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Epidemiological, Clinical, Bacteriological and Evolutionary Profiles of Bacterial Meningitis in Children in Bangui (CAR)

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Abstract

Background: Bacterial meningitis is a major public health problem worldwide due to its severity. It is a vaccine-preventable disease. **Methodology:** It was a retrospective descriptive study conducted at the Pediatric Teaching Hospital of Bangui from June 2019 to May 2021. Children aged 1 month to 15 years hospitalized for bacterial meningitis were included in the study. Data were entered and analyzed using Stata/IC version 16.1. **Results:** Of 2490 patients hospitalized during the study period, 122 (4.9%) had bacterial meningitis. The patients were male in 54.92% of cases with a sex ratio of 1.21. The mean age was 35.95 months ± 49.16. Most of the patients (84.42%) came directly from home. The average consultation delay was 3.4 days ± 2.6. The vaccination coverage was 56.55%. The CSF study isolated germs from 24 patients (19.67%), the main ones being *S. pneumoniae* (75%) and *H. influenzae* (16.67%). Ceftriaxone was prescribed alone or in combination in all cases as first-line treatment. The average duration of antibiotic therapy was 8.95 days. The mortality rate was 27.87% and 12.30 % of patients had sequelae. **Conclusion:** Bacterial meningitis is common in Bangui and still poses a public health problem despite the introduction of new vaccines in the EPI. Improving vaccination coverage and raising awareness for early consultation could improve the situation.

Keywords

Bacterial Meningitis, Child, Bangui

1. Introduction

Bacterial meningitis is a major public health problem worldwide [1] [2] [3] [4].

It is a very serious disease, with severe sequelae and a high case-fatality rate within 24 to 48 hours [1] [3] [5] [6] [7]. Severe sequelae are observed in 10% to 20% of survivors. These include mental retardation, deafness, epilepsy or other neurological disorders [3] [5] [6] [7]. A higher case-fatality rate (37% - 60%) has been reported in developing countries [3]. The "African meningitis belt" comprises 26 countries, including the Central African Republic (CAR) [2] [5] [6] [8]. A study carried out in Bangui (CAR) from October 2004 to September 2005 showed a high prevalence of bacterial meningitis at 40.05%, with a case-fatality rate of 35% [9]. The most common germs in CAR are *Streptococcus pneumoniae*, *Haemophilus influenzae* and *Neisseria meningitidis* [4] [10]. The introduction of vaccines in the Expanded Program on Immunization (EPI) against *Haemophilus influenzae* and *Streptococcus pneumoniae* took place in 2008 and 2011 respectively. Mass vaccination against Neisseria meningitidis began in 2010. According to the 2012 EPI evaluation report, 13% of children were fully vaccinated by the age of 1. In 2014, the proportion of children having received three doses of Pentavalent vaccine was 45% [11]. These reports mention coverage levels from one year to the next, without devoting any time to assessing the effectiveness of vaccines against meningitis-causing germs since their introduction. In carrying out this study more than ten years after the introduction of these vaccines, we set ourselves the objective of evaluating the effectiveness of the preventive strategy by reporting here on the epidemiological, clinical, bacteriological and evolutionary aspects of bacterial meningitis in children treated in the only paediatric referral hospital in the Central African Republic.

2. Materials and Methods

This was a cross-sectional, descriptive study with retrospective data collection, over a two-year period; running from June 1, 2019 to May 31, 2021. It concerned children aged 1 month to 15 years hospitalized in the intensive care unit of the pediatric university hospital complex of Bangui for probable bacterial meningitis or in whom the diagnosis of bacterial meningitis was confirmed. Probable bacterial meningitis is defined as: Any clinical situation with neurological signs and a cerebrospinal fluid (CSF) test result showing at least one of the following:

- Cloudy or purulent fluid;
- Leukocyte count greater than 10 cells/mm^3 with elevated-proteinorachy (≥1 g/L) and/or decreased glycorachy < 0.4 g/L;
- Gram stain positive.

Bacterial meningitis was confirmed by culture or identification of a germ in the CSF [3] [4] [12].

Sampling was exhaustive. A pre-established survey form was used to collect data from hospitalization records. The variables studied were: epidemiological data, vaccination status, clinical and biological history, and hospitalization outcome. Data entry was performed using Excel software.

The study was carried out in strict confidence.

3. Results

3.1. Epidemiological Characteristics

A total of 122 cases of bacterial meningitis were recorded out of 2490 children hospitalized during this period, representing a rate of 4.9%. In this study, 69 patients (56.55%) had a notified vaccination status.

3.2. Socio-Demographic Profile

The average age was 35.95 months ± 49.16, with extremes ranging from 1 to 180 months. Males accounted for 54.92%, with a sex ratio of 1.21. Children aged 1 to 59 months accounted for 50.81%, with those aged 24 to 59 months accounting for 29.50%. Patients came from home in 84.42% and referred in 15.58%.

3.3. Clinical Features

The main functional signs are represented by fever (100%), vomiting (61.5%), convulsion (52.5%), digestive disorder (26.2%), loss of consciousness (24.3%), neck pain (22.1%), and headache (19.7%).

The main physical signs were stiff neck (77%), Brudzinski and Kernig signs in 64.7% and 59% respectively; bulging fontanel (15.6%), hypotonia (11.5%) and irritability (11.5%).

3.4. Paraclinical Profile

The mean cellulorachy was 469.541/mm^3 with extremes of 50 - 6800. The mean proteinopathy was 235.2623/mm^3 with a minimum of 100 and a maximum of 500. Hypoglycorrhachia was noted in 13.93% (Table 1).

In terms of treatment, Ceftriaxone was used as first-line therapy in 46.73% of cases, followed by the combination Ceftriaxone + Vancomycin (44.26%). Seventeen patients received second-line treatment, with the Ceftriaxone + Ciprofloxacin combination accounting for 64.77% (Table 2).

In this series, 84 patients (68.85%) had a favorable outcome, with sequelae in 15 (12.30%), and 4 patients (3.27%) were discharged against medical advice. Sequelae included speech, visual, motor and tone disorders. The case-fatality rate was 27.87%. The mean duration of death was 2.29 ± 2.2 days, with extremes ranging from 1 to 13 days. Four out of five patients died within the first 48 hours. Fourteen patients had benefited from a sterile CSF study. No brain scans were performed in this study.

4. Discussion

4.1. Prevalence

From the point of view of the extent of meningitis at national level, comparing the prevalence in 2021 with that in 1996, before the introduction of vaccines against the germs responsible for bacterial meningitis, shows an increase, whereas we would expect a decrease. The prevalence of bacterial meningitis in our

Table 1. Distribution of patients by paraclinical characteristics.

LCS study	Number (N = 122)	Percentage
Macroscopic appearance		
Disorder	104	85.25
Purulent	13	10.66
Xantochromic	2	2.46
Clear	3	1.64
Cytology WBC (element/mm^3)		
10 - 99	19	15.57
100 - 999	89	72.95
>999	14	11.48
Cytology PNN (%)		
50 - 70	4	3.28
>70	118	96.72
Chemistry (glycorachy: mg/dL)		
0 - 39	17	13.93
40 - 125	105	86.07
Bacteriology (Direct examination)		
Gram-positive bacilli	2	1.63
Gram-negative bacilli	5	4.09
Gram-positive cocci	35	28.68
Gram-negative cocci	2	1.63
Absence of germs	78	63.93
Bacteriology (culture)		
Pneumococcus	18	14.75
H. influenzae	4	3.27
E. coli	1	0.81
Acinetobacter baumannii	1	0.81
Sterile	84	68.85
Not performed	14	11.47

Table 2. Distribution of patients by age and germs.

Age (months)	Germs				Total
	Pneumococcus	*H. influenzae*	*E. coli*	*Acinetobacter baumannii*	
>3 - 59	11	4	1	1	17
60 - 180	7	0	0	0	7
Total	18	4	1	1	24

No germs were identified in the 1 to 3 months age group.

series was 4.9%, compared with 4.5% in Bangui in 1999 [13]. This high prevalence may be explained by inadequate vaccination coverage. Bangui, the capital of the Central African Republic, has experienced a number of military and political events, which may influence the updating of children's vaccination status. Ignorance of the importance of vaccination on the part of some parents would explain exposure to this disease, contrary to the findings of some African authors [14] [15] [16] [17] [18].

4.2. Sociodemographic Characteristics

The average age was 35 months, and patients under 5 years of age were the most represented (50.81%). In this age group, immunity is still low, which would expose these children to all infections [2]. Our results corroborate data from the literature and other authors [2] [3] [19] [20] [21]. In their studies, some authors have found that children under one year of age are the most affected [12] [15] [17] [22]. Males predominate in our series, with a sex ratio of 1.21. This result corroborates data from numerous authors [4] [9] [13] [22]. The majority of children (84.42%) came directly from their homes. This can be explained by parents' ignorance of the need to take their children to hospital in the event of the first symptoms of illness, on the one hand, and their reliance on traditional treatment, on the other. This observation was made by Maiga B *et al.* [18]. In our series, 69 patients (56.55%) had their vaccination status recorded in the files, of whom we do not know the proportion of children who had received the appropriate doses of vaccine for their age, or those who were fully vaccinated. On the one hand, the number of vaccines received was not specified in the files, and on the other, most of the information was given by the parents and not verified in the vaccination record, making it difficult to know whether these children are really vaccinated. However, immunity is acquired after three doses of pentavalent vaccines [1] [19] [23]. Nguefack F *et al.* found a low vaccination coverage rate of 19.4% [24]. On the other hand, Maiga *et al.* showed a vaccination coverage of 88% against pneumococcus and H influenzae [18]. With regard to the timing of bacterial meningitis, an upsurge in cases has been observed in the first half of 2021. The COVID-19 pandemic began in Bangui in the middle of 2020, and with confinement, parents would not have been able to update their children's vaccination status, which would expose them to this disease after a few months.

4.3. Clinical and Paraclinical Data

Meningeal signs were dominated by fever (100%), stiff neck (77%), brudzinski (64.7%) and kerning (59%). These signs represent the classic triad of the meningeal syndrome [1] [2] [3] [5] [19] [25]. In infants, the signs are frustrated. Many authors have reported these signs in their studies [7] [10] [12] [17] [26] [27].

Cerebrospinal fluid studies were carried out in all patients. Cloudy and purulent aspects predominated in 85.25% and 10.66% respectively. Cellulorachy was

greater than 50/mm^3 overall, with neutrophilic polynuclear predominance in 96.72% of cases. Proteinorachy greater than or equal to 100 mg/dl in all cases. Bacterial invasion of the CSF is linked to local cytokine production (TNF, IL1). This production is responsible for activation of the endothelium, which is necessary for leukocyte diapedesis [28] [29] [30] [31]. Chemical studies point to bacterial infection in all patients. This corroborates literature data [2] [3] [8] [19] [23]. Direct examination was positive in 44 patients (36.06%). Culture was performed in 88.52%, only 24 germs were isolated (19.69%) and the culture was sterile in 68.85%. Antibiotic therapy received by patients prior to hospitalization could decapitate germs. According to WHO recommendations, presumptive diagnosis of bacterial meningitis can be made by Gram staining of the CSF centrifugation pellet, or by testing for specific antigens by agglutination of sensitized latex particles. A positive result with one of these tests is proof of bacterial meningitis, even if the culture remains negative [30]. This result is lower than that of Humera et al, who isolated germs in 35% of their cases [22], and similar to those of other authors in Bangui, Côte d'Ivoire and Senegal [4] [22] [26] [27]. No germs were found in any of the 54 infants aged 1 - 3 months. Pneumococcus was found in 18 (75%) patients, H. influenzae in 4 (16.67%) aged between 3 and 59 months, and *E. coli* and *A. baumanii* in 2 (8.33%) patients in the same age group. The fact that meningococcus was not found in our series is justified by the fact that the northern region of CAR belongs to the classic "Lapeyssonnie meningitis belt", where epidemics of meningococcal meningitis sometimes break out. Bangui, the capital of CAR, lies in the south of the country. This observation was made by T Crellen *et al.* [28] and Clouzeau *et al.* in Bangui [13]. This result is similar to that of Tall and Coll [29]. Maiga B and Coll [18] found a frequency of 8% for *N. meningitidis*.

Evolutionary aspects

Monitoring was based more on clinical than biological data. Clinical elements were assessed by the regression or non-regression of signs on entry. The case fatality rate was 27.87%. The mean duration of death was 2.29 ± 2.2 days. This high rate can be explained by the high frequency of highly virulent *S. pneumoniae* [5] and by a delay in consultation. Young age, unavailability of antibiograms and the virulence of the germ could also explain this high case-fatality rate. The short length of stay was only observed in patients who died or were discharged against medical advice. Sequelae are related to the severity of bacterial meningitis. M. Tfifha *et al.* in Tunisia found a mortality rate of 8.2%, with a mean time to death of 6.8 days, and 21.3% of sequelae [16]. The paraclinical evolution is marked by the performance of control LCS in 14 patients (11.47%). These studies were all sterile. This check-up was carried out in patients presenting an unfavorable evolution but with no signs of clinical involvement. No cerebral CT scans were performed in this study, although some patients did have a follow-up LCS scan, and it is recommended that this be performed after the CT scan to show the presence or absence of signs of internal involvement [2] [3] [19]. The fact that this LCS test was carried out without a CT scan justifies the

fact that the country did not have this equipment.

5. Conclusion

Bacterial meningitis remains a major public health problem in paediatric settings in Bangui. *S. pneumoniae* is more frequent despite the introduction of vaccine in the expanded vaccination program. Lethality remains high. Vaccination should be emphasized as primary prevention, to ensure immunity against this disease and raise awareness for early consultation.

Conflicts of Interest

There are no conflicts of interest.

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