Epidemiological, clinical, biological and therapeutic profile of bacterial meningitis and factors associated with lethality: a retrospective study in the Fann Infectious and Tropical Diseases Service (2020-2023)

Abstract

Introduction

Bacterial meningitis remains a major public health problem in Africa, with a persistently high incidence and case fatality. The objective of this study is to describe the epidemiological, clinical, biological and therapeutic profile of bacterial meningitis, and to identify the factors associated with lethality.

Patients and method

A descriptive and analytical retrospective study was conducted from the records of patients hospitalized for bacterial meningitis at the SMIT in Fann January 1, 2020 to December 31, 2023~~between January 2020 and December 2023~~. A multivariate regression, with a significance threshold set at 5%, was performed using R software version 4.2.0.

Results

During the study period, we collected 138 inpatient records of patients hospitalised for bacterial meningitis, representing a hospital frequency of 3.06%.

The median age of patients was 35 years with IQC [27-52]. HIV infection (17.39%), high blood pressure (8.76%) and diabetes (8.03%) were the most common comorbidities. Cerebrospinal fluid (CSF) was clear in nearly half of the cases (49.28%), and cytology found a predominantly polynuclear neutrophil white blood cell count in 50% of cases. The median length of hospital stay was 10 days with IQI [7-17]. add a word about the treatment received by the patients During hospitalization, 49 patients had died, i.e., a case fatality rate of 35.51%.

Factors associated with death were HIV infection (aOR= 3.09; 95% CI [1.05-9.57]), p-value=**0.041**, Glasgow score < 13 (aOR: 3.62; 95% CI [1.57-8.57]), p-value=**0.003** and CRP > 96 mg/L (aOR: 2.85; 95% CI [1.25-6.72]), p-value=**0.013**.

Conclusion

Bacterial meningitis has a high lethality rate at Fann Infectious and Tropical Diseases ServiceFann's SMIT. Improving immunization coverage, strengthening diagnostic capacity and early management could reduce this fatality.

Introduction

Bacterial meningitis remains a global public health problem[1]. These are serious infections of the central nervous system that are life-threatening and with a poor functional prognosis. In 2019, there were an estimated 2.51 million new cases worldwide, with an estimated 236,000 deaths[2]. Despite the efforts made, especially with vaccination, Africa is the continent most affected by meningitis with incidence rates ranging from 87.2 to 105.8 cases per 100,000 inhabitants[2]. Mortality in this continent remains the highest in the world with rates of up to 18.4 per 100,000 inhabitants. particularly in countries in the African meningitis belt Various factors can explain this high morbidity and mortality in Africa: climatic conditions, low vaccination rates, migration and displacement, limited access to health care, antibiotic resistance and poor socio-economic conditions[3–5].

In Senegal, the Infectious and Tropical Diseases Department (SMIT) of the CHUN? Write in full at firs de Fann, located in Dakar, is the main referral centre for the management of meningitis in adults. The studies conducted so far at this department have generally been oriented towards a specific aetiology [6–8]. The most comprehensive study was published in 2005 and focused on neuromeningeal infections; These conditions accounted for 11.4% of new admissions, with a high case fatality rate of 44.5%[9]. To our knowledge, few studies conducted in the department on bacterial meningitis and the factors influencing its lethality have been found in the literature. This study aims to describe the epidemiological, clinical, biological and therapeutic profile of bacterial meningitis, and to identify the factors associated with death. This also aims to update the data on bacterial meningitis in this department

Materials and methods

Type and period of study

This was a retrospective, descriptive and analytical study, carried out from the hospital records of patients admitted to the infectious diseases department of the Fann University Hospital in Dakar, from January 1, 2020 to December 31, 2023. All patients hospitalized for bacterial meningitis (after biochemical and/or bacteriological analysis of CSF) were included. Bacterial meningitis was defined by a cellularity of more than 10 white blood cells/mm3 associated with CSF glucose levels < 0.5 g/l with or without bacterial isolation on CSF examination.

Data collection

Data were collected from patients' medical records, using a survey sheet, that was developed based on a literature review. Data were then entered into Microsoft Excel before being exported to R software. They included epidemiological (date of hospitalization, age, sex, geographical origin, marital status), clinical (lifestyle, vaccination status, comorbidities, symptoms and signs), laboratory (CBC, CRP, biochemical and bacteriological analysis of CSF), therapeutic (antibiotics used, adjuvant measures), and evolutionary (length of hospitalization, lethality) characteristics.

Statistical analyses

Qualitative variables were expressed as a proportion and quantitative variables as a mean with standard deviation (in the case of a normal distribution) or as a median with interquartile ranges (in the case of a non-normal distribution). Factors associated with lethality were assessed using multivariate logistic regression, adjusted according to relevant confounding factors: age, comorbidities, duration of evolution of symptoms, Glasgow coma score, focal neurological signs, C-Reactive protein. P values less than 0.05 were considered statistically significant. We reported the effect of variables as odds ratios (ORs) with 95% confidence intervals (CIs). Statistical analyses were carried out using the R studio software, version 4.4.0.

Ethical considerations

All data collected were treated confidentially and anonymously. Prior authorization from the head of the infectious and tropical diseases department was obtained.

Results

Epidemiological data

During the study period, we collected 138 cases of bacterial meningitis out of a total of 4222 admissions, i.e., a hospital frequency of 3.06%. The monthly distribution of cases showed peaks during the months of January and February (Figure 1). A male predominance was noted with a sex ratio of 1.3 and the median age of patients was 35 years with an interquartile range (IQR) of **[27-52]** years. The most represented age group was 20-40 years old representing 46.37% of cases. Nearly half of the patients came from the peri-urban area of Dakar (46.38%), followed by the urban area (34.78%). HIV infection (17.4%), high blood pressure (8.8%) and diabetes (8.03%) were the main comorbidities found. Only 3 patients had an up-to-date vaccination status. Pre-hospitalization antibiotic use was reported in 41.3% of patients.

Clinical data

Headache was the main reason for consultation, present in 73.91% of patients (Figure 2). This was accompanied by vomiting in 33.33% of cases. The most common physical signs were those of meningeal irritation: stiff neck (88.41%), Kernig's sign (66.67%), Brudzinski's sign (63.04%). More than 10% of patients showed focal neurologic signs, and 8.70% had seizures. Add A word about the delay in consultation

Laboratory data

We found a non-specific inflammatory reaction with C-reactive protein (CRP) greater than 96 mg/l in one third of patients (33.33%) and 38.54% of patients had elevated white cell count (> 12,000 cells/mm^3).

CSF was clear in 49.28% of cases and cloudy in 36.23%. Pleiocytosis was predominantly polynuclear neutrophils, impaired and unaltered in 50%. The majority of patients (96.35%) presented with elevated CSF protein. CSF microscopy and culture were performed on all patient specimens. In 85.51% of cases, no germs were found. Thus, direct examination, soluble antigen testing and culture were positive in only 13 cases, including 8 cases of *Mycobacterium tuberculosis* identified by the Xpert/MTB-Rif test, 3 cases of *Streptococcus pneumoniae* and 2 cases of *Neisseria meningitidis* isolated (Table I).

Brain CT scan performed in 16 patients showed mainly ischemia (5 cases), hydrocephalus (4 cases), and sinusitis lesions (3 cases). There was no expansive brain lesion, no mass effect, no peripheral contrast intake.

Therapeutic and evolutionary aspects

The most commonly used antibiotic was ceftriaxone, which was administered to 92.04% of patients, either alone or in combination with other antibiotics, such as gentamicin (86.21%) or vancomycin (47.06%). Approximately 35.51% of patients received quadruple anti-tuberculosis therapy. Adjuvant corticosteroid therapy was administered to 48.55% of patients, particularly in those with tuberculous meningitis, prednisone was the most commonly used corticosteroid (31.16%). The median length of hospital stay was 10 days, with an interquartile range (IQR) of [7-17] days. The case fatality rate was 35.51% (49 patients). The treatment was mostly probabilistic (add in how much percent) because this can explain the lethality

Si possible utiliser ce aspect pour rechercher de facteur de létalité entre ceux qui ont reçu un traitement probabiliste et ceux ayant eu un traitement basé sur un antibiogramme. Dire un mot sur la sensibilité des germes isolés(*Staphylococcus saprophyticus*,*Neisseria meningitidis*,*Staphylococcus aureus*,*Streptococcus pneumoniae*,*Haemophilus influenzae*)

Factors associated with the lethality of acute bacterial meningitis

After multivariate logistic regression, HIV infection (aOR = 3.09; 95% CI [1.05-9.57]), Glasgow Coma score < 13 (aOR: 3.62; 95% CI [1.57-8.57]) and CRP > 96 mg/L (aOR: 2.85; 95% CI [1.25-6.72]) were the factors associated with case fatality (Table II~~I~~). Add p-value

Discussion

The study has some limitations, particularly its retrospective nature, which led to missing data for some variables. In addition, since the study is single-centre and based solely on hospital data, we could not statistically generalize the results to the entire Senegalese population. However, the results obtained can be compared with the data in the literature.

In our study, the in-hospital frequency of bacterial meningitis was 3.06% with a predominance of cases observed in January and February. This seasonal variation has also been reported in several studies[10,11]. The hypothesis that dust particles damage the pharyngeal mucosa, thus facilitating bacterial invasion, is possible. In recent years, much research has focused on exploring the link between bacterial meningitis and climatic conditions[11]. The median age of 35 years and the 20-40 years age group being the most represented, reflect trends observed around the world. Although bacterial meningitis affects people of all ages, young children and young adults are most at risk[12]. In addition, the SMIT being a department dedicated to the care of adults, may explain this demographic profile. As far as vaccination coverage is concerned, vaccination rates were very low (2.17%) in our study. This result is in agreement with the work of Dollo et al. in Mali, where the vaccination status was unknown for all cases[13] and a study by Merabet et al. in Morocco, where the vaccination rate was 5.57%[14].

The clinical profile observed in this study is marked by fever (52.55%), headache (73.91%), stiff neck (88.41%) and Kernig's sign (66.67%). These features are consistent with clinical descriptions reported in previous studies, including those of Tekpa et al., where fever, headache, and Kernig's sign were also among the most frequently observed manifestations [14,15]. More than 10% of patients showed focal neurological signs. The presence of focal neurologic signs suggest damage to the cerebral parenchyma, which may characterize encephalitis or cerebral abscesses, especially when the presumed etiology is *Streptococcus pneumoniae*. Thus, CT scans were performed to look for these abnormalities and revealed cases of ischemia (5 cases) and hydrocephalus (4 cases). Our data are comparable to those reported in the literature, where focal neurologic signs are associated with severe meningeal involvement[16,17].

Macroscopically, nearly half of the cases (49.28%) had clear cerebrospinal fluid, while more than one in three patients (36.23%) had cloudy CSF. The clarity of CSF could be attributed either to prior antibiotic therapy or to clear-fluid bacterial meningitis such as tuberculous meningitis. On the other hand, the abnormalities typical of bacterial meningitis, such as the predominance of polynuclear cells and elevated CSF protein, were found. However, the microbiological identification of pathogens was a major challenge in our study, with 85.51% of samples detecting no germs. This finding is consistent with the results of an earlier study conducted in the same department, where 72% of the etiologies of neurological infections remained unknown[18].

Similarly, in Cameroon, among 742 cerebrospinal fluid samples analysed in patients with clinical signs of meningitis, only 9.57% revealed a germ[19]. These results highlight the difficulties encountered in the detection of pathogens, often due to an inadequate technical platform. For this reason, several studies have validated polymerase chain reaction (PCR) tests to diagnose bacterial meningitis. This work shows that PCR can overcome the limitations of conventional methods[20–23]. However, the use of antibiotics before hospitalization, reported in 41.3% of our patients, may also explain this high rate of CSF culture negativity. With 58.2% of antibiotic therapy before admission, Coulibaly DS et al made the same observation[24].

Regarding treatment, ceftriaxone remains the reference antibiotic in our study, despite the frequent lack of formal identification of pathogens. It is an empirical approach that reflects practices in resource-limited settings, where etiological diagnosis often remains inaccessible. In accordance with current recommendations, the choice of initial treatment is by necessity empirical and probabilistic in view of the severity of any delay in care[25]. In our patients who presented with signs of sepsis associated with meningitis, gentamicin was most frequently associated (86.21%) with ceftriaxone in their management.

Prognostically, the lethality reported in our study remains relatively high at 35.51percent. Poor prognostic factors were HIV infection, a Glasgow coma score < 13 and a CRP level > 96 mg/L. find a transition for the next three paragraphs

During HIV infection, neurologic pathologies are common and can occur at all stages of infection. Regardless of their etiology, they increase the risk of serious neurological complications and death, as shown in our study and other similar studies [26,27].

Coma is a sign of poor prognosis in cases of bacterial meningitis. Other studies have also found such an association [28–30]. This is the consequence of an excessive inflammatory response, thus leading to neurological damage [31]. The main causes of coma are: cerebral edema, convulsions and cerebrovascular lesions [32]. Alterations of consciousness may indicate a delay in diagnosis and treatment, hence the interest in rapid initial management of meningitis cases [33].

Other authors had reported similar results, pointing to elevated CRP as a factor associated with death [34,35]. The morbidity and mortality of meningitis are due to an uncontrolled inflammatory response of the host, especially at the level of neurons, leading to fatal complications [36]. This might explain why CRP being an inflammatory marker would be elevated in fatal cases of bacterial meningitis. Elevated CRP levels can also be due to sepsis as part of a general complication, responsible for multiorgan failure[37].

Conclusion

This study highlights the high mortality associated with bacterial meningitis, with insufficient vaccination coverage. The clinical profile observed is in line with those reported in the literature, but the microbiological identification of pathogens remains a major challenge. Finally, the poor prognostic factors identified include HIV infection, a Glasgow score below 13 and a high CRP. These results highlight the importance of early management and strengthening of prevention strategies in the field of vaccination, the fight against HIV and the improvement of technical platforms for more important etiological research.

Tables and figures

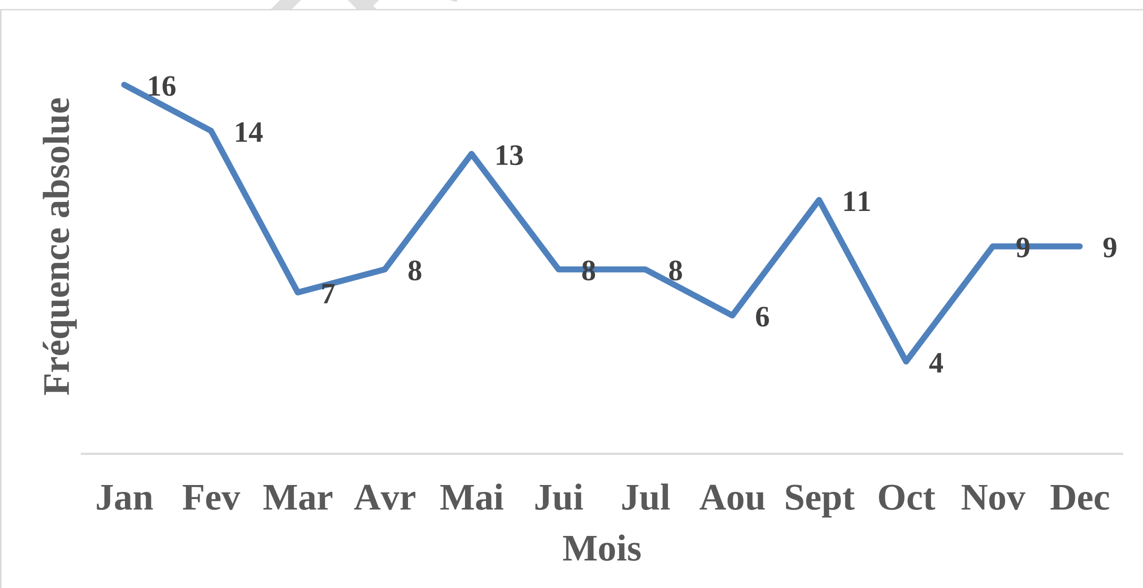

Figure 1: Distribution by month of patients hospitalized for bacterial meningitis at SMIT, Fann from 2020 to 2023

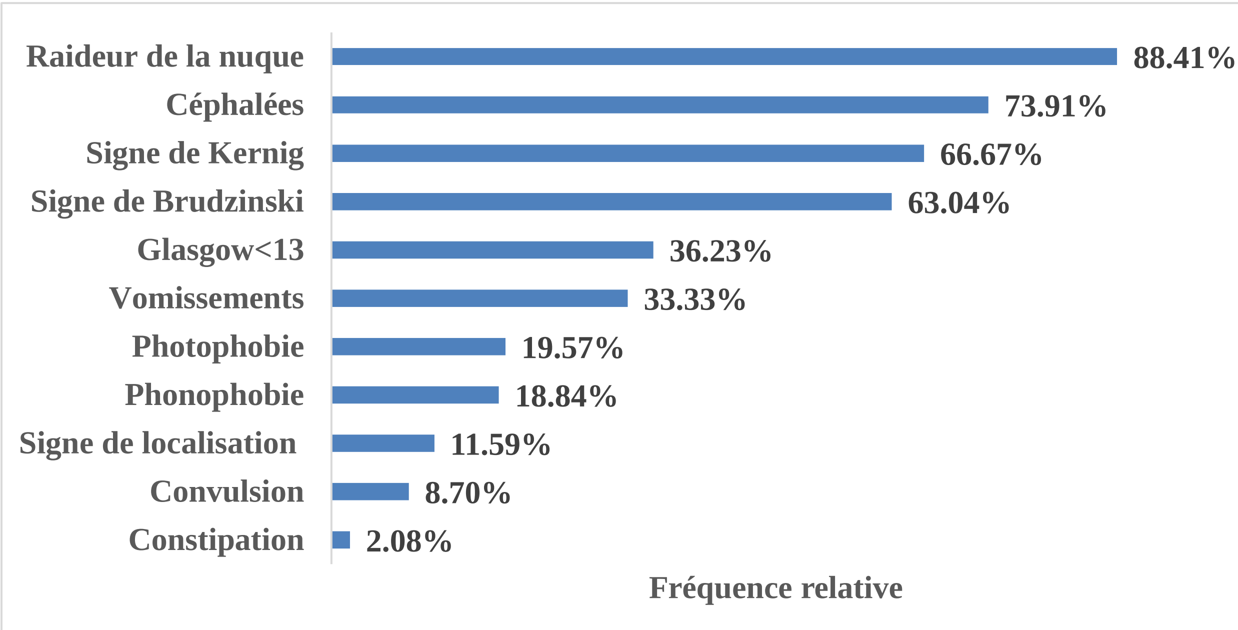

Figure 2 : Distribution by neurological signs of patients hospitalized for bacterial meningitis at SMIT, Fann from 2020 to 2023

Table I: Distribution by CSF examination results of patients hospitalized for bacterial meningitis at SMIT, Fann from 2020 to 2023

CSF Features	**Absolute Frequency (N)**	**Relative Frequency (%)**
Macroscopy		
Clear	68	*49,28*
Cloudy	50	*36,23*
Xanthochromic	9	*6,52*
Hematic	2	*1,45*
Cytology	9	*6,52*
Polynuclear predominance	50	*50*

Lymphocyte predominance	49	*49*
Variegated	1	*1*
Biochemistry		
Low Glucose	138	*100*
High protein	133	*96,35*
Bacteriological examination of CSF		
Germs not detected	118	*85,51*
Mycobacterium tuberculosis	8	*5,80*
Staphylococcus saprophyticus	4	*2,90*
Neisseria meningitidis	2	*1,45*
Staphylococcus aureus	2	*1,45*
Streptococcus pneumoniae	3	*2,17*
Haemophilus influenzae	1	*0,72*

Table II: Predictive factors for death of patients hospitalized for bacterial meningitis at SMIT, Fann from 2020 to 2023

	Univariate			**Multivariate**		
Characteristics	**OR1**	**95% CI1**	**p-value**	**OR1**	**95% CI1**	**p-value**
Age> 65 years	1.21	0.60, 2.44	0.59	0.90	0.39, 2.05	0.8
Focal signs	1.98	0.68, 5.74	0.21	1.44	0.43, 4.79	0.5
HIV infection	**3.92**	**1.59, 10.2**	**0.003**	**3.09**	**1.05, 9.57**	**0.041**
Glasgow coma score < 13	**4.72**	**2.24, 10.3**	**<0.001**	**3.62**	**1.57, 8.57**	**0.003**
CRP >96 mg/l	**2.46**	**1.21, 5.09**	**0.013**	**2.85**	**1.25, 6.72**	**0.013**

Symptoms> 21 days	1.58	0.76, 3.28	0.22	1.74	0.76, 4.04	0.2

[1]OR = Odds Ratio, CI = Confidence Interval

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Add references to Burkinabe, Nigerien and Ivorian authors if possible!