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Pattern and outcome of paediatric pleural effusion seen at Usmanu Dafodiyo University Teaching Hospital, Sokoto: A 5-year retrospective study

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Abstract

Background: Pleural effusion is an abnormal accumulation of fluid in the pleural cavity which present with spectrum of clinico-aetiological manifestations often requiring multidisciplinary approach.
Objectives: This study set out to determine the prevalence, aetiology, clinical presentation, treatment modalities and outcome of pleural effusion in children.
Materials and Methods: This was a retrospective study where records of children with diagnosis of pleural effusion admitted at UDUTH, Sokoto were obtained between January 2017 and December 2022 and reviewed. Diagnosis was based on clinical presentation and radiological confirmation of pleural effusion. Data was analyzed with SPSS version 20.0.
Results: A total of 49 cases were retrieved. The prevalence of pleural effusion was 0.54% (9,056). It was more prevalent in males with ratio of 2.5:1 ($\chi^2 = 9.833$, P = 0.007). The median age was 9 years (IQR 7). The most common cause of pleural effusion was pneumonia 26 (53.1%) followed by tuberculosis 16 (32.6%), malignancy 3 (6.1%), cardiac and renal causes accounted for 2 (4.1%) each. Cough (100.0%), difficulty in breathing (100.0%), tachypnea (100.0%), respiratory distress (100.0%), and desaturation (98.0%) were the common presentations. Most (77.5%) of them presented with right sided pleural effusion. The majority (93.9%) had closed thoracostomy tube drainage. The outcome showed majority (83.7%) of the cases been discharged, with a median duration of hospital stay of 22days (IQR 17). However, mortality rate for the malignant causes was 100.0%.
Conclusion: Infections were the major cause of paediatric pleural effusion with relatively good outcome. Surgical intervention and multidisciplinary team approach are needed to reduce the morbidity and mortality in patients with pleural effusion especially for the malignant causes.

Keywords: Pleural effusion, Aetiology, Clinical manifestation, Pneumonia

Introduction

Pleural effusion is the commonest manifestation of pleural diseases.[1] The pleural cavity is the potential space between the visceral and parietal pleurae. Pleural effusion is the collection of excessive fluid and/or reduced lymphatic absorption in the pleural cavity.[2,3] The mechanism of pleural effusion formation results from an imbalance between the oncotic and hydrostatic pressure as well as impairment in lymphatic drainage. Increased capillary permeability, altered pleural membrane permeability and decrease pleural cavity pressure have also been implicated.[2,3] The fluid could either be exudative, transudative or mixed depending on the aetiological factors.[2,3]

The presentation of pleural effusion in children indicates an ongoing disease, of which the prevalence reflects that of the causative disease.[3] The prevalence of pleural infections is increasing globally even in the industrialized countries like

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United States with a rate of 70% increment between 1997 and 2006 (2.2 and 3.7per 100,000 respectively), with dearth of studies on paediatric pleural effusion in developing nations. Effusion associated with bacterial pneumonia accounted for about 0.6-2 % of the cases.[4,5] Tuberculous pleural effusion is common in developing countries like ours which have many cases of tuberculosis infection.[6-8]

Pleural effusion is commonly caused by infective processes such as pulmonary tuberculosis, Staphylococcal, Streptococcal and Klebsiella infections and non- infective causes like nephrotic syndrome, cardiopulmonary diseases, connective tissue disorders, malignancies, chest trauma, sarcoidosis among others.[3,9]

Para-pneumonic effusion is caused by bacterial pneumonia while empyema thoracis (pyothorax), is a complication of pleural effusion, which is a purulent effusion.[3,9,10] Most cases of empyema are closely linked with para-pneumonic effusion due to necrotizing pathogens especially Staphylococcus aureus. Other associated risk factors for pyothorax include infancy, malnutrition and measles.[9,10,11]

Pleural effusion is associated with significant morbidity and mortality, including prolonged hospital stay, exposure to surgical procedures with attendant complications (such as hemothorax, pneumothorax), atelectasis, heart failure, empyema thoracis, air leak syndromes, broncho-pleural fistula, empyema neccesitans, pleural thickening and scoliosis.[3,9,12] Yet, extensive researches among paediatric cases with pleural effusion is only available for the developed countries, with scarcity of data in developing countries like ours despite it being one of the commonest pleural disorders with high morbidity.[3]

This study aimed to determine the prevalence, clinical presentations, aetiology, treatment modalities and outcome of pleural effusion among hospitalized paediatric patients in a Nigerian health facility.

Materials and Method

Study design and site: This was a retrospective hospital-based study with data collected over a period of five years (January 2017 to December 2022). The study was conducted in the Paediatrics Department of the Usmanu Danfodiyo University Teaching Hospital UDUTH, in Sokoto state, North western Nigeria. The hospital serves as a referral centre for hospitals within Sokoto and neighboring states including Kebbi, Zamfara, Niger, Katsina states and neighboring countries like Niger and Benin Republic.

Method of data extraction: The records of all children with pleural effusion admitted into the department between 1st January 2017 and 31st December 2022 were retrieved and reviewed from the admission registers and case folders. Other details such as complications, comorbid illness were retrieved from the case notes of the patient. The total number of patient admissions per year and the overall admissions of children with pleural effusion were recorded.

Diagnosis of pleural effusion was based on a combination of clinical evaluation including thoracocentesis and chest radiographs in all patients and other investigations, including chest ultrasound scan, Mantoux test, blood/aspirate/sputum cultures, Gene-Xpert tests, blood counts and differentials, erythrocyte sedimentation rate, urinalysis and echocardiograms, where necessary. The data extracted from the records included the age, sex, domicile, risk factors (contact with chronically coughing adult, immunization status, nutritional status, anthropometric measurements), examination findings on admission, diagnosis, complications and co-morbidities so also the duration of stay and outcome the diagnostic approach and modalities of treatments.

Inclusion criteria: All children, between the ages of 1 month – 15years admitted for pleural effusion (patients aged less than 1 month are admitted into the special care baby unit while 15 years is upper limit of patient's age admitted into the paediatric department in Usmanu Danfodiyo University Teaching Hospital (UDUTH), Sokoto).

The diagnosis of pleural effusion definition in this study is the accumulation of fluid in the pleural cavity based on 1. Clinical features and chest examination findings and 2.

Radiologic investigations: chest radiography, chest ultrasonography or chest computer tomography.

Exclusion criteria: All children without radiologic confirmation of the pleural effusion.

Data Analysis: The data was analyzed with

Statistical Package for the Social Sciences, version 20 (SPSS Inc., Chicago, IL, USA).

Median, and interquartile range (IQR) were calculated for non-normally distributed continuous variables. Categorical variables were summarized using proportions and percentages. Descriptive weighted prevalence was used to compute for the prevalence of pleural effusion. A chi-square test was used to determine for association between the socio-demography and outcome parameter. A p-value of less than 0.05 was considered significant.

The ethical approval was obtained from the Usmanu Danfodiyo University Teaching Hospital (UDUTH) ethical review committee with UDUTH Health Research Ethics Committee assigned number: UDUTH/HREC/2022/1195/V1.

Results

Table 1: Age and Sex distribution of the study participants

Variable	Gender		N (%)	Test statistical & P-value
Age	**Male**	**Female**		
0-5 years	5 (38.5%)	8 (61.5%)	13 (26.5)	$\chi^2 = 9.833$
6-10 years	20 (87.0%)	3 (13.0%)	23 (47.0)	**P = 0.007**
11-15 years	10 (77.0%)	3 (23.0%)	13 (26.5)	
Total	35 (71.4%)	14 (28.6%)	49 (100.0)	

Table 2: Spectrum of Clinical features of Patients with Pleural effusion

Symptoms	Frequency	Percentage (%)
Cough	49	100.0
Difficulty in Breathing	49	100.0
Fever	39	79.6
Weight loss	35	71.4
Chest Pain	10	20.4%
Right sided abdominal pain	7	14.2
Body swelling	6	12.2
Signs		
Respiratory distress	49	100.0
Tachypnea	49	100.0
Desaturation (SPO2 <92%)	48	98.0
Stony dull percussion notes	46	93.9
Tachycardia	43	87.8
Chest asymmetry	39	79.6
Absent breath sounds	37	75.5
Tender hepatomegaly	36	73.5
Dyspnea	32	65.3
Tracheal shift	32	65.3
Reduced breath sounds	12	24.5
Ascites	6	12.2

During the study period, a total of 9,056 children were admitted and of which 49 were diagnosed with pleural effusion, contributing to 0.54% of the total admissions. Their ages ranged from 6 months to 15 years with a median age of 9 years (IQR 6). Ages 0 – 10 years accounted for nearly three-fourth of the patients (73.5%). Males accounted for more than two-third of the study participants with male to female ratio of 2.5:1 there was also a significant difference in disease prevalence based on age and gender (p=0.007). (Table 1).

Cough (100.0%), difficulty in breathing (100.0%), respiratory distress (100.0%), tachypnea (100.0%), low oxygen saturation (98.0%) and stony dull percussion note (93.9%) were the major clinical features among patients with pleural effusion. (Table 2)

Over two-thirds of the patients (77.5%) had right sided pleural effusion. All the malignant causes of pleural effusion presented with left sided pleural effusion (Figure 1).

Pneumonia was the major cause (53.1%) of pleural effusion followed by tuberculosis (32.6%). Two cases of lymphoma and metastatic rhabdomyosarcoma accounted for the malignant causes (6.1%) of pleural effusion. The cardiac causes included dilated cardiomyopathy and rheumatic valvular heart disease while acute glomerulonephritis and nephrotic syndrome constituted the renal causes (Table 3).

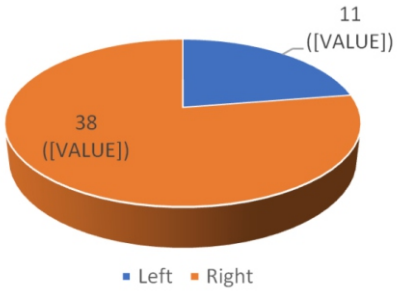

Figure 1: Site of Accumulation of Pleural Effusion

Table 3: Aetiology of Pleural Effusion

Aetiology	Frequency	Percentage
Pneumonia	26	53.1
Tuberculosis	16	32.6
Malignancy	3	6.1
Renal	2	4.1
Cardiac	2	4.1

Table 4: Aetiology of Pleural Effusion by Age and Gender

Aetiology	Pneumonia	Tuberculosis	Malignancy	Renal	Cardiac	Statistical test & P value
Age						
0-5 years	10 (20.4%)	3 (6.2%)	0	0	0	$\chi^2 = 11.513$
6-10 years	13 (26.5%)	7 (14.4%)	1 (2.0)	1 (2.0%)	1(2.0%)	p = 0.174
11-15 years	3 (6.2%)	6 (12.2%)	2 (4.1%)	1(2.0%)	1(2.0%)	
Gender						
Male	18(36.7%)	10 (20.4%)	3 (6.2%)	2 (4.1%)	2 (4.1%)	$\chi^2 = 4.615$
Female	8(16.3%)	6(12.2%)	0	0	0	p = 0.329

Table 5: Modalities of Treatment in Patients with Pleural Effusion

Type of Treatment	Frequency	Percentage (%)
CTTD and Antibiotics	26	53.1
CTTD and Anti-Tuberculous agents	16	32.6
CTTD, Antibiotics and Anti-failure regimen	4	8.2
Thoracocentesis and Chemotherapy	2	4.1
Pleurodesis and Chemotherapy	1	2.0

CTTD = Chest Tube Thoracostomy Drainage

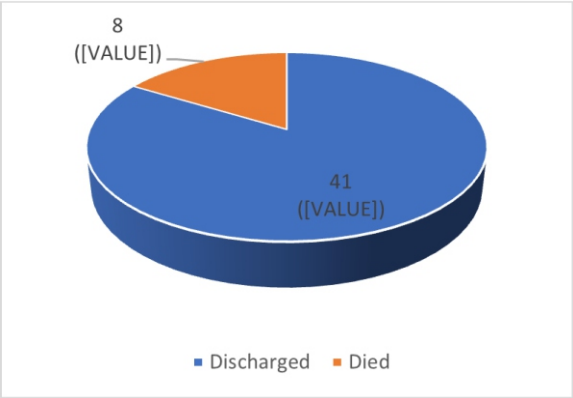

Figure 3: Outcome of hospitalization in Patients with Pleural Effusion

Pneumonia was the commonest cause of pleural effusion among preschool (20.4%) and school aged (26.5%) children while tuberculosis (12.2%) in adolescents. All the females presented with parapneumonic effusion (pneumonia and tuberculosis) while all the malignant causes were seen in males. There was no statistically significant difference in disease prevalence based on the age and gender distribution (p = 0.174 and 0.329) respectively. (Table 4).

Majority of the cases (93.9%) had CTTD in combination with antibiotics, anti-tuberculous and anti-failure agents (parenteral diuretics) as a form of treatment modality, while a small proportion (6.1%) which constituted the malignant causes of pleural effusion had thoracocentesis, pleurodesis and chemotherapy.

Median duration of hospitalization was 22 days (IQR17). The majority (83.7%) of the pleural effusion cases were managed and discharged. The three malignant cases (two cases of metastatic lymphoma and a case of metastatic rhabdomyosarcoma) of pleural effusion died while on admission, accounting for 37.5% of total mortality rate.

Discussion

This study reported 0.54% overall prevalence rate of paediatric pleural effusion, the finding is consistent to studies in Ilorin, North Central Nigeria, Morocco and India which reported a prevalence of 0.5%, 0.51%, 0.82% respectively.[13-15] In contrast, a higher prevalence of 7.5% was observed among paediatric oncology patients with Wilms tumor.[16] The variation could be explained by the fact that these patients with pleural effusion and Wilms tumor were more likely to present with advanced stage tumors, have their preoperative tumor rupture and lacked standardized management protocol, thereby predisposing them more to pleural fluid collection compare to other population.[16] Also, patients with Wilms tumour did not feature in this study.

The prevalence of pleural effusion was higher in males (71.4%) than in females (28.4%) which commensurate with Nabila and Hasan's report of 80.0% and 66.7% accordingly.[17,18] Pleural cavity infection is mostly due to pulmonary infection, and this was reported to be the main cause of paediatric pleural effusion in 50-60% of cases.[19] This was consistent with the index study. Thus, a potential

reason for the male preponderance for pleural effusion may be linked to the role of X-chromosome in immunoglobulin production which is responsible for fighting infections.[20] The male gender has only one X-chromosome compare to two X-chromosomes in females which offer more protection against infections, since infectious (pneumonia and tuberculosis) are the major causes of pleural effusions, hence the susceptibility of the male gender to pleural effusion. The median age of presentation was 9 years (IQR 7) with 6-10 years age category accounting for nearly half of the cases which is similar to reports in India and Pakistan., and this was also higher than reports from previous studies.[18,21-23] These discrepancies could be due to differences in the sample method, study population and causes of pleural effusion in different places of the world.

Infectious/parapneumonic effusion (pneumonia and tuberculosis) was the major cause (85.7%) of paediatric pleural pneumonia with pneumonia and tuberculosis accounting for more than half and one – third respectively. This finding was similar to majority of the studies reported all over the world.[14,17,19,21,22] This observation could be attributed to the global reflection of parapneumonic effusion occurring in as many as 50-70% of patients admitted with a complicated pneumonia.[24] Malignancy was the second most common cause of Pleural effusion with lymphoma responsible for two-third of the malignant causes which was in concordance with these reports.[14,17,25] Additionally, lymphoma was the most common malignancy associated with pleural effusion as reported by these studies.[19,26] In contrast, other studies observed that congestive cardiac failure was the second commonest cause.[19,22]

The most common clinical manifestations were cough, difficulty in breathing, fever, respiratory distress, tachypnea, desaturation, stony dull percussion note, tachycardia, chest asymmetry which is in keeping with previous findings.[14,17,18,21,23,27]

Majority of the cases presented with right sided pleural effusion which was in agreement with previous studies, and this may be due to the anatomy of the right bronchus being shorter, larger diameter and oriented more vertical than the left bronchus, aspirated microorganisms and particles tend to find their way into it or its branches.[13,15,19,23] However, Nabila et al reported a contrasting finding with the left sided pleural effusion more common in their study.[17]

Majority of the cases had CTTD (93.9%) in combination with antibiotic (53.1%), anti-tuberculous (32.6%) and anti-failure agents (8.2%) as a form of treatment modality. Late presentation and massive pleural effusion compromising respiratory function requiring urgent relief of symptoms were the commonest presentation in all the cases necessitating the need for CTTD procedure, making it the mainstay of treatment in paediatric pleural effusion. This result is comparable to these studies, while a small proportion (6.1%) which constitutes the malignant causes of pleural effusion had thoracocentesis, pleurodesis and chemotherapy.[13,15,23] However, in other studies, treatment with antibiotic alone was the most frequent form of therapeutic measure.[22,27]

Most of the patients (83.7%) responded well to treatment and were discharged with median duration of hospitalization of 22 days (IQR 17). This was also reported these studies.[13,23] The high number of recovery and discharged could be explained by the fact that majority of the causes of paediatric pleural effusion in this study was infection (85.7%), which are often vaccine preventable and can be cured with antibiotics, hence the good response and high rate of discharge. A total of 8 cases (16.3%) died while on admission, out of which all the cases associated with malignancy died, accounting for 37.5% of the total pleural effusion case mortality recorded. This demonstrates the poor survival, outcome and high mortality rate associated with pleural effusion associated with malignancy.[28,29]

Limitation

This was a retrospective study where the data was obtained from case notes. Pleural aspirate biochemistry analysis was not done in the patients which would have been useful in the diagnosis and classification of pleural effusion.

Conclusion

Paediatric pleural effusion is caused by a wide range of disorders, with pleural infections largely contributing as a cause of the disease, hence prevention, early presentation, prompt diagnosis and inter professional/health care team management approach of pleural effusion will

reduce the morbidity and mortality rate.

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