	AMP	CLOX	CIPR	CETR	CPC	GENT	ERYT	CEFU
S. aureus	19	10 (52.6)	10 (52.6)	14 (73.9)	18 (94.7)	15 (78.9)	12 (63.2)	12 (63.2)	12 (63.2)	18 (94.7)
S. pneumoniae	2	1 (50.0)	1(50.0)	1(50.0)	2 (100.0)	2 (100.0)	1 (50.0)	1 (50.0)	1 (50.0)	2 (100.0)
Klebsiella	2	0 (0.0)	0 (0.0)	0 (0.0)	2 (100.0)	2 (100.0)	1 (50.0)	2 (100.0)	1(50.0)	2 (100.0)
E.coli	1	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	1 (100.0)	1 (100.0)	1 (100.0)	1 (100.0)	1 (100.0)
No growth	4									

PEN = Penicillin; AMP = Ampicillin; CLOX = Cloxacillin; CETRI = ceftriaxone; CPC = chloramphenicol; GENT = gentamicin; CIPRO = ciprofloxacin. The figures in parentheses are percentages of the total in each row.

Table 3 Isolated organisms and in-vitro antibiotic sensitivity pattern from the pleural aspirate of the children

Discussion

The present study has presented data on the clinical profile and risk factors for parapneumonic effusions among children with CAP at a tertiary centre in southwest Nigeria.The 8.0% incidence of parapneumonic effusions among the children with pneumonia found in this study is the same prevalence reported by Cirino et al[12] among South Africa children and is similar to 7.7% reported by Johnson et al13 in Ibadan and the 6.8% reported from a general hospital in The Philippines.[14] It is, however, less than the 10–40% incidence reported from developed countries.[4,5] The variation may be related to the use of more efficient and sensitive computerised tomography scanning and video thoracoscopy in diagnosing even minimal effusions in developed countries; in contrast, in the present study, and similar studies from developing countries, diagnosis was based on clinical and chest radiographic findings.

About one-half of the parapneumonic effusions found in this study were empyemic, this is similar to reports from other developing countries.[14,15] This may be related to the delayed presentation and the high pre-admission use of antibiotics which are often sub-therapeutic and substandard, or the use of unorthodox medicine, all of which allow the pathologic process to progress to the more advance fibrinopurulent stage.[3,14-16] These factors were found in the present study to be significantly associated with the development of parapneumonic effusions among the children with CAP.

It is noteworthy that the majority of the pleural collections were on the right pleural space with only 7.1% bilateral. This is in agreement with reports by Gomez-Go et al[14] and Baranwal et al[15] among children in Nepal. The high incidence of right-sided pleural fluid collections may be related to the fact that the right main bronchus is shorter, wider and straighter in comparison to the left, facilitating the descent of the infection and/or causing foreign bodies to preferentially lodge there.[2-5]

Infants were found in this study to be more likely to develop effusions than older children, as the majority of the children with effusions were infants. This is at variance with the reports by Gomez-Go et al[14] and Baranwal et al[15] among children in Nepal, where infants constituted less than 30.0% of those with effusions. This variation from the present study may be due to the fact that while the present study considered all parapneumonic effusions, including pus and serous fluids, the study from Nepal considered only childhood empyema thoracis.

Infants have difficulty localising infection and the detection of pneumonia in them may be relatively difficult as the clinical signs of dull percussion note and reduced or absent breath sounds on auscultation may be more difficult to elicit from this age group because of their relatively small chest wall. This may delay adequate treatment and consequently result in more complications including parapneumonic effusions compared with other age groups.

Inadequate immunisation was found to be associated with parapneumonic effusions in the present study. At the time of the study, the routine immunisation schedule for children in Nigeria did not include vaccines against pneumococcus and *Haemophilus influenzae* type B which are common causes of childhood pneumonia. Nonetheless, vaccine coverage against measles and pertussis which offer protection against childhood pneumonia and its complications was poor. In the present study, over 40% of the children with parapneumonic effusions had inadequate immunisation and 21% had evidence of measles infection at admission. This is similar to the report from Nepal[14] where 37.5% of the children with pleural effusions had incomplete vaccination. Pneumonia as a complication following measles infection has been reported to occur in 2–27% of children in community-based studies and in 16–77% of hospitalised children.16 Additionally, complicated pneumonia contributes to 56–86% of all deaths attributed to measles.[16] The pathogenesis may be due to the virus itself or to superimposed viral or bacterial infections occurring in 47–55% of cases.[17] Immunisation against measles

Outcome	Pneumonia with effusion n=28 (%)	Pneumonia without effusion n=324 (%)	Total	χ^2	*p*-value
Discharge home	24 (85.7)	279 (85.1)	303	0.000	1.000
DAMA	0 (0.0)	14 (4.3)	14	0.000	1.000
Died	4 (14.3)	35 (10.8)	39	0.062	0.803

The figures in parentheses are percentages of the total in each column. DAMA = discharge against medical advice

Table 4 Outcome of children with pneumonia with and without parapneumonic effusions

has been reported to reduce the incidence of lower respiratory tract infections among children by 2.8-fold compared with children who were not immunised in a community-based study of acute lower respiratory infections in Ibadan.[18] High rates of routine childhood immunisation,including vaccination against pneumococcus and *Haemophilus influenzae* type B, will go a long way to reducing childhood pneumonia and parapneumonic effusions.[19]

Children with parapneumonic effusions in the present study were found to more likely present with grunting, head nodding, and cyanosis. These clinical manifestations of severe respiratory distress denote ventilation perfusion mismatch.[20] In childhood pneumonia they have been reported to be significantly associated with hypoxaemia and poor prognosis.[21,22] In parapneumonic effusions, the presence of fluid in the pleural space from lung consolidation and increased dead space impairs gaseous exchange, often from alveolar congestion.[20,21] In a bid to improve oxygenation, infants and young children employ the use of accessory muscles of respiration, including the sternocleidomastoid muscles, to assist breathing. Because this muscle is attached to the base of the skull, the head bobs or nods with each breath, hence the nodding observed. Children with parapneumonic effusions also tend to inspire against a closed or partially closed glottis (grunt). This acts as a form of positive pressure ventilation in a further attempt to overcome the increased dead space caused by the lung consolidation and/or effusions.[21] Cyanosis ensues with increasing hypoxaemia and build-up of deoxygenated haemoglobin in excess of 5g/dl. These manifestations, as shown in the present study, denote increased breathing efforts and in childhood pneumonia should increase the suspicion of parapneumonic effusions.[21,22]

Late presentation was found in the present study to be an important risk factor for developing pleural effusion in childhood pneumonia. Children who presented after 1 week of illness were 3–4 times more likely to have parapneumonic effusions compared

Variables	β	SE	95% CI		OR	*p*-value
			Lower	Upper		
Infancy	1.172	0.965	0.027	6.654	3.529	0.225
Inadequate immunisation	0.996	0.944	0.001	2.662	2.579	0.291
Pre-admission antibiotic use	1.300	1.103	0.486	36.740	2.923	0.239
Symptoms > 1 week	0.381	0.778	1.614	6.925	**3.821**	**0.007**
Grunting	0.293	0.951	0.360	22.041	7.172	0.758
Head nodding	2.036	5.224	0.345	2.678	3.490	0.999
Cyanosis	0.865	1.165	0.243	46.610	6.826	0.457
Measles	1.458	1.022	0.494	37.604	7.091	0.154
Heart failure	0.835	0.898	0.396	13.400	4.940	0.353

β = coefficient of regression; SE = standard error; CI95% confident interval; OR = odds ratio.

Table 5 Predictors of parapneumonic effusion among children admitted with pneumonia at the WGH, Ilesa using regression analysis

Area under the curve			
Test result variable(s): duration of symptoms > 1 week before presentation			
Area	Std error[a]	Asymptotic sig.[b]	Asymptotic 95% confidence interval
0.635	0.065	0.035	0.508-0.763
The test result variable(s): duration of pc has at least one tie between the positive actual state group and the negative actual state group. Statistics may be biased. a. Under the nonparametric assumption b. Null hypothesis: true area = 0.5			

Table 6 Area under the curve analysis for predictors of parapneumonic effusions in childhood pneumonia

with those who presented early. Though poorly sensitive, late presentation is highly specific in detecting the presence of effusion in childhood pneumonia. The significantly high proportion of pre-admission use of antibiotics among the children whose pneumonia was complicated by effusions gives credence to the fact that the false assurance of often ineffective home treatment and over-the-counter-drugs may contribute to the late presentation and hence complications.[23]

Staphylococcus aureus was the organism most commonly isolated from the pleural aspirates of the children. This is in agreement with other studies from developing countries.[13-15] Reports from developed countries, however, showed that *Streptococcus pneumoniae* predominates.[4,5] This variation may be due to the high exposure of children in developing countries to over-the-counter antibiotics, as reflected in this study and similar studies in developing countries.[6,12-15] The indiscriminate use of antibiotics may eradicate the less resilient *Pneumococcus*, leaving the hardy and more ubiquitous *Staphylococcus* to proliferate. It also explains the high resistance rate to widely available and affordable antibiotics such as penicillin that was observed in the study. In addition, the humid and warm weather of the tropics, coupled with widespread skin colonisation, has been reported to favour the proliferation of *Staphylococcus aureus*, hence its high prevalence as a cause of childhood infection in these regions.[24]

Children with parapneumonic effusions stayed longer in the hospital in the present study compared with those without effusions. This finding is in agreement with reports from other workers.[12-15] Pneumonia complicated by effusions increased the duration and cost of hospitalisation as well as the likelihood of a fatal outcome. In resource-constrained regions where cost is a major factor, the importance of early diagnosis and prompt treatment of childhood pneumonia cannot be overemphasised.

We recognise the limitations of this study, in that chest ultrasound or video-assisted thoracoscopy were not carried out to detect minimal effusions which may not be obvious on a plain chest radiograph and to differentiate effusion from extensive consolidation producing white-out on chest radiography. However, children with no yield of free-flowing fluid on pleural tap were not included in the

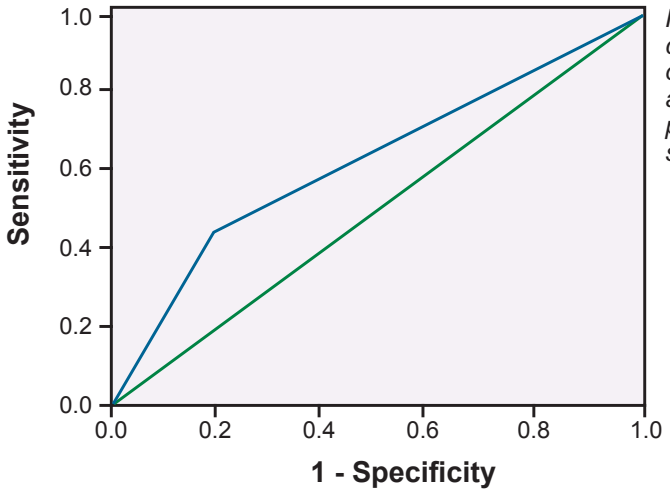

Figure 1 Receiver operating characteristic curve for duration of symptoms greater than 1 week as a diagnostic tool for childhood parapneumonic effusions. Diagonal segments are produced by ties.

parapneumonic effusion numbers in this study.

In conclusion, parapneumonic effusions in children often complicate untreated and poorly treated pneumonia. Inadequate immunisation, concurrent measles infection, grunting, head nodding, and cyanosis – particularly in infants with late presentation – are predisposing factors for the development of pleural collection. The presence of these features in children with pneumonia should therefore raise the suspicion of the possible presence of parapneumonic effusions which should be confirmed and managed early to improve prognosis.

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