Epidemiological aspect and antibiotic susceptibility profile of bacteria responsible for meningitis in children in the Paediatrics Department of the CHU Donka National Hospital (Conakry).—(change the title font stye)

Abstract :

Introduction: Meningitis is an inflammatory process, generally infectious in origin, affecting the meninges, and represents a major public health problem due to its high morbidity and mortality. **Objective**: To determine the antibiotic susceptibility of the bacteria responsible for bacterial meningitis in children in order to improve their management. **Method**: This is a prospective and descriptive cross-sectional study which lasted three months, from 20 January to 20 April 2022.**Results**: Out of a total of 110 children received in the laboratory, 13 CSF samples contained bacteria (12%) compared with 88% of negative samples. The 13 positive samples were distributed between 7 for Streptococcus with 54%, Haemophilus influenzae b with 31% and 15% for Escherichia coli. The age group most affected was between 1 and 5 years, with 26%. Males predominated, with a sex ratio of 1.2. The commune of Ratoma was the most represented with 36%. The clinical picture was dominated by fever (54%), vomiting (35%), meningeal stiffness (20%), convulsion (24%) and headache (27%). Antibiogram results showed that Aminosides (GEN) were most effective against Streptococcus pneumoniae. Amikacin was effective in four children (57%), followed by Trobramycin (43%) and Gentamicin (29%). Ofloxacin and Levofloxacin were highly sensitive, at 100% (7/7). The Nitrofurans class is represented by a single antibiotic, Nitrofurantoine, which was effective in two cases, i.e. 29% (2/7), intermediate sensitivity in 43% (3/7) and resistant in 29% of cases (2/7). Aminosides (TOB) were more effective against Haemophilus influenzae. In 4 children, Tobramycin and Gentamicin were effective in three samples, i.e. 75% (3/4), followed by Amikacin, i.e. 50% (2/4). Sensitivity to Ciprofloxacin, Ofloxacin and Levofloxacin in the treatment of 3 out of 4 children was observed, i.e. 75% (3/4). Nitrofurantoin was effective in one case, i.e. 25% (1/4), and was resistant in one case tested, i.e. 25% (1/4). Aminosides (GEN) were more effective against Escherichia coli as, in two samples tested, Gentamicin was 100% effective (2/2) followed by Tobramycin and Amikacin with 50% each. Ciprofloxacin, Ofloxacin and Levofloxacin were 100% (2/2) effective in treating two out of two children. Nitrofurantoine was effective on all samples, i.e. 100% (2/2).

Conclusion: This study showed that several germs are responsible for bacterial meningitis, but the germ most frequently encountered was Streptococcus pneumoniae, and the management of infections requires an antibiogram or chemogram.

Key words: Sensitivity, Antibiotic, Bacterial meningitis, Children, Donka University Hospital.

1.**Introduction**

Meningitis is an inflammatory process, generally infectious in origin, affecting the meninges. In 70-80% of cases, meningitis is viral in origin. It is generally benign, and recovery is usually spontaneous. In 20-25% of cases, infectious meningitis is caused by bacteria. This is a serious condition, as spontaneous recovery is virtually fatal. Less than 5% of cases are due to non-pyogenic bacteria, parasites or neoplastic processes [1]. The incidence of bacterial meningitis in industrialised countries is between 2.5 and 10 per 100,000 inhabitants, whereas

it is 10 times higher in developing countries. 2/3 of these cases occur in children under the age of 5 [2]. Bacterial meningitis is an infection of the membranes (meninges) and the cerebrospinal fluid that surrounds the brain and spinal cord. After the perinatal period, three bacteria, transmitted from human to human via respiratory secretions, are responsible for most bacterial meningitis: Neisseria meningitidis, Streptococcus pneumoniae and Haemophilus influenzae. Every year, there are an estimated one million cases of meningitis worldwide, 200,000 of which are fatal. The case-fatality rate depends on age and the bacteria involved, ranging from 3% to 19% in developed countries. A higher case-fatality rate (37%-60%) has been reported in developing countries [3].In Sahelian Africa, between the 300 mm isohyets in the north and 1100 mm in the south, more than 10,000 cases of cerebro-spinal meningitis are recorded each year, with more than 10% of deaths. This region, known as Lapeyssonnie's "meningitis belt", stretches from the Red Sea to the Atlantic. Meningococcal meningitis differs from other bacterial meningitis in its epidemic potential. Serogroup A is the main cause of epidemics in Africa and Brazil, serogroup B is the most widespread in Europe, and serogroup C, which causes endemic outbreaks in the United States and Europe, has appeared in Africa: Nigeria (1975), Chad (1976), Ethiopia (1977) [4]. During epidemics, children and young adults are the most affected, with a very high rate of around 1,000 per 100,000 inhabitants, i.e. 100 times the rate of sporadic or endemic disease. The Neisseria meningitidis serogroups responsible for epidemics are Neisseria meningitidis A, C and W135 [5].Meningitis in infants, young children and the elderly is generally caused by Streptococcus pneumoniae. It is endemic in Africa, with no seasonal upsurge or epidemic outbreak. Its prognosis is severe, with a fatality rate of 30-60%. Haemophilus influenzae meningitis occurs almost exclusively in children under the age of 5. The peak incidence of infection is between 6 and 7 months of age, and most cases are due to germs with a type b polysaccharide capsule (Hib) [3]. According to the World Health Organisation (WHO), there are an estimated 650 million cases of Haemophilus influenzae type b infection in children aged 0-4 years worldwide, and between 250,000 and 400,000 deaths each year due to Streptococcus pneumoniae. Around 70% of child pneumonia deaths per year occur in Africa and South-East Asia. The annual incidence is 250 per 100,000 in children under the age of 5 [6]. Streptococcus pneumoniae is the agent of frank lumbar pneumonia. It is also responsible for cases of meningitis and septicaemia [7].The bacterium responsible for serious and fatal meningitis is Neisseria meningitidis. In the Republic of Guinea, in 2017, the country recorded 1,103 cases of meningitis in all administrative regions, including 11 cases in the Boké region, 281 cases in Conakry, 251 cases in Faranah, 133 cases in Kankan, 24 cases in Kindia, 19 cases in Labé, 9 cases in Mamou and the worst affected region was Nzérékoré with 366 cases [8]. In 2013, a prospective study recorded 480 suspected cases of meningitis notified in 21 health districts. The average age was 18 years and 62.5% were men. Vaccination status was unknown for all patients. The highest attack rates were observed in Siguiri (3.2 per 10,000), Kankan (2.6 per 10,000) and Dabola (3.9 per 10,000).

The locality of Kintinian in Siguiri was the only one to cross the epidemic threshold. The germs identified were Haemophilus influenzae (1 time), pneumococcus (2 times), Neisseria meningitidis A (4 times) and W135 (10 times), with a total of 17 positive samples. All these germs were sensitive to chloramphenicol, ceftriaxone and ciprofloxacin. The average length of hospital stay was 6.5+or-2 days. Case fatality was 14%. The 2013 epidemic was characterised by the emergence of Neisseria meningitidis W135 [9].

2.Materials and working methods

This was a prospective and descriptive cross-sectional study lasting 3 months, from 20 January to 20 April 2022. Our study included all children admitted to the Paediatric Department of the Donka National Hospital during the survey period. The sample was simple random and the sample size (N=110) was obtained using the formula of Schwartz Françoise (2016). Our study included all children who came to the laboratory with a report card or examination booklet on which the cytobacteriological examination of the cerebrospinal fluid (CSF) or bacteriology of the cerebrospinal fluid (CSF) was mentioned. Cytology, Gram staining and antibiotic susceptibility testing were carried out on all CSF samples.

2.1 Epidemiological variables :

- Age

- Sex

- Residence

2.2 Biological variables

- Cytology

- Gram stain

- Pastorex kit

- Culture

- Identification

- Antibiogram

2.3 Data collection method :

We used the following documents for data collection:

- Pre-prepared survey forms,

- Consultation notebooks,

- Laboratory registers.

2.4 Ethical considerations :

Before undertaking the data analysis phase, the Study Research Protocol was submitted to the Master's Directorate. The Research Team guaranteed the confidentiality of the information collected and the anonymity of the study participants.

2.5 Data collection and analysis

Our data are collected, entered, processed and analysed using Word and Excel software from the 2010 Office pack and SPSS.

3. Results

Application of the Research Methodology led to the following results in the form of tables and figures, which were interpreted, commented on and discussed according to the available literature data:

Table 1: Search for bacteria in children with bacterial meningitis according to Gram stain:

Gram	Number	Percentage

Antibiotics	S	I	R	ND	Total
	N (%)	N (%)	N (%)	N (%)	
Gram-negative bacilli	2			2	
Gram-positive diplococci	11			10	
Absence of germs	97			88	
Total	**13**			**100**	

The results of this table show that, on Gram staining, the most common morphological types were Gram-positive diplococci (11 cases, 85%), Gram-negative bacilli (2 cases, 15%) and germ-free samples (97 cases, 88%). The high prevalence of Gram-positive diplococci compared with other bacteria in cerebrospinal fluid could be explained by the children's exposure to this bacteria and the resulting septicaemia, since CSF is a sterile fluid.

Table 2: Overall prevalence of CSF infections after culture in children with meningitis

Culture	Number	Percentage
Positive	13	12
Negative	97	88
Total	**110**	**100**

This table shows that of the 110 CSF samples analysed, 13 contained bacteria, a prevalence of 12%, compared with 97 negative samples, or 88%. The high prevalence of meningeal infections could be due to children's exposure to bacterial infections and their vulnerability because of their weak immune system.

Table 3: Identification of bacterial species involved in bacterial meningitis in children

Bacterial species isolated	Number	Percentage
Escherichia coli	2	15
Haemophilus influenzae	4	31
Streptococcus pneumoniae	7	54
Total	**13**	**100**

The table shows that of the 13 children with meningitis, the bacterium Streptococcus pneumoniae was the most common with 7 cases, a prevalence of 54%, followed by Haemophilus influenzae b with 31% and Escherichia coli with 15%.

The high prevalence of Streptococcus pneumoniae in meningeal infections could be due to septicaemic respiratory infections.

Table 4: Overall sensitivity to antibiotics of the different species isolated from urinary

Streptococcus pneumoniae					
Amikacin	4(57)	1(14)	2(29)	0(00)	7(100)
Gentamicin	2(29)	5(71)	0(00)	0(00)	7(100)
Tobramicin	3(43)	2(29)	2(29)	0(00)	7(100)
Ciprofloxacin	3(43)	2(29)	2(29)	0(00)	7(100)
Ofloxacin	7(100)	0(00)	0(00)	0(00)	7(100)
Levofloxacin	7(100)	0(00)	0(00)	0(00)	7(100)
Nitrofurantoine	2(29)	3(43)	2(29)	0(00)	7(100)
Haemophilus influenzae					
Amikacin	2(50)	1(25)	1(25)	0(00)	4(100)
Gentamicin	3(75)	0(00)	1(25)	0(00)	4(100)
Tobramicin	3(75)	0(00)	1(25)	0(00)	4(100)
Ciprofloxacin	3(75)	1(25)	0(00)	0(00)	4(100)
Ofloxacin	3(75)	0(00)	1(25)	0(00)	4(100)
Levofloxacin	3(75)	0(00)	1(25)	0(00)	4(100)
Nitrofurantoine	1(25)	2(50)	1(25)	0(00)	4(100)
Escherichia *coli*					
Amikacin	1(50)	1(50)	0(00)	0(00)	2(100)
Gentamicin	2(100)	0(0)	0(00)	0(00)	2(100)
Tobramicin	1(50)	0(00)	1(50)	0(00)	2(100)
Ciprofloxacin	2(100)	0(00)	0(00)	0(00)	2(100)
Ofloxacin	2(100)	0(00)	0(00)	0(00)	2(100)
Levofloxacin	2(100)	0(00)	0(00)	0(00)	2(100)
Nitrofurantoine	2(100)	0(00)	0(00)	0(00)	2(100)

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Legends: S: sensitivity; I: intermediate; R: resistance; N: Number

From this table, we can see that of the 7 children suffering from Streptococcus pneumoniae meningitis, Aminosides (GEN) were more effective against the germ. Amikacin was effective in four children (57%), followed by Trobramycin (43%) and Gentamicin (29%). Ofloxacin and Levofloxacin were highly sensitive, at 100% (7/7). The Nitrofurans class is represented by a single antibiotic, Nitrofurantoine, which was effective in two cases, i.e. 29% (2/7), intermediate sensitivity in 43% (3/7) and resistant in 29% of cases (2/7).

Aminosides (TOB) were more effective against Haemophilus influenzae. In 4 children, Tobramycin and Gentamicin were effective on three samples, i.e. 75% (3/4), followed by Amikacin, i.e. 50% (2/4). Sensitivity to Ciprofloxacin, Ofloxacin and Levofloxacin in the

treatment of 3 out of 4 children was observed, i.e. 75% (3/4). Nitrofurantoin was effective in one case, i.e. 25% (1/4), and was resistant in one case tested, i.e. 25% (1/4).

Aminosides (GEN) were more effective against Escherichia coli as, in two samples tested, Gentamicin was 100% effective (2/2) followed by Tobramycin and Amikacin with 50% each. Ciprofloxacin, Ofloxacin and Levofloxacin were 100% (2/2) effective in treating two out of two children. Nitrofurantoine was effective on all samples, i.e. 100% (2/2).

Table 5: Breakdown of children with bacterial meningitis by epidemiological parameters

Parameters	Number	Pourcentage
Sexe		
Male	**8**	**62**
Female	5	38
Age groups		
0-5 months	2	15
6-12 months	2	15
1-5 years old	5	34
6 years and over	4	31
Education		
Enrolled	3	23
Not attending school	10	77
Residence		
Kaloum	-	-
Dixinn	3	23
Matam	1	8
Ratoma	6	46
Matoto	3	23
Kaloum	-	-

This table shows that of the 13 children with bacterial meningitis, children aged 1 to 5 years were the most affected, with 5 cases, i.e. a prevalence of 34%. The table shows that of the 13 children with bacterial meningitis, the majority were male, with 8 cases (62%) and a sex ratio of 1.2 in favour of males, compared with 5 cases (38%) in favour of females.

The high prevalence of males in this study is random and could be explained by their greater frequency of use than females in our study. In this table, we note that of the 13 children with bacterial meningitis, children from Ratoma Commune were the most represented in the city of Conakry with 6 cases, or 46%. They were followed by children from the Communes of Dixinn and Matoto, with 23% each. Children from the Commune of Matam accounted for only 8%.

The high prevalence in Ratoma Commune can be explained by the fact that it is one of the largest and most densely populated communes in Conakry. More children came from this commune than from any other during our survey period. These results show that more than half of the children were not attending school, with 10 cases, or 77%, while children attending school accounted for only 23%.

4. Discussion

Of a total of 110 children received in the laboratory, 13 CSF samples contained bacteria, i.e. 12% compared with 88% of negative samples. The 13 positive samples were distributed between 7 for Streptococcus with 54%, Haemophilus influenzae b with 31% and 15% for Escherichia coli. 51.85% of the children were under 5 years of age, with a median age of 4.6 months. The age group most affected was between 1 and 5 years, with 34%. The male sex ratio was 62, with a sex ratio of 1.2 (table 5).

With regard to the epidemiology of the germs incriminated in bacterial meningitis in children, our results are comparable to those of certain authors:

A study carried out by Thabet L. et al in 2002 at the Tunis Children's Hospital reported that Streptococcus B and Escherichia coli were the most predominant. In children aged between three months and three years, Haemophilus influenzae was the main bacterium isolated (75%), followed by Pneumococcus (22%). In children aged over three years, Streptococcus pneumoniae was the main bacterium (57%), followed by Neisseria meningitidis (30%) [10] and by Ben Haj Khalifa A. et al., 2010, in the region of Monastir, Tunisia (1999-2006), reported that enterobacteria and group B streptococci were the pathogens most frequently identified in neonatal meningitis. H. Influenzae was the predominant micro-organism in children aged between three months and five years (36.3%), followed by S. Pneumoniae (28.8%). S. Pneumoniae was the main bacterium, responsible for 47% of cases in children aged over five years [11].

In our study of 7 children with Streptococcus pneumoniae meningitis, Aminosides (GEN) proved more effective against the germ. Amikacin was effective in four children (57%), followed by Trobramycin and Gentamicin (43% and 29% respectively). Ofloxacin and Levofloxacin were 100% sensitive, followed by 43% sensitivity to Ciprofloxacin. Nitrofurantoine was 43% effective. For Haemophilus influenzae, Tobramycin and Gentamicin were 75% effective, followed by Amikacin at 50%. Ciprofloxacin, Ofloxacin and Levofloxacin were 75% effective. Nitrofurantoin was 25% effective. Similarly, Escherichia coli was 100% sensitive to Aminosides (GEN), followed by Tobramycin and Amikacin at 50% each. Ciprofloxacin, Ofloxacin and Levofloxacin were 100% effective, and the Nitrofuran class, presented by a single antibiotic, Nitrofurantoin, was 100% effective in the samples tested(table 4).

Our results were superior to those of the same authors in terms of the sensitivity of the germs incriminated in bacterial meningitis in children to antibiotics:

Ben Haj Khalifa A. et al, 2010, in the region of Monastir, Tunisia (1999-2006), reported that 38.8% of S. pneumoniae strains were less sensitive to penicillin. Rates of resistance to amoxicillin and cefotaxime were 4.1% in both cases. Only one strain of N. meningitidis (6.2%) showed reduced sensitivity to penicillin. 22.9% of H. Influenzae strains produced β-lactamase. The rate of resistance of enterobacteria to third-generation cephalosporins was 25%. In our study, the rate of nosocomial meningitis was 24.4%. The departments most affected were neurosurgery, paediatrics and intensive care. The increasing prevalence of meningitis caused by pneumococci with low susceptibility to penicillin G makes it difficult to provide adequate treatment [10]. A study carried out by L. Thabet et al in 2002 at the Tunis

Children's Hospital showed that 33% of H. influenzae strains are resistant to ampicillin through the production of a penicillinase and 56% of pneumococci have reduced sensitivity to penicillin [11].

5. Conclusion

In our study of the antibiotic susceptibility profile of *Streptococcus pneumoniae* in meningitis patients, we came to the following conclusion:

Out of a total of 110 children received in the laboratory, 13 CSF samples contained bacteria (12% compared with 88% of negative samples). The 13 positive samples were distributed between 7 for Streptococcus with 54%, Haemophilus influenzae b with 31% and 15% for Escherichia coli. 51.85% of the children were under 5 years old, with a median age of 4.6 months. The age group most affected was between 1 and 5 years, with 34%. The male sex ratio was 62, with a sex ratio of 1.2.

The antibiogram carried out on the 13 samples containing the Bacteria showed that on the 7 Children suffering from Streptococcus pneumoniae meningitis, Aminosides (GEN) were more effective on the germ. Amikacin was effective on four children (57%), followed by Trobramycin and Gentamicin (43% and 29% respectively). Ofloxacin and Levofloxacin were 100% sensitive, followed by 43% sensitivity to Ciprofloxacin. Nitrofurantoin was effective in two cases (43%) and ineffective in two cases (29%). In four children with Haemophilus influenzae, Tobramycin and Gentamicin were effective in three samples (75%), followed by Amikacin (50%). Ciprofloxacin, Ofloxacin and Levofloxacin were effective on four children (75%). Of the four samples tested, Nitrofurantoin was effective in one case (25%) and was resistant in one case (25%).

Escherichia coli was sensitive to Aminosides (GEN). In two samples tested, Gentamicin was 100% effective, followed by Tobramycin and Amikacin, each 50% effective. Ciprofloxacin, Ofloxacin and Levofloxacin were 100% effective and the Nitrofuran class presented by a single antibiotic, Nitrofurantoine, was 100% effective in the samples tested.

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