Scientific Research Publishing

Advances in Infectious Diseases, 2024, 14, 220-232
https://www.scirp.org/journal/aid
ISSN Online: 2164-2656
ISSN Print: 2164-2648

Epidemiological, Diagnostic, Therapeutic, and Prognostic Profile of Non-Tuberculous Community-Acquired Purulent Pleurisy in Children at the Bouaké University Hospital Center, 2017-2021

Yapo Thomas Aba[1,2*], Christian Yao[2,3], Pacôme Monemo[2,4], Richard Azagoh-Kouadio[5], Iburaima Akandji[3], Noelle Gonné[3], Jean-Marie Karidioula[1,2], Vincent Achi[2,6], Vincent Kouadio Asse[2,3]

[1]Department of Infectious and Tropical Diseases, University Hospital of Bouaké, Bouaké, Ivory Coast
[2]University Alassane Ouattara of Bouake, Bouake, Ivory Coast
[3]Department of Pediatrics, University Hospital of Bouaké, Bouaké, Ivory Coast
[4]Department of Bacteriology & Virology, University Hospital of Bouake, Bouaké, Ivory Coast
[5]Department of Pediatrics, University Hospital of Angré, Abidjan, Ivory Coast
[6]Department of Pneumology, University Hospital of Bouake, Bouaké, Ivory Coast
Email: *chefaba@yahoo.fr

How to cite this paper: Aba, Y.T., Yao, C., Monemo, P., Azagoh-Kouadio, R., Akandji, I., Gonné, N., Karidioula, J.-M., Achi, V. and Asse, V.K. (2024) Epidemiological, Diagnostic, Therapeutic, and Prognostic Profile of Non-Tuberculous Community-Acquired Purulent Pleurisy in Children at the Bouaké University Hospital Center, 2017-2021. *Advances in Infectious Diseases*, **14**, 220-232.
https://doi.org/10.4236/aid.2024.141017

Received: January 18, 2024
Accepted: March 24, 2024
Published: March 27, 2024

Abstract

Introduction: In Côte d'Ivoire, there is a scarcity of data on children's purulent pleurisies. **Objective:** This study aims to elucidate the epidemiological, diagnostic, therapeutic, and evolutionary facets of non-tuberculous purulent pleurisies in pediatric patients. **Methods:** A retrospective analysis was conducted using the medical records of children aged one month to fifteen years with purulent pleurisies at Bouaké University Hospital Center from January 2017 to December 2021. **Results:** The study identified 124 cases of purulent pleurisies, constituting 18% of lower respiratory tract infections and 0.8% of all hospitalizations. The majority of these cases (69%) were in children between 1 and 24 months of age. Prominent symptoms included dyspnea (85.5%), O_2 saturation below 95% in room air (76.6%), respiratory distress (68.5%), cutaneous-mucosal pallor (63.7%), and fever (43.5%). Radiological findings predominantly showed right-sided pleurisy (62.1%). The pleurisy was often extensive (78.2%), accompanied by pneumothorax (37.1%), alveolo-interstitial opacities (8.1% of cases), and abscess formations (1.6%). Pleural fluid cultures were positive in 46.9% of cases, with Staphylococcus aureus (75%, methi-S) identified among 32 bacteria. Initial antibiotic treatment was empirical, favoring oxacillin (53.2%) or amoxicillin-clavulanic acid (53.2%) in dual (42%) or triple therapy (33%) with

gentamicin (64.1%) and/or metronidazole (21.8%). Treatments also included pleural drainage (68.5%) or repeated evacuation punctures (33.1%), and blood transfusion (39%). The mortality rate was 18.8%. **Conclusion:** Non-tuberculous purulent pleurisy remains a significant concern in pediatric hospitalizations at the CHU of Bouaké, marked by high mortality rates.

Keywords

Community-Acquired Purulent Pleurisies, Children, Mortality, Bouaké

1. Introduction

Purulent pleurisies, also known as empyemas, are characterized by the accumulation of a thick, creamy liquid effusion, or a turbid to clear fluid laden with variably altered polymorphonuclear leukocytes typical of pus, between the two layers of the pleura [1] [2]. These conditions are a major complication of community-acquired acute pneumonia in children. Byington *et al.* report that 28% of childhood pneumonia leads to purulent pleurisy [3]. Although the current global incidence is not well-documented, purulent pleurisies have been significant public health challenges in developed countries over the past two decades [4]-[10]. The World Health Organization (WHO) has identified it as the second leading cause of hospitalization and pediatric deaths after malaria in developing countries [11]. Specifically in Côte d'Ivoire, and particularly in Bouaké, there is a scarcity of data regarding purulent pleurisies in children [12] [13]. Although diagnosing purulent pleurisy can be straightforward based on the macroscopic and/or cytological characteristics of the pleural puncture fluid, identifying the causative pathogens is challenging in resource-limited settings like Côte d'Ivoire. This difficulty is due to pre-analysis antibiotic treatments, inadequate technical resources, and the prohibitive cost of paraclinical evaluations for many patients. The aim of this study was to describe the epidemiological, diagnostic, therapeutic, and evolutionary aspects of purulent pleurisies in a pediatric context, contributing to data essential for developing strategies to reduce child morbidity and mortality at the Bouaké University Hospital Center (CHU).

2. Patients and Methods

This study was a descriptive retrospective analysis utilizing the records of children admitted to the CHU of Bouaké from January 2017 to December 2021. Situated in central Côte d'Ivoire, 347 km from Abidjan, the CHU of Bouaké stands as the sole tertiary health care facility serving the central, north, and west regions of the country. The study encompassed children from 1 month to 15 years old diagnosed with purulent pleurisy. The diagnosis was confirmed through radiological imaging and the biological examination of pleural puncture fluid, primarily of an exudative type (protein > 30 g/l), marked by the presence of polymorphonuclear neutrophils, either intact or altered [1] [2]. Exclusion criteria in-

cluded being younger than one month, lacking a pulmonary radiograph, or having a bacterial superinfection of a tuberculous pleurisy, pleurisy not confirmed radiologically and biologically, as well as cases of pleurisy not hospitalized. The study employed comprehensive sampling of all eligible children's medical records from the specified period. We retrieved filing numbers from the admission/discharge records of the pediatric, pneumophthisiology, and internal medicine departments for children aged 01 month to 15 years with lower respiratory tract infections. Using these numbers, we then compiled the relevant patient records that met our inclusion criteria. Data were gathered using a validated, pre-established survey form, capturing epidemiological (frequency/prevalence, age, sex, residence), diagnostic (clinical, radiological, bacteriological), specific treatment (antibiotic therapy, local treatment), and outcome (recovery, death, other) information. Pleurisy was categorized by its extent: 1) Low abundance, indicated by radiological evidence of fluid in the costo-diaphragmatic recess(es); 2) Medium abundance, occupying the lower two-thirds of the lung field; 3) High abundance, extending over more than two-thirds of the lung field [14] [15]. Ethical approval was granted by the scientific medical commission of the CHU of Bouaké. Confidentiality was maintained through anonymous numbering. Record review and data collection were performed at the storage sites. Data processing and analysis were conducted using Epi Info software version 7. Qualitative variables were represented as proportions, while quantitative variables were analyzed using mean and standard deviation.

3. Results

3.1. Epidemiological Profile

In the period from January 2017 to December 2021, the study at CHU of Bouaké's pneumophthisiology and pediatrics departments identified 124 cases of purulent pleurisy in children, out of 687 children with lower respiratory tract infections and a total of 15,505 pediatric hospitalizations for various conditions. Purulent pleurisies thus constituted 18% of lower respiratory tract infections and accounted for 0.8% of all pediatric hospitalizations. The annual distribution was as follows: 6 cases (4.8%) in 2017, 8 cases (6.5%) in 2018, 70 cases (56.5%) in 2019, 19 cases (15.3%) in 2020, and 21 cases (16.9%) in 2021. Male children formed the majority of cases, accounting for 67%, with a sex ratio of 2.1. The age range of these patients was from 1 month to 168 months, with an average age of 33 months and a median age of 11 months. Children aged ≤ 60 months represented 81% of cases, with a significant proportion (69%) being between 1 to 24 months old. Regarding the geographic origin, 56% of these children were from outside the city of Bouaké, including 52% from different health regions.

3.2. Diagnostic Profile

- *Clinical Aspects* (Table 1)

  The vaccination history indicated that 39% (n = 48) of the children were not

Table 1. Clinical and paraclinical manifestations.

Symptoms	Number (N = 124)	Percentage (%)
Functional Signs		
Dyspnea	106	85.5
Fever	54	43.5
Cough	10	8.1
Chest Pain	8	6.5
Diarrhea/vomiting	4	3.2
Abdominal pain	4	3.2
Pulmonary Physical Signs		
Pleural liquid effusion	107	86.3
SaO_2 < 95% ambient air	95	76.6
Respiratory distress	85	68.5
Mixed pleural effusion	14	11.3
Pulmonary condensation syndrome	8	6.5
Gaseous pleural effusion	4	3.2
Other Physical Signs		
Cutaneous-mucosal pallor	79	63.7
Poor general condition	75	60.5
Dermatoses	25	20.2
Splenomegaly	12	9.7
Hepatomegaly	6	4.8
Radiological Images		
Right pleurisy	77	62.1
Pleurisy of great abundance	97	78.2
Medium abundance	24	19.4
Low abundance	3	2.4
Hydropneumothorax	46	37.1
Alveolo-interstitial opacities	10	8.1
Abscess image	2	1.6
Pleural Fluid Macroscopy		
Purulent	83	66.9
Turbid	13	10.5
Hematique	12	9.7
Cloudy	8	6.5
Citrine	4	3.2
Clear	4	3.2
Hemaglobin Level < 9 g/dl	106	85.5

up-to-date with their routine immunizations. Among the patients, 37% (n = 46) had received the 13-valent pneumococcal and *Haemophilus influenzae* type b vaccines as part of the expanded immunization program. The medical history in

the past three months included skin rash in six (5%), exposure to passive smoking in twelve (10%), and pneumonia in three (Table 1) patients. Prior to hospitalization, self-medication practices involved antibiotics in 39 (31%), antipyretics in 19 (15%), corticosteroids in 15 (12.1%), traditional remedies in 14 (11.3%), and antimalarials in 12 (9.7%) patients. observed were malnutrition in five (4%) and HIV infection in four (3%) patients. The symptom duration before the first medical consultation ranged from 2 to 60 days, with 44% presenting within less than 7 days, 33% between 8 and 14 days, and 23% after more than 14 days. The primary symptoms at admission were dyspnea (85.5%) and fever (43.5%). The predominant physical findings in the pleuropulmonary examination included pleural effusion syndrome (86.3%), O_2 saturation below 95% in ambient air (76.6%), and respiratory distress (68.5%). Other physical examination findings were cutaneous-mucosal pallor (63.7%), deterioration of the general condition (60.5%), and dermatoses (20.2%).

- ***Radiological Findings*** (Table 1)

Pulmonary radiographs at the time of admission primarily showed right-sided pleurisy (62.1%) with a significant accumulation of fluid (78.2%). Additional radiographic findings included Hydropneumothorax (37.1%), alveolo-interstitial opacities (8.1% of cases), and abscess formations (1.6%).

- ***Bacteriological Results*** (Figure 1, Table 2)

Out of the 124 patients, 64 (52%) had documented results of pleural fluid

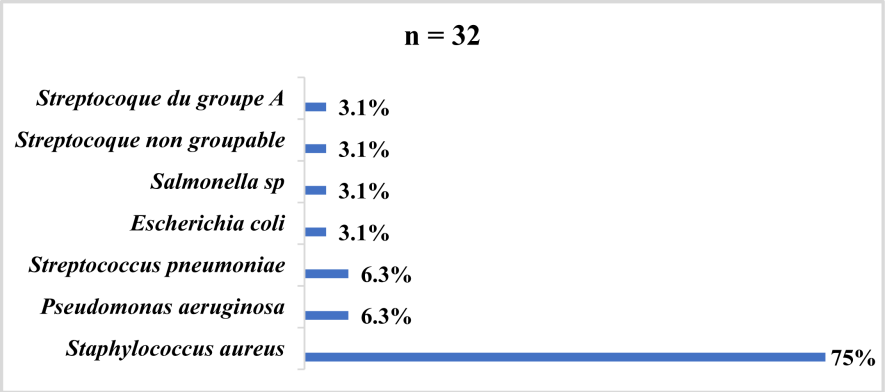

Figure 1. Prevalence of bacteria isolated from pleural fluids.

Table 2. Antibiotic sensitivity and resistance profile of isolated *Staphylococcus aureus.*

Antibiotics	Number of Tests	Sensitivity Rate	Resistance Rate
Cefoxitin	24	100%	0%
Erythromycin	24	87.5	8.3
Gentamicin	24	79.2%	16.7
SXT	24	62.5	16.7%
Penicillin G	24	4.2%	83.3%

Note: SXT stands for Trimethoprim-sulfamethoxazole. Oxacillin was not tested; cefoxitin was used as a substitute.

culture. Among these, 30 (46.9%) exhibited positive pleural fluid cultures, identifying a total of 32 bacteria. *Staphylococcus aureus* was the predominant bacterium, accounting for 75% of these cases (Figure 1). Antibiotic sensitivity testing on 24 *S. aureus* strains showed complete sensitivity to Cefoxitin (100%) (Table 2).

3.3. Treatment and Outcome Profile (Table 3, Table 4)

Empirical antibiotic treatment was administered to all 124 patients. Oxacillin (53.1%) and amoxicillin-clavulanic acid (53.1%) were the commonly used beta-lactams, often in combination with other antibiotics such as gentamicin (64.1%) and/or metronidazole (21.9%), resulting in dual therapy (42%) or triple therapy (33%). Single-drug antibiotic therapy was applied in 25% of the cases (Table 3). Pleural drainage was executed in 68.5% of patients, while iterative evacuation punctures were employed in 33.1% of children due to the unavailability of drainage kits. Among the 106 patients with anemia, 41 (39%) received blood transfusions. The outcomes for the 124 patients included a favorable progression in 73.4%, a mortality rate of 18.5%, and surgical transfer for 4 (3.2%) patients. The hospital stay was ≤7 days for 88 (71%) patients, averaging 6 days, with a range from 1 to 13 days

4. Discussion

4.1. Epidemiological Perspectives

Between January 2017 and December 2021, the CHU of Bouaké's pediatric department recorded 124 cases of purulent pleurisy out of how many patients observed during the study. These accounted for 0.8% of hospital admissions and 18% of lower respiratory tract infections among children aged one month to years. The recruitment methodology for purulent pleurisy cases in this study may underrepresent the actual incidence in the CHU of Bouaké. The analyzed

Table 3. Antibiotics prescribed for purulent pleurisies.

Antibiotics	Number (N = 124)	Percentage
Gentamicin	79	63.7
Oxacillin	66	53.2
Amoxicillin-Clavulanic Acid	66	53.2
Metronidazole	27	21.8
Erythromycin	8	6.5
Bactrim	6	4.8
Ciprofloxacin	4	3.2
Fusidic Acid	2	1.6
Cefixime	2	1.6
Cefotaxime	2	1.6

Table 4. Local treatments and patient outcomes.

Local Treatment and Outcome	Number (N = 124)	Percentage
Invasive Procesdures		
Pleural drainage and lavage	85	68.5
Iterative evacuation punctures	41	33.1
Surgery	4	3.2
Exsufflation	2	1.6
Respiratory Physiotherapy	100	80.6
Patient Outcomes		
Favorable	91	73.4
Death	23	18.5
Discharge against medical advice	06	4.8
Transfer	04	3.2

Note: A child could undergo one or several of these local care interventions.

data solely encompassed biologically confirmed purulent pleurisy in hospitalized patients, potentially excluding less severe cases managed on an outpatient basis. Additionally, before 2019, the CHU of Bouaké's biology laboratory faced challenges with frequent shortages of biological materials, only improving post-2019 following an Ivorian-German partnership. The years 2020 and 2021 also saw reduced healthcare facility attendance due to the SRAS-Cov 2 pandemic [16], possibly influencing the lower pleurisy cases recorded in 2017, 2018, 2020, and 2021 compared to 2019. Regular monitoring of hospital incidence rates is vital to accurately track current annual trends of children's purulent pleurisy. Similar hospitalization rates have been observed in other African studies [17] [18]. The average age of the patients was 33 months, with a median of 11 months. Children aged ≤ 60 months comprised 81% of the cases, with 69% between 1 and 24 months. This vulnerability of young infants, noted by authors like Ndiaye, Thiam, and Andriatahihirintsoa [17] [18] [19], is likely due to their developing immune systems [19] [20]. A notable male predominance was observed, with a sex ratio (M/F) of 2.1%, consistent with other studies reporting ratios from 1.2 to 2.7 [3] [8] [10] [17] [18] [19] [21] [22] [23]. This male susceptibility, though not fully explained, is recognized in pediatric healthcare [24] [25]. Regarding residence, most children (52%) hailed from other health regions of Côte d'Ivoire, indicating that any policy aimed at addressing infantile purulent pleurisies should encompass these broader regions.

While our study was not designed as an analytical one, we did observe several risk factors for purulent pleurisy in children, as highlighted in previous literature [3] [6] [10] [18] [26]-[30]. Notable among these were inadequate pneumococcal vaccination coverage (37%), self-administered antibiotic treatment (31%), and malnutrition (4%). Our findings did not include the use of non-steroidal anti-inflammatory drugs (NSAIDs). However, it's noteworthy that corticosteroid

therapy was administered to 12.5% of patients prior to their hospitalization.

4.2. Diagnostic Profile

- ***Clinical and Radiological Characteristics***

While fever is typically a prevalent symptom in studies of purulent pleurisy [17] [37], it was present in only 43.5% of cases in our study. This contrasts with the more severe symptoms noted upon admission, such as respiratory distress (68.5%) and extensive pleurisy (78.2%). Over half (55.7%) of the patients in our study experienced a delay in seeking medical attention, a common occurrence reported in African research [17] [21] [32]. This delay and the gradual worsening of pleuropulmonary symptoms could be partially attributed to self-medication practices involving antibiotics, antipyretics, and corticosteroids.

Radiologically, most studies indicate a predilection for purulent pleurisies to occur on the right side, as was the case in 62.1% of our study's cases [17] [19] [21] [23]. This tendency may be due to the anatomical orientation of the right main bronchus, which is obliquely inclined nearly vertically, making the right lung more susceptible to infections, pollutants, and consequently to fluid effusions. In contrast, the left bronchus has a more horizontal oblique angle [33] [34]. The presence of pneumothorax, seen in 37.1% of our study's patients, is often associated with staphylococcal infections [19] [35].

- ***Microbiological Considerations***

Bacteriological diagnosis of purulent pleurisies is crucial for guiding antibiotic treatment and for epidemiological surveillance of bacterial ecology. In our research, 52% of patients had documented pleural fluid culture results. The rate of bacterial identification from these cultures was 46.9%. Lower positivity rates, between 25% and 42%, have been observed in studies conducted in Burkina Faso, India, Madagascar, and Senegal [17] [18] [21] [31]. The lower rate could be attributed to prior antibiotic treatments and the challenges faced by microbiology laboratories in developing countries, such as the lack of appropriate culture media and the delay in culturing the biological samples, which can lead to bacterial death. An alternative approach, as demonstrated in Garba's study [36], is the use of latex tests for detecting soluble antigens. In their research, while all pleural fluid cultures were negative, the latex test detected *Streptococcus pneumoniae* in 46% and *Staphylococcus aureus* in 4% of cases. Akoua also reported the interest of latex tests applied to biological fluids [37]. In our study, *Staphylococcus aureus* was the most frequently isolated bacterium, accounting for 75% of cases, differing from other studies where pneumococcus is typically predominant [17] [36]. The prevalence of *Staphylococcus aureus* might be influenced by the warm, humid climate and inadequate skin hygiene among children and/or mothers, which facilitates the spread of skin and mucosal infections caused by *Staphylococcus aureus*, eventually leading to pleuropulmonary infections [38]. Other factors potentially influencing the low incidence of pneumococcus in our findings include routine empirical antibiotic therapy for pulmonary conditions,

delayed sample processing, inadequate laboratory equipment, and the protective effects of pneumococcal and *Haemophilus influenzae* type b vaccines [17] [27] [39] [40].

Additionally, our study did not identify any cases of *Haemophilus influenzae.*

4.3. Treatment Profile

Antibiotic strategies for purulent pleurisies should be adapted to local bacterial ecologies and antibiotic sensitivity profiles [41]. In our cohort, the predominant bacterium, *Staphylococcus aureus* (75%), was methicillin-sensitive, unlike the methicillin-resistant strains reported by Thiam *et al.* [17]. All our patients received empirical antibiotic therapy, mainly oxacillin (53.2%) or amoxicillin-clavulanic acid (53.2%), combined with other antibiotics like gentamicin (64.1%) and/or metronidazole (21.8%), administered as either dual (42%) or triple therapy (33%). The use of aminoglycosides has been questioned by some due to their limited efficacy in acidic conditions and poor penetration in experimental empyema [42]. The selection of oxacillin or amoxicillin-clavulanic acid in our study aligns with the wild-type nature of *Staphylococcus aureus* identified. Pleural drainage, the recommended urgent intervention for moderate to large pleurisies [43], was performed in 68.5% of patients. However, the immediate unavailability of drainage kits led to delays or the inability to drain the pleural fluid in some cases, a challenge also observed by Garba *et al.* in Niamey [36]. Consequently, 33% of children underwent repeated evacuation punctures. Early physiotherapy, targeting the reduction of functional sequelae [44], was implemented in 80% of the patients. Fibrinolysis and thoracoscopy, however, were not conducted in our study.

4.4. Outcome Profile

The course of the disease was favorable in 73.4% of the cases. Nonetheless, a significant mortality rate of 18.5% was observed, higher than the rates reported by Thiam in Dakar, Alao in Cotonou, and Garba in Niamey [17] [32] [36]. Literature identifies several factors that contribute to increased mortality, such as delayed initiation of pleural evacuation [45], prolonged time before hospitalization exceeding 7 days, young age, malnutrition, and severe anemia [21], all of which were observed in our study. Furthermore, mortality rates are heavily influenced by underlying comorbidities, with potential mortality rates reaching up to 40% in cases of immunosuppression [46]. In our study, the only notable comorbidities were malnutrition (4%) and HIV infection (3%). Mortality also appears to be linked to the microbial cause of the infection. According to the bacteriological data from the MIST-1 study [47], infections caused by Gram-negative bacilli, *Staphylococcus aureus*, or polymicrobial aerobic germs have higher mortality rates. Conversely, infections caused by *streptococcus* and anaerobes tend to have a better prognosis. In our cohort, *Staphylococcus aureus* was the predominant pathogen (73%). Therefore, addressing these prognostic factors is crucial for

improving outcomes in children with purulent pleurisy.

5. Conclusion

This study highlights that non-tuberculous purulent pleurisies continue to be a significant concern in pediatric hospitalizations at the CHU of Bouaké. Infants are predominantly affected, with notable incidences of home self-medication and delays in seeking healthcare. Methicillin-sensitive *Staphylococcus aureus* emerges as the primary etiological agent, despite challenges in pathogen identification. The observed mortality rate was alarmingly high. Implementing microbiological monitoring and establishing a comprehensive management policy for infantile purulent pleurisies are imperative steps towards reducing their morbidity and mortality.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Coffel, C. (1976) Les pleurésies purulentes. Encyclopédie. Médico-Chirurgicale, Paris.

[2] Decroix, G. and Crestier, Y. (1970) Les pleurésies purulentes non tuberculeuses. *Vie Médicale*, **51**, 3553-3594.

[3] Byington, C.L., Spencer, L.Y., Johnson, T., Pavia, A.T., Allen, D., Edward, O., *et al.* (2002) An Epidemiological Investigation of a Sustained High Rate of Pediatric Parapneumonic Empyema: Risk Factors and Microbiological Associations. *Clinical Infectious Disease*, **34**, 434-440. https://doi.org/10.1086/338460

[4] Deceuninck, G., Quach, C., Panagopoulos, M., Thibeault, R., Côté-Boileau, T., Tapiéro, B., *et al.* (2014) Pediatric Pleural Empyema in the Province of Quebec: Analysis of a 10-Fold Increase between 1990 and 2007. *Journal of the Pediatric Infectious Diseases Society*, **3**, 119-126. https://doi.org/10.1093/jpids/pit075

[5] Desrumaux, A., François, P., Pascal, C., Cans, C., Croizé, J., Gout, J.P., *et al.* (2007) Épidémiologie et caractéristiques cliniques des complications suppuratives des pneumonies de l'enfant. *Archives de Pediatrie*, **14**, 1298-1303. https://doi.org/10.1016/j.arcped.2007.06.008

[6] Roxburgh, C.S. and Youngson, G.G. (2007) Childhood Empyema in North-East Scotland over the Past 15 Years. *Scottish Medical Journal*, **52**, 25-27. https://doi.org/10.1258/rsmsmj.52.4.25

[7] Gupta, R. and Crowley, S. (2006) Increasing Pediatric Empyema Admissions. *Thorax*, **61**, 179-180. https://doi.org/10.1136/thx.2005.049510

[8] Thumerelle, C., Santos, C., Morillon, S., Bott, L., Pouessel, G. and Deschildre, A. (2005) Facteurs de risque de survenue des pleuropneumopathies bactériennes en pédiatrie. *Archives de Pediatrie*, **12**, 827-829. https://doi.org/10.1016/j.arcped.2005.04.042

[9] Guyon, G., Allal, H., Lalande, M. and Rodibre, M. (2005) Les pleurésies purulentes de l'enfant expérience montpelliéraine. *Archives de Pediatrie*, **12**, S54-S57. https://doi.org/10.1016/S0929-693X(05)80013-2

[10] Eastham, K.M., Freeman, R., Kearns, A.M., Eltringham, G., Clark, J., Leeming, J., *et al.* (2004) Clinical Features, Etiology and Outcome of Empyema in Children in the North East of England. *Thorax*, **59**, 522-525. https://doi.org/10.1136/thx.2003.016105

[11] Rudan, I., Boschi-Pinto, C., Biloglav, Z., Mulholland, C. and Campbell, H. (2008) Epidemiology and Etiology of Childhood Pneumonia. *Bulletin of the World Health Organization*, **86**, 408-416. https://doi.org/10.2471/BLT.07.048769

[12] Amon-Tanoh-Dick, F., Timité-Konan, A.M., Biafry, M.M., Adonis-Koffy, Y.L., A.M., N'Goan-Domoua, A.M., Assé, K.V., *et al.* (1999) Pleuropneumopathies bactériennes non tuberculeuses de l'enfant à Abidjan. *Cahier Santé*, **9**, 145-149.

[13] Asse, K.V., Plo, K.J., Yao, K.C., Konan, R.C. and Yenan, J.P. (2013) Pneumonie aiguë communautaire de l'enfant à Bouaké, Côte d'Ivoire. *Revue internationale des Sciences médicales*, **15**, 124-131.

[14] Hirsch, A. (1978) Physiopathologie des épanchements pleuraux. *La Revue du Praticien*, **28**, 2015-2022.

[15] Berthrand, D. (1992) Décision en pneumologie. Edition VIGOT, Paris.

[16] (2021) Evaluation des effets de la crise sanitaire à COVID-19 sur l'offre et la demande des services VIH en Côte d'Ivoire. https://www.afro.who.int/fr/publications/evaluation-des-effets-de-la-crise-sanitaire-covid-19-sur-loffre-et-la-demande-des

[17] Thiam, L., Faye, P.M., Ba, I.D., Niang, B., Boiro, D., Seck, N., Fall, A.L. and Ndiaye, O. (2017) Les pleurésies purulentes de l'enfant: Expérience du Centre Hospitalier National d'enfants Albert Royer de Dakar (Senegal). *Revue Cames santé*, **5**, 34-40.

[18] Andriatahirintsoa, E.J.P.R., Rambeloson, S.H., Rakotomalala, L.H., Rakotozanany, A.L. and Robinson, A.L. (2016) Facteurs de risque de pleurésie purulente non-tuberculeuse de l'enfant au Centre Hospitalier Universitaire Mère-Enfant Tsaralalana (CHUMET). *Revue d'Anesthésie-Réanimation*, **8**, 27-31.

[19] Ndiaye, O., Diack-Mbaye, A., Ba, M., Sylla, A., Sow, H.D., Sarr, M. and Fall, M. (2000) Pleurésies purulentes à staphylocoque doré de l'enfant. Expérience de l'hôpital d'enfants Albert-Royer du CHU de Fann à Dakar. *Sante*, **10**, 93-96.

[20] Ranaivoarisoa, R., Rasamoelisoa, J. and Raobijaona, H. (2005) Prise en charge des pleurésies purulentes de l'enfant à Antananarivo. *Medecine d'Afrique noire*, **52**, 116-120.

[21] Koueta, F., Ouedraogo, S.O., Ouedraogo, G., Ngardjibem, D., Dao, L. and Napon, A.M. (2011) Pleurésies chez l'enfant: Aspects épidémiologiques, cliniques, paracliniques, thérapeutiques et évolutifs au centre hospitalier universitaire pédiatrique Charles de Gaulle de Ouagadougou (Burkina Faso). *Clinics in Mother and Child Health*, **8**, 1-6. https://doi.org/10.4303/cmch/C110803

[22] Mangété, E.D., Kombo, B.B. and, Legg-Jack, T.E. (1993) Thoracic Empyema: A Study of 56 Patients. *Archives of Disease in Childhood*, **69**, 587-588. https://doi.org/10.1136/adc.69.5.587

[23] Lukuni-Massika, L., Binda, K., Muaka, P. and Omanga, U. (1990) Suppurations pleurales chez l'enfant: Aspects épidémiologiques et étiologiques. *Medecine d'Afrique Noire*, **37**, 24-28.

[24] Klein, S.L., Marriott, I. and Fish, E.N. (2015) Sex-Based Differences in Immune Function and Responces to Vaccination. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, **109**, 9-15. https://doi.org/10.1093/trstmh/tru167

[25] Fish, E. (2008) The X-Files in Immunity: Sex Based Differences Predispose Immune

Responses. *Nature Reviews Immunology*, **9**, 737-744.
https://doi.org/10.1038/nri2394

[26] Plouvier, N. (2015) Impact de la prise d'anti-inflammatoires non stéroïdiens en pré-hospitalier sur le risque de complication pleuro-parenchymateuse au cours d'une pneumopathie aiguë communautaire.
https://dumas.ccsd.cnrs.fr/dumas-01291383/document

[27] Kellner, J.D. (2011) Mise à jour sur le succès du vaccin conjugué contre le pneumocoque. *Paediatrics Child Health*, **16**, 237-240. https://doi.org/10.1093/pch/16.4.237

[28] Boutin, A., Bosdure, E., Schott, A., Beydon, N., Chabrol, B. and Dubus, J.C. (2008) Pleuropneumopathies bactériennes au cours de la varicelle. *Archives de Pediatrie*, **15**, 1643-1647. https://doi.org/10.1016/j.arcped.2008.08.011

[29] Ulrich, E., Schaible Stefan, H. and Kauf, E. (2007) Malnutrition and Infection: Complex Mechanisms and Global Impacts. *PLOS Medicine*, **4**, 806-812.
https://doi.org/10.1371/journal.pmed.0040115

[30] Lesko, S.M., O'Brien, K.L., Schwartz, B., Vezina, R. and Mitchell, A.A. (2001) Invasive Group A Streptococcal Infection and Non Steroidal Antiinflammatory Drug Use among Children with Primary Varicella. *Pediatrics*, **170**, 1108-1115.
https://doi.org/10.1542/peds.107.5.1108

[31] Dass, R., Deka, N.M., Barman, H., Duwarah, S.G., Khyriem, A.B., Saikia, M.K., *et al.* (2011) Empyema Thoracis: Analysis of 150 Cases from a Tertiary Care Centre in North East India. *Indian Journal of Pediatrics*, **78**, 1371-1377.
https://doi.org/10.1007/s12098-011-0416-y

[32] Alao, M.J., Sagbo, G.G., Diakité, A.A. and Ayivi, B. (2010) Pleurésie chez l'enfant au centre national hospitalier et universitaire de Cotonou: Aspect Epidémiologiques, Cliniques, Paracliniques et Thérapeutiques. *Le Mali Médical*, **4**, 47-51.

[33] Mupepe, A.K., Mukuku, O., Bagale, Y. and Ruhindiza, B.M. (2014) Corps étranger métallique inhalé: 36 mois d'évolution intrabronchique chez un enfant de 8 ans. *Pan African Medical Journal*, **18**, Article 225.
https://doi.org/10.11604/pamj.2014.18.225.4823

[34] Falase, B., Sanusi, M., Majekodunmi, A., Ajose, I. and Oke, D. (2013) Preliminary Experience in the Management of Tracheobronchial Foreign Bodies in Lagos, Nigeria. *Pan African Medical Journal*, **15**, Article 31.
https://doi.org/10.11604/pamj.2013.15.31.2710

[35] Agbere, A.D., Agbobli, E., Assimadi, J.K., Atakouma, D.Y., Gbadoe, A., Katchalla-Moustapha, B., *et al.* (1995) Aspects cliniques, thérapeutiques et évolutifs de la staphylococcie pleuropulmonaire du nourrisson au CHU de Lomé-Tokoin (Togo). *Medecine d'Afrique noire*, **42**, 260-266.

[36] Garba, M., Rabiou, S., Kamaye, M., Soumaila, A. and Alido, S. (2015) Profil épidémiologique et pronostic de la pleurésie chez l'enfant. *Journal Franco—Vietnamien de Pneumologie*, **19**, 49-54. https://doi.org/10.12699/jfvp.6.19.2015.49

[37] Akoua-Koffi, G., Faye-Kette Achi, H., Sylla-Koko, F., Kacou-N'douba, A., Acho, Y.B., Avoaka-Cisse, I., Bouzid, S.A., Kouassi, A.A. and Dosso, M. (1993) Interet et limite des tests au latex comme moyen de diagnostic des liquides biologiques à Abidjan. *Médecine d'Afrique Noire*, **40**, 303-308.

[38] Baranwal, A.K., Singh, M., Marwaha, R.K. and Kumar, L. (2003) Empyema Thoracis: A 10 Years Comparative Review of Hospitalized Children from South Asia. *Archives of Disease in Childhood*, **88**, 1009-1014.
https://doi.org/10.1136/adc.88.11.1009

[39] Koshy, E., Murray, J., Bottle, A., Sharland, M. and Saxena, S. (2010) Impact of the Seven-Valent Pneumococcal Conjugate Vaccination (PCV7) Programme on Childhood Hospital Admissions for Bacterial Pneumonia and Empyema in England: National Time-Trends Study, 1997-2008. *Thorax*, **65**, 770-774. https://doi.org/10.1136/thx.2010.137802

[40] Cissé, M.F., Breugelmans, J.G., Bâ, M., Boss Diop, M., Faye, P.C., Mhlanga, B., *et al.* (2010) The Elimination of *Haemophilus influenzae* Type b Meningitis Following Conjugate Vaccine Introduction in Senegal. *The Pediatric Infectious Disease Journal*, **29**, 499-503. https://doi.org/10.1097/INF.0b013e3181ccb0a0

[41] Gaudelus, J., Dubos, F., Dommergues, M.A., Vuthien, H., Bingen, E. and Cohen, R. (2008) Antibiothérapie des pleuropneumopathies de l'enfant: Quelles leçons tirer des études cliniques publiées et propositions thérapeutiques. *Archives de Pediatrie*, **15**, 584-592. https://doi.org/10.1016/S0929-693X(08)74222-2

[42] Shohet, I., Yellin, A., Meyerovitch, J. and Rubinstein, E. (1987) Pharmacokinetics and Therapeutic Efficacy of Gentamicin in an Experimental Pleural Empyema Rabbit Model. *Antimicrobial Agents and Chemotherapy*, **31**, 982-985. https://doi.org/10.1128/AAC.31.7.982

[43] Debesse, B. and Bellemy, J. (1983) Drainage pleural et éradication du foyer pulmonaire: Traitement standard des pleurésies purulentes aiguës à germe banal. *Revue Française des Maladies Respiratoires*, **11**, 245-246.

[44] (2022) ePILLY Trop Maladies infectieuses tropicales. 3è édition. https://www.infectiologie.com/UserFiles/File/formation/epilly-trop/livre-epillytrop2022.pdf

[45] Cham, C.W., Haq, S.M. and Rahamim, J. (1993) Empyema Thoracis: A Problem with Late Referral? *Thorax*, **48**, 925-927. https://doi.org/10.1136/thx.48.9.925

[46] Sahn, S.A. (2007) Diagnosis and Management of Parapneumonic Effusions and Empyema. *Clinical Infectious Diseases*, **45**, 1480-1486. https://doi.org/10.1086/522996

[47] Maskell, N.A. (2006) The Bacteriology of Pleural Infection by Genetic and Standard Methods and Its Mortality Significance. *American Journal of Respiratory and Critical Care Medicine*, **174**, 817-823. https://doi.org/10.1164/rccm.200601-074OC