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Purulent Meningitis in Children in African Hospitals

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Abstract

Introduction: Purulent meningitis (PM) in children poses a public health problem, particularly in countries in the African meningitis belt. The aim of this study was to investigate the epidemiological, clinical, and evolutive aspects of pediatric bacterial meningitis in African hospitals. **Methodology:** This is a retrospective, descriptive, and analytical study covering a six-year period from 2017 to 2022. **Results:** The hospital admission rate was 1.17%. The average age was 12.4 months. Malnutrition, asthma, and sickle cell disease were the main underlying conditions. Thirty-seven children (41.1%) had received antibiotics prior to hospitalization. Fever, seizures, and signs of meningeal irritation were the main clinical manifestations. The cerebrospinal fluid (CSF) was cloudy in 52.2% of patients. The average cytorrhea was 123 elements/mm^3. The glycorrhea-glycemia ratio was less than 0.40 in 36 patients. CSF culture was positive in 8.9% of cases. Pneumococcus was the most common pathogen (37.5%). Bacterial resistance to amoxicillin was the most significant. Ceftriaxone was the most commonly used drug in therapy (83.3%). Thirty-four patients (37.77%) had received corticosteroid therapy. The mortality rate was 12.22%. Epilepsy was the main sequella encountered (3.3% of cases). Factors associated with poor prognosis were low birth weight, lack of vaccination, delayed consultation, malformation of the central nervous system, glycorrhachia below 0.40, and pneumococcal or meningococcal infection. **Conclusion**: Purulent meningitis in children remains a serious disease despite the progress made thanks to vaccination and improved hospital care. Awareness of antibiotic abuse must be raised.

Keywords

Purulent Meningitis, Children, Senegal

1. Introduction

Meningitis is an inflammation of the meninges and cerebrospinal fluid caused by common germs, the main ones in children being *Haemophilus influenzae b*, *Streptococcus pneumoniae*, and *Neisseria meningitidis*. Other germs may be encountered depending on age (newborns), underlying conditions (immunodeficiency), and specific circumstances (iatrogenic meningitis) [1]. It is a significant medical emergency and public health issue, particularly in countries within the Lapeyssonnie meningitis belt in sub-Saharan Africa, where periodic epidemics of cerebrospinal meningitis occur. It is estimated that there are one million cases of meningitis worldwide each year, resulting in 200,000 deaths. It is more common in tropical areas, with a prevalence of 17 to 38 cases per 100,000 inhabitants, depending on the area [2]. The case fatality rate varies between 3% and 19% in developed countries, but remains higher (37% - 60%) in developing countries where treatment conditions are often precarious [3]. The epidemiology of purulent meningitis in children is constantly changing. These changes are the result of several factors, the most important of which is the introduction of vaccines against *Haemophilus influenzae type b*, *Streptococcus pneumoniae*, and *Neisseria meningitidis* in many countries [4]. In Senegal, purulent meningitis continues to be prevalent among children, with an estimated hospital admission rate of 1.9% in 2018 [5]. We decided to undertake this work with the overall objective of providing an overview of current knowledge on purulent meningitis from an epidemiological, diagnostic, and prognostic perspective in pediatric hospitals in sub-Saharan Africa.

2. Methodology

2.1. Study Setting

The study was conducted in the Thies region (70 km from Dakar, the capital of Senegal), in the department of Mbour, located 80 km south of the capital and known for its seaside resort of Saly Portudal. The department of Mbour is a crossroads between the capital Dakar and the northern and eastern parts of the country, with a population of over 935,304. The largest healthcare facility in this region remains the MBOUR Departmental Hospital Center, which is a Level 1 hospital offering specialized medical and surgical care. The pediatrics department is divided into a general pediatrics unit, a type 2A neonatal unit, and a pediatric emergency room. It has 44 beds and admits an average of 1200 patients per year, nearly half of whom are newborns.

2.2. Type and Period of Study

This was a retrospective descriptive and analytical study covering a period of six (06) years, from January 1, 2017, to December 31, 2022.

2.3. Study Population

All children aged 0 to 16 years hospitalized in the pediatric ward for common bacterial meningitis during the study period were included in the study.

The diagnosis of purulent meningitis, suspected on the basis of suggestive symptoms and/or cloudy or purulent CSF, was confirmed by the presence of hyperproteinorachia greater than 1 g/L, hypoglycorrhachia with a CSF glucose to blood glucose ratio of less than 0.4 associated with hypercellularity greater than 10 cells/mm^3 with the presence of altered neutrophils and/or the discovery of a common germ in cerebrospinal fluid bacteriology.

2.4. Data Collection

The parameters taken into account in the files were:

- Socio-demographic data: month of hospitalization, year of hospitalization, age in days or months, sex, geographical origin, mother's occupation, socioeconomic status, ante- and perinatal history in newborns, and predisposition.
- Clinical data: vaccination, antibiotic therapy prior to hospitalization, mode of arrival, time of consultation, length of hospitalization, reasons for consultation, vital signs on arrival, clinical signs on arrival, lumbar puncture conditions, and macroscopic results.
- Paraclinical data: results of cytological, chemical, and bacteriological analysis of cerebrospinal fluid (CSF), blood cultures and their results, imaging results.
- Treatment and progression: the delay in starting antibiotic therapy, the antibiotics administered, the addition of corticosteroid therapy, and treatment modalities as the condition progresses.

2.5. Data Analysis

Data entry was performed using Excel version 16.0, and analysis was performed using R Studio software version 5704.12.1.0.

Qualitative variables were described in terms of numbers and percentages, and quantitative variables were described in terms of means with extremes.

We investigated the possible influence of variables such as age, birth weight, time to consultation, predisposition, proteinuria, glycorrhachia, causative bacteria, corticosteroid therapy, and antibiotic therapy on patient outcomes using the chi-square test. The difference was statistically significant when the p-value was strictly less than 0.05.

3. Results

3.1. Epidemiological and Sociodemographic Data

- Hospitalization frequency

From January 1, 2017, to December 31, 2022, 7685 children were hospitalized in the pediatric ward: among them, 90 cases of purulent meningitis were recorded, representing 1.17% of hospitalizations.

- Hospitalization period

The year 2020 recorded the highest number of cases with 31.1% (n = 28), followed by 2021 with 30% (n = 27). The disease was prevalent throughout the year; the majority were admitted in January with 18.9% of cases (n = 17); June recorded the fewest hospitalizations with 3.3% of cases (n = 3) (**Figure 1**).

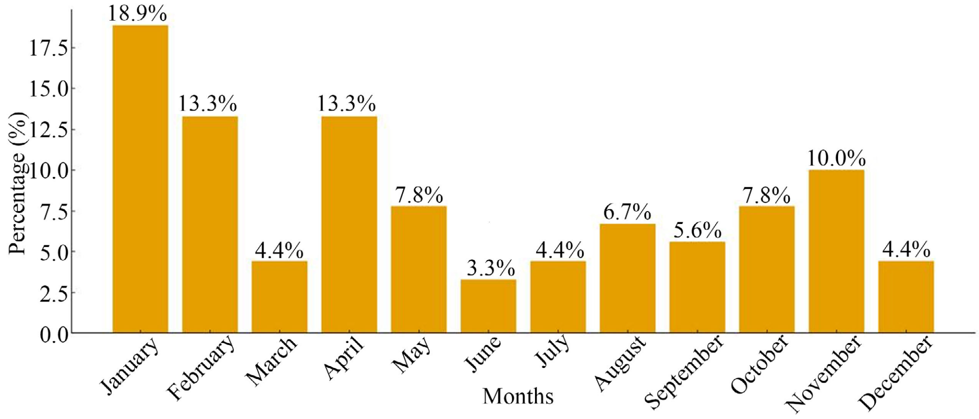

Figure 1. Distribution by month of hospitalization.

- Distribution by gender

Males were predominant at 74.4% (n = 67) with a sex ratio of 2.9.

- Distribution by age

It ranged from 0 days to 192 months (16 years). The average age was 12.4 months. Most cases of meningitis occurred between 2 and 24 months (48 cases, or 53.3%).

The peak frequency was among infants between 1 and 6 months (25 cases, or 27.8%). Neonatal bacterial meningitis accounted for 13.3% of the total in our series, or 12 newborns. We found a proportion of older children at 16.7% (n = 15).

- Parents' socioeconomic status (SES)

Most of the children's mothers (62.2%) were homemakers.

We noted that 63.33% of patients (n = 57) had a low socioeconomic status, 18.8% (n = 17) had a medium SES, and 3.3% (n = 3) had a high SES.

3.2. Background and Specific Circumstances

- Term and birth weight

Three newborns weighed less than 2500 g, two were premature.

- Neonatal infection risk factors

We found these in 50% of newborns (n = 6). Premature rupture of membranes and unexplained prematurity were the most common infectious risk factors (66.6%). Unexplained prematurity in 33% of cases (n = 2), maternal fever in 16% (n = 1).

- Existence of a predisposing condition

Malnutrition, asthma, and sickle cell disease were the main predisposing conditions found. In relation to the study population, we found that 12.22% of children were malnourished (n = 11), 12.22% of children with asthma, nine children with sickle cell disease (10%), encephalopathy in 10% (n = 4), heart disease in

7.5% (n = 3), malformations of the central nervous system in 5% (n = 2) and HIV infection in 2.5% (n = 1). A history of hospitalization was present in 10% of patients (heart disease, sickle cell disease, encephalopathy, pulmonary infections).

- Vaccination status

The vaccination status was known for 77 children (85.5%); among them, 54 patients (60%) were up to date according to Senegal's expanded program on immunization (EPI) and 8 patients (8.9%) had received all doses of vaccines included in this EPI. Sixteen percent (n = 15) had incomplete vaccination status.

- Antibiotic therapy initiated prior to hospitalization

Thirty-seven patients (41.1%) had received antibiotics prior to hospitalization.

Amoxicillin-clavulanic acid, prescribed in 21 cases (56.75%), and cefixime, prescribed in 33.75% (n = 12) of cases, were the two most commonly used antibiotics. Five patients (13.72%) received dual antibiotic therapy; a triple combination was used in one child (2.7%). In addition, the use of unspecified oral herbal medicine was reported in 5.2% of patients in our series.

3.3. Clinical Data

- Time to consultation

Fifty-three patients, or 58.9% of cases, had their first consultation between the 2nd and 7th day after the onset of symptoms, and 19% after more than 7 days. The minimum time between the onset of symptoms and the first consultation was 0 days, or less than 24 hours, while the maximum time was 14 days. The average was 4.65 days (±3.85).

- Mode of arrival

This information was provided for 87 patients (96.67%). Children were brought in by their parents in 60.91% of cases (n = 53) and 39.08% (n = 34) arrived by transfer. Among the transferred patients, 26.47% (n = 9) came from the hospital's emergency and admissions department, representing 10% of the patients in the series.

- Reasons for consultation

The main reasons for consultation were: fever in 85.60% of cases, convulsions (55.6%), vomiting (31.10%), and impaired consciousness (23.30%).

- Temperature on arrival

The average temperature was 38.0˚C, with extremes of 35.1˚C and 40.6˚C. A total of 81 patients (90%) had a measured fever on admission. The majority had hyperthermia between 38˚C and 39˚C.

- Physical examination data

The main physical signs found in our patients were: convulsions (37.78%), signs of meningeal irritation (stiff neck, Kernig's and/or Brudzinski's signs) in 30% of cases, bulging fontanelle (24.4%), and altered consciousness in 23.3% of cases.

One patient presented with purpura (Table 1).

Table 1. Distribution according to physical examination data.

Physical signs	Number	Percentage (%)
Convulsions	34	37.78
Signs of meningeal irritation	27	30
Bulging fontanelle	22	24.4
Altered consciousness	21	23.3
ENT or pulmonary signs	19	21.1
Muscle tone disorders	17	18.89
Dehydration	13	14.4
Shock	9	10
Cutaneous hyperesthesia	7	7.78

ENT or pulmonary signs: rhinorrhea, congestive otitis, pulmonary condensation, wheezing.

3.4. Biological Data

- Orientation tests

For the blood count: neutrophils were predominant in 91.2% of cases. The average hemoglobin level was 09.31 g/dl (±1.49) with a minimum of 5.2g/dl and a maximum of 14.9 g/dl. Blood ion levels were measured in 49.3% of cases, or 44 patients. Hyponatremia was present in 22.6% of cases and hyperkalemia in 19.8% of cases (**Table 2**). CRP was performed in 96.7% of cases, or 88 patients, and was positive > 12 in 66.7%. Blood culture results were reported in five (5) patients, or 5.5% of cases, and were all negative.

Table 2. Distribution according to CBC and blood ionogram results.

		Frequency (%)		
Parameters		Normal	Lowered	Hight
CBC	White blood cells	30.1	0	70.9
	Hemoglobin	16.7	83.3	0
	Platelets	64.4	7.8	27.8
Blood ionogram	Na^+	59.22	22.68	18.1
	K^+	74.9	5.3	19.8
	Cl^-	93.1	3.6	3.3

- Certitude examination

➢ Study of the CSF

The time between admission to hospital and the first puncture was specified in 84 patients (93.33%). The majority (56.7%) received a puncture on the day of admission. The average delay was 2 days, with extremes of 0 and 10 days. The puncture was performed more than 48 hours after admission in 14 patients (15.6%)

and more than 72 hours after admission in 5.6% of cases. CSF was hypertensive in 63.3% of cases. It was cloudy or turbid in 52.2% of children and frankly purulent in 7 patients (7.8%). It had returned to clear in 33.3% of cases.

Cytology ranged from 10 cells/mm^3 to uncountable leukocyte clusters, with an average of 123 cells/mm^3. The majority of patients (52.8%) had pleocytosis greater than 100 cells/mm^3. Patients with cytorachia greater than 500 cells/mm^3 accounted for 28.9%. The percentage of altered polymorphonuclear neutrophils (PMNs) was reported in 73 patients (81.06%). Twenty-one patients (29.48%) had a percentage of altered NPM greater than or equal to 50%. In addition, 7 children, or 7.7%, had a predominantly lymphocytic leukocyte count.

Proteinorachia ranged from 0.13 g/L to 7.8 g/L, with an average of 1.4 g/L. The vast majority of patients (94.14%) had hyperproteinorachia. Among them, 36.12% had hyperproteinorachia between 0.40 g/L and 1 g/L; one child (1.1%) had proteinorachia greater than 5 g/L. The average glycorachia was 0.41 g/L, ranging from 0.03 g/L to 2.01 g/L. The majority of patients (66.77%) had hypoglycorachia.

The glycorachia/glycemia ratio was less than 0.4 in 40% of cases (n = 36). For bacteriology, direct examination of CSF was positive in 18.8% of cases (n = 17): 4% were Gram-negative bacilli; Gram-positive diplococci suggestive of *Streptococcus pneumoniae* were found in 8%; Gram-positive cocci in 3.4% and Gram-negative diplococci in 3.4%. The latex test was performed in 41 patients (45.55%).

It was positive in 18 of them, or 20.00%. The results of the CSF culture were known in 90 patients (100%). It was positive in 8 of them, or 8.9% of cases. The bacteria identified were *Neisseria meningitidis W*135 (1 case), *Escherichia coli* (1 case), *Staphylococcus aureus* (1 case), *Streptococcus pneumoniae* (3 cases), *Haemophilus influenzae b* (1 case), and *Klebsiella oxytoca* (1 case). The child affected by *Haemophilus influenzae type b* meningitis was up to date with vaccinations according to the national program. Vaccination against *Neisseria meningitidis* is not included in the national vaccination program, and a large part of the population does not receive it as a supplement.

Among the 37 children who had received antibiotic therapy prior to hospitalization, 35 (94.6%) had negative cultures. Depending on age, *Streptococcus pneumoniae* was found in the 0 - 24 month and 61 - 180-month age groups. It was more common in infants. It infected 1 of the 4 sickle cell children in our series, or 25% (**Table 3**). The affected children had completed the full vaccination schedule according to the national program.

Antibiograms were performed in 8 cases (8.88%). Among the *Streptococcus pneumoniae* strains that were tested, only one was resistant to ceftriaxone. The Hib strains were sensitive to ceftriaxone but resistant to the combination of amoxicillin and clavulanic acid. *Klebsiella oxytoca* was sensitive to the penicillins tested (ampicillin and amoxicillin); *E. coli* was resistant to penicillins but remained sensitive to third-generation cephalosporins (C3G), aminoglycosides, and imipenem. *Neisseria meningitidis* was resistant to penicillins but sensitive to C3Gs, ciprofloxacin, and vancomycin. *Staphylococcus aureus* was sensitive to amoxicillin and ceftriaxone.

Table 3. Distribution by age and identified pathogen.

Germs/age	0 - 24 months	25 - 60 months	61 - 180 months	Total
*Nm W*135	1	0	1	1
Pneumococcus	2	1	0	3
Haemophilus influenzae b	1	0	0	1
Staphylococcus aureus	1	0	0	1
Klebsiella oxytoca	0	1	0	1
Escherichia coli	1	0	0	1
Total	5	2	1	8

3.5. Imaging Data

ETF was performed in 18.88% of cases (17 patients) and was normal in 12.22% (11 patients). The abnormalities observed were: intracranial hypertension (3 cases), hydrocephalus (2 cases), and cortical atrophy (1 case). Cerebral CT scans were performed in 23.3% of cases (21 patients) and were normal in 11.1% of cases (11 patients). The abnormalities observed were: intracranial hypertension (6 cases), hydrocephalus (2 cases), cerebral abscess (1 case), cortical atrophy (1 case), and cerebral ischemia (1 case).

3.6. Therapeutic Data

Regarding antibiotic therapy, the time of initiation was reported in 87 patients (96.6%) and had been started on the first day in 98.34% of patients. The average was 1 day; the time varied between 1 and 2 days.

Third-generation cephalosporins were the preferred molecules for patient management: ceftriaxone was the most commonly used antibiotic. It was used in the treatment of 75 patients (83.3%): as monotherapy in 66.66% of cases or in combination therapy in 15 patients, *i.e.*, 20%. Aminoglycosides (amikacin and gentamicin) were always used in combination with other antibiotics. Dual antibiotic therapy was used in 38 patients (42.22%). The most common combinations were: ceftriaxone + gentamicine (39.47%, n = 15);

- Ciprofloxacin + gentamicin (7.9%, n = 3);
- Cefotaxime + gentamicin (5.26%, n = 2).

The duration of this antibiotic therapy ranged from 5 to 29 days, with an average of 13 days. The majority (76.67%) received antibiotics for 8 to 14 days. We noted prolonged treatment beyond 3 weeks in 3.3% of patients. Corticosteroid therapy was instituted in 34 patients (37.77%) in combination with antibiotic treatment.

Hydrocortisone was the most commonly used drug (50%). Six patients (17.64%) received dexamethasone, eight received betamethasone (23.5%), and three received methylprednisolone (8.8%).

3.7. Patient Outcomes

The average length of hospital stay was 11.3 days, ranging from 5 to 29 days. Thirty-seven patients (41.1%) were hospitalized for between 6 and 10 days. Nearly 13% of patients stayed for more than 2 weeks. More than two-thirds (75.55%, n = 68) had a favorable outcome. Complications were present in 24.44% of our patients (n = 22). Ionic disorders were the most common at 59% (n = 13), followed by status epilepticus at 50% (n = 11), intracranial hypertension at 27% (n = 6), shock at 13% (n = 3), renal failure 13% (n = 3), and hydrocephalus 9% (n = 2). Transfer to a higher-level facility was performed in 7.7% of cases (n = 7).

The mortality rate was 12.22% (n = 11). The time of death was recorded for 7 patients (63.63%); death occurred on average after 12.3 days of hospitalization, but this period varied from 4 to 29 days.

Newborns and young infants aged 1 to 6 months were the most affected (53.37%). Sequelae were found in 4 patients (4.44%). The most common was epilepsy.

Sensory deficits such as deafness, blindness, speech disorders, and facial paralysis were also found in surviving patients (n = 1 for each). Certain factors influencing the outcome were analyzed:

- Age: we observed more deaths (26.66%) in children aged 5 years (**Table 4**).

Table 4. Evolution by age.

Age group	Recovery	Death	Sequelae	Transfert
	N (%)	N (%)	N (%)	N (%)
0 à 24 months	46 (76.7)	8 (13.3)	2 (3.3)	4 (6.7)
25 - 60 months	10 (66.7)	2 (13.3)	1 (6.7)	2 (13.3)
61 - 181 months	12 (80)	1 (6.7)	1 (6.7)	1 (6.7)

P-value = 0.04.

- Outcome according to vaccination status, time to consultation, and glycorrhachia/glycemia ratio

The outcome was favorable in patients who were properly vaccinated (88.09%) compared to those who had not been vaccinated or those whose vaccination was incorrect, P = 0.05. The outcome was less favorable in patients who consulted a week after the onset of symptoms, P-value = 0.04.

The outcome was less favorable in patients with a glycorrhachia/glycemia ratio of less than 0.40.

- Progression according to bacteriology, antibiotic therapy, and corticosteroid therapy

We observed more deaths among patients whose bacteriology had returned negative and those infected with pneumococcus and meningococcus. No deaths or sequelae were recorded among patients infected with *Haemophilus influenzae b*. We observed a favorable outcome when the following molecules were used:

C3G (ceftriaxone, cefotaxime), vancomycin, ciprofloxacin, Imipenem. p = 0.023

The addition of a corticosteroid improved the clinical outcome with a p = 0.03.

4. Discuss

4.1. Epidemiological Data

- **Hospitalization frequency**

In our study, the hospital frequency of purulent meningitis was 1.17%, or 1170 cases per 100,000 hospitalizations. This incidence has remained similar in Africa over the last 10 years, with Basse *et al.* [5] reporting a hospital incidence of 1900 cases per 100,000 hospitalizations in Senegal in 2018. In Mali, Kane *et al.* [6] in 2020 reported a hospital frequency of 1400 cases per 100,000 hospitalizations.

- **Hospitalization period**

There was an increase in the number of PM cases from 8.9% in 2019 to 31.1% in 2020. This increase can be explained by the fact that in 2020, a 50% reduction in resources for the elimination of purulent meningitis by 2030 was noted in African countries due to the COVID-19 pandemic.

The pandemic has caused significant disruptions to health services, including routine immunization programs, with more than 50 million children in Africa not vaccinated against type A meningitis. Lockdowns, transportation issues, and the reallocation of health resources have led to a decline in vaccination coverage rates for different meningococcal serogroups in several countries in 2020.

Public health messages about staying home and fear of contracting COVID-19 in health care facilities discouraged people from seeking medical care for other symptoms, including those of meningitis [7].

Confirming the trends presented in the literature [8], our study found that PM was prevalent throughout the year. The main peaks were recorded during the dry season.

- **Age**

Half of the children admitted to hospital for MP were between 1 and 24 months old. Infants were therefore the most affected age group, as described in the literature by Tfifha *et al.* in Tunisia [9].

4.2. Antibiotic Therapy Received Prior to Hospitalization

We observed antibiotic use in 41.1% of cases. This latter observation is higher than that reported in studies by Sonko *et al.* [10] and Basse *et al.* [8] in Senegal and by El Fakiri *et al.* [11] in Morocco, which indicated rates of antibiotic therapy prior to hospitalization of 18%, 22.86%, and 26%, respectively.

4.3. Clinical Signs

The symptoms did not vary greatly from those reported in previous studies, with fever accompanied by headaches, vomiting, and seizures. However, altered consciousness was found in 23.3% of cases. The study by El Fakiri *et al.* in Morocco reported a lower rate of 17% [11]. An ENT or pulmonary infection was observed during physical examination in 21.1% of cases. The role of ENT and pulmonary infections as entry points for MPE is no longer in question [12]. The high rate of antibiotic use prior to hospitalization (41.1%) contributes to significant diagnostic delay by masking the typical manifestations of the disease.

4.4. Paraclinical Data

➢ **Biology**

Hyponatremia was noted in 22.68% of our cases. This result is comparable to that of Basse *et al.*, [8] who reported 28.57% of cases. Blood culture was negative in 100% of cases. This result differs from that of Thifha *et al.* [9] in Tunisia and Vu Thien [13] in France, who reported positive blood cultures in 20.4% and 70% of cases, respectively. This difference can be attributed to the under-equipment of our laboratories, the availability of blood culture bottles, and difficulties in transporting, storing, and analyzing samples.

➢ CSF analysis

The CSF was cloudy in 52.2% of cases, consistent with what is usually reported in studies [8].

Identification of the pathogen by CSF culture was positive in 8.9% of cases. This rate is lower than that reported in other studies, such as that by Jouhadi *et al.* [14] in Morocco, which found a rate of 64.4%. Detection of pathogens by CSF culture in developing countries in general, and in CM countries in particular, is difficult. The reasons for this are inadequate technical facilities, the administration of antibiotics before LP, and the time and conditions of transport of the sample to the laboratory, which are incompatible with the survival of fragile bacteria or a very low bacterial inoculum. Among the germs identified, the main one was pneumococcus in 42.85% of cases, as reported in the recent study by Smith *et al.* in the United States [15]. The high rate of antibiotic use prior to hospitalization (41.1%) is a major limitation of the study. This likely contributed to the low rate of positive CSF cultures (8.9%), which could lead to an underestimation of the true prevalence of certain pathogens.

4.5. Treatment

A third-generation cephalosporin (C3G) was used in 84.5% of cases. Ceftriaxone was the most commonly used antibiotic (83.3%). Gillet *et al.* reported in 2023 that C3Gs remained the antibiotics of choice [16]. In Canada, while awaiting culture results, most experts recommend adding vancomycin to third-generation cephalosporin to protect the patient against the possibility of cephalosporin-resistant S pneumoniae, which has been reported in some regions of Canada. Third-generation cephalosporins are also suitable for the empirical treatment of *N meningitidis* and *Haemophilus influenzae* [17]. Only one (1) case of resistance to ceftriaxone was noted in our study. In France, over the last few years, the national pediatric meningitis network of the Pediatric Infectious Diseases Group (PIDG) and the National Pneumococcal Reference Center have not recorded any cases of meningitis caused by pneumococci resistant to third-generation cephalosporins (C3G), even though strains with a less favorable profile appeared in 2021 [16].

Indeed, the high rate of antibiotic use prior to hospitalization (41.1%) contributes to the emergence of antibiotic-resistant bacteria, which has justified the use in some cases (0.7%) of rarely administered antibiotics such as vancomycin and ciprofloxacin.

However, resistance to amoxicillin was found in 42.85% of cases. In 2015 in France, Hoen *et al* [18] found in their work that Nm was resistant to amoxicillin and penicillin G in 30% of cases.

The SPILF recommends that antibiotic therapy should ideally be started within one hour of the arrival at the hospital of a patient suspected of having purulent meningitis, regardless of the time elapsed since the presumed onset of the disease [18] [19]. In our study, antibiotic therapy was started on the day of admission in 98.34% of cases. The average duration of treatment with ceftriaxone was 13 days ±10.3 days. This corresponds to the recommended duration for the treatment of purulent meningitis with C3G (7 to 21 days depending on the etiology) [19].

Corticosteroids were used in 37.77% of cases. Due to the potential benefits and low risk profile of initial treatment with dexamethasone for 24 to 48 hours, European guidelines recommend empirical administration of dexamethasone in both adults and children with suspected or confirmed meningitis [20]. Only dexamethasone is recommended because it is the only corticosteroid that has been evaluated as an adjunct to the treatment of purulent meningitis. The dose is 0.15 mg/kg intravenously, repeated every 6 hours for 4 days [17]. The debate on the use of corticosteroids depends on the school of thought. In the context of our study, it is all the more difficult to reach a conclusion given the low percentage of objectively identified causative organisms. These reasons explain the low rate of corticosteroid therapy recorded in our study.

4.6. Evolution

The recovery rate without sequelae varies and depends on hospital facilities, the populations studied, treatment conditions, countries, etc. In our study, it was 75.55%, higher than that reported by Camara *et al.* [21] in 2003 in Senegal. There has therefore been an increase in patient survival thanks to advances in vaccination and improvements in hospital care.

The mortality rate was 12.22%. This is comparable to the rate observed by Thabet *et al.* [12] in Tunisia, which was 13.7%. This mortality rate was higher in children under 5 years of age, n = 10/11, representing 90.90% of deaths. These results demonstrate the severity of purulent meningitis at this age. The immaturity of the immune system and the virulence of the germs involved at this age contribute, among other factors, to an unfavorable clinical outcome in patients. *S. pneumoniae* is known to be the most deadly germ and the leading cause of post-meningitis sequelae [3]. In our study, it was the most lethal pathogen after meningococcus and the only one to cause sequelae. Based on our study, we identified the following factors as indicators of poor prognosis: low birth weight, the presence of a central nervous system malformation or encephalopathy, a glycorrhachia-glycemia ratio of less than 0.40, pneumococcal or meningococcal infection, lack of vaccination or incorrect vaccination, and delayed consultation.

5. Conclusion

Purulent meningitis remains a major public health problem in Africa, particularly among young children. Despite advances in diagnosis and treatment, mortality rates remain high, largely due to the growing emergence of bacterial strains resistant to conventional antibiotics, which complicates treatment. However, there is real hope on the horizon. On the one hand, the expansion of vaccination programs, particularly against *Haemophilus influenzae type b*, pneumococcus, and meningococcus, is already helping to reduce the incidence of these serious infections. This strategy to combat meningitis must prioritize the systematic vaccination of young children and young adults in communities, while maintaining rigorous epidemiological surveillance in densely populated areas.

Conflicts of Interest

The authors declare that they have no conflicts of interest regarding the publication of this article.

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