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INFANT BACTERIAL MENINGITIS: DIAGNOSTIC, THERAPEUTIC, AND PROGNOSTIC CHALLENGES IN RECENT CASE REPORTS

MENINGITE BACTERIANA INFANTIL: DESAFIOS DIAGNÓSTICOS, TERAPÊUTICOS E PROGNÓSTICOS EM RELATOS DE CASO RECENTES

MENINGITIS BACTERIANA INFANTIL: DESAFÍOS DIAGNÓSTICOS, TERAPÉUTICOS Y PRONÓSTICOS EN REPORTES DE CASOS RECIENTES

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ABSTRACT

Introduction: Pediatric bacterial meningitis is a rapidly progressive medical emergency with high morbidity and mortality, especially in neonates and young infants, due to immunological immaturity and the wide diversity of etiological agents. Despite advances in vaccination, the disease remains a major global public health challenge.

Methods: This systematic review analyzed 20 case reports published over the last five years, selected from the PubMed, Medline, and LILACS databases. The descriptors “Meningitis, Bacterial,” “Pediatrics,” and “Clinical Diagnosis” were used. Of the 118 articles initially identified, after screening titles, abstracts, and full texts, 20 case reports met the inclusion criteria.

Results: Fourteen distinct agents were identified, with predominance of Streptococcus pneumoniae (20%) and Streptococcus agalactiae (10%). Listeria monocytogenes and Mycoplasma hominis also accounted for 10% each. Children under 12 months of age represented nearly 50% of cases. The most frequent clinical manifestations were fever (85%), seizures (35%), vomiting (30%), and irritability (20%), while classic meningeal signs were present in only 20% of patients. The most commonly used empirical treatment was a combination of a third-generation cephalosporin and vancomycin, with therapeutic adjustment required in 70% of cases after culture and antibiogram. Eleven children recovered without sequelae, while nine developed neurological deficits, such as hearing loss, residual hydrocephalus, motor deficits, and cranial neuropathies, and one death was associated with non-K1 Escherichia coli.

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Conclusion: Pediatric bacterial meningitis shows marked etiological heterogeneity and clinical variation according to age group, hindering early diagnosis, particularly in neonates. Although appropriate treatment favors good outcomes, more virulent or resistant pathogens remain associated with significant neurological complications and mortality. Immediate initiation of empirical antibiotic therapy, followed by adjustment according to the isolated agent, is essential for a better prognosis. The expansion of vaccination coverage against S. pneumoniae, Haemophilus influenzae type b, and meningococcus is also emphasized as a fundamental measure for prevention and reduction of morbidity and mortality.

Keywords: Bacterial Meningitis. Pediatrics. Etiological Agents.

RESUMO

Introdução: A meningite bacteriana infantil é uma emergência médica de rápida evolução e elevada morbimortalidade, especialmente em neonatos e lactentes, devido à imaturidade imunológica e à grande diversidade de agentes etiológicos. Apesar dos avanços vacinais, a doença continua sendo um importante desafio em saúde pública global.

Métodos: Esta revisão sistemática analisou 20 relatos de casos publicados nos últimos cinco anos, selecionados nas bases PubMed, Medline e LILACS. Utilizaram-se os descritores “Meningitis, Bacterial”, “Pediatrics” e “Clinical Diagnosis”. Dos 118 artigos inicialmente identificados, após triagem por títulos, resumos e leitura integral, 20 relatos atenderam aos critérios de inclusão.

Resultados: Foram identificados 14 agentes distintos, com predominância de Streptococcus pneumoniae (20%) e Streptococcus agalactiae (10%). Listeria monocytogenes e Mycoplasma hominis também representaram 10% cada. Crianças menores de 12 meses corresponderam a quase 50% dos casos. As manifestações clínicas mais frequentes foram febre (85%), convulsões (35%), vômitos (30%) e irritabilidade (20%), enquanto sinais meníngeos clássicos ocorreram em apenas 20% dos pacientes. O tratamento empírico mais utilizado foi a combinação de cefalosporina de terceira geração com vancomicina, sendo necessário ajuste terapêutico em 70% dos casos após cultura e antibiograma. Onze crianças evoluíram sem sequelas, enquanto nove apresentaram déficits neurológicos, como perda auditiva, hidrocefalia residual, déficits motores e neuropatias cranianas, e houve um óbito associado a Escherichia coli não-K1.

Conclusão: A meningite bacteriana pediátrica apresenta grande heterogeneidade etiológica e variação clínica conforme a faixa etária, dificultando o diagnóstico precoce, principalmente em neonatos. Embora o tratamento adequado favoreça bons desfechos, agentes mais virulentos ou resistentes permanecem associados a complicações neurológicas importantes e mortalidade. O início imediato da antibioticoterapia empírica, seguido de ajustes conforme o agente isolado, é essencial para melhor prognóstico. Reforça-se também a importância da ampliação da cobertura vacinal contra S. pneumoniae, H. influenzae tipo b e meningococo como medida fundamental para prevenção e redução da morbimortalidade.

Palavras-chave: Meningite Bacteriana. Pediatria. Agentes Etiológicos.

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RESUMEN

Introducción: La meningitis bacteriana infantil es una emergencia médica de rápida evolución y alta morbimortalidad, especialmente en neonatos y lactantes, debido a la inmadurez inmunológica y a la gran diversidad de agentes etiológicos. A pesar de los avances en la vacunación, la enfermedad sigue siendo un importante desafío de salud pública a nivel mundial.

Métodos: Esta revisión sistemática analizó 20 reportes de casos publicados en los últimos cinco años, seleccionados en las bases de datos PubMed, Medline y LILACS. Se utilizaron los descriptores “Meningitis, Bacterial”, “Pediatrics” y “Clinical Diagnosis”. De los 118 artículos inicialmente identificados, tras la selección por títulos, resúmenes y lectura completa, 20 reportes cumplieron los criterios de inclusión.

Resultados: Se identificaron 14 agentes distintos, con predominio de Streptococcus pneumoniae (20%) y Streptococcus agalactiae (10%). Listeria monocytogenes y Mycoplasma hominis también representaron el 10% cada uno. Los niños menores de 12 meses correspondieron a casi el 50% de los casos. Las manifestaciones clínicas más frecuentes fueron fiebre (85%), convulsiones (35%), vómitos (30%) e irritabilidad (20%), mientras que los signos meníngeos clásicos se presentaron solo en el 20% de los pacientes. El tratamiento empírico más utilizado fue la combinación de una cefalosporina de tercera generación con vancomicina, siendo necesario el ajuste terapéutico en el 70% de los casos tras el cultivo y el antibiograma. Once niños evolucionaron sin secuelas, mientras que nueve presentaron déficits neurológicos, como pérdida auditiva, hidrocefalia residual, déficits motores y neuropatías craneales, y se registró un fallecimiento asociado a Escherichia coli no K1.

Conclusión: La meningitis bacteriana pediátrica presenta una gran heterogeneidad etiológica y variación clínica según el grupo etario, lo que dificulta el diagnóstico precoz, especialmente en neonatos. Aunque el tratamiento adecuado favorece buenos desenlaces, los agentes más virulentos o resistentes siguen estando asociados a complicaciones neurológicas significativas y mortalidad. El inicio inmediato de la antibioticoterapia empírica, seguido de ajustes según el agente aislado, es esencial para un mejor pronóstico. También se refuerza la importancia de ampliar la cobertura vacunal contra S. pneumoniae, Haemophilus influenzae tipo b y meningococo como medida fundamental para la prevención y la reducción de la morbimortalidad.

Palabras clave: Meningitis Bacteriana. Pediatría. Agentes Etiológicos.

1 INTRODUCTION

Meningitis is characterized by inflammation of the meninges, membranes that line the brain and spinal cord, and constitutes a medical emergency in the pediatric population due to its rapid evolution and the potential to cause serious complications. Inflammation is mainly triggered by bacterial or viral infections, although fungal and non-infectious causes, such as autoimmune reactions or the use of certain medications, can also occur (Van Ettekoven et al., 2024). Childhood meningitis remains a relevant global public health problem, especially in children under five years of age, due to the immaturity of the immune system. The disease is estimated to cause thousands of deaths annually, with a higher concentration in low- and middle-income countries, where vaccination coverage and access to health care are limited (Liu, L. et al., 2025). The introduction of conjugate vaccines against *Haemophilus influenzae* type b*, Streptococcus pneumoniae,* and *Neisseria meningitidis* has significantly reduced incidence and mortality, although outbreaks still occur in regions with low vaccine adherence or circulation of new serogroups. Recent studies point to changes in the etiological profile after the COVID-19 pandemic, with a relative increase in pneumococcal cases and maintenance of seasonal viral forms, showing that socio-environmental and demographic factors directly influence the epidemiology of the disease (Guimarães et al., 2022).

The classic presentation of acute bacterial community meningitis (CABM) includes fever, neck stiffness, and altered mental status, although this triad is present in less than 50% of patients. Initial symptoms are often nonspecific and may mimic other infectious conditions (Hovmand et al., 2023). The clinical picture varies according to the age group: in newborns and infants, signs such as irritability, refusal to feed, fever and lethargy predominate; In older children, severe headache, neck stiffness, vomiting, and photophobia stand out. The bacterial forms, especially caused by *S. pneumoniae*, *N. meningitidis* and *H. influenzae* type b, usually begin in the respiratory tract, with dissemination through the bloodstream and subsequent invasion of the meninges, triggering the characteristic inflammation that presents high morbidity and mortality and risk of permanent neurological sequelae, requiring rapid diagnosis and immediate initiation of antibiotic therapy (Liu et al., 2024).

Bacterial meningitis can cause immediate and late complications, with a significant impact on the prognosis. The most common sequelae include neurological deficits, hearing loss, epileptic seizures, hydrocephalus, cognitive impairment, and behavioral

changes. The risk is higher in infants, in severe cases, and in *S. pneumoniae* or *H. influenzae infections*. Exacerbated inflammatory response and genetic factors, such as complement system dysfunctions, can also aggravate the condition (Mohanty et al., 2024).

Management should be initiated as soon as there is clinical suspicion, as delays of more than six hours increase mortality and the risk of neurological sequelae (Van de Beek et al., 2021). Empiric antibiotic varies according to age: in newborns, ampicillin is recommended in combination with an aminoglycoside or cefotaxime; in infants and older children, the combination of ceftriaxone or cefotaxime with vancomycin is indicated, especially in regions with high pneumococcal resistance (Kim et al., 2010). After identification of the agent, the antimicrobial regimen should be adjusted. The use of dexamethasone as an adjuvant therapy is recommended by the European Society of Clinical Microbiology and Infectious Diseases (ESCMID) for children over six weeks, as it reduces the risk of hearing loss and neurological sequelae — except in cases of *Listeria monocytogenes* Continuous clinical surveillance and maintenance of vaccination coverage are essential, as new serotypes may emerge (Hasbun et al., 2022).

2 METHODOLOGY

This systematic review aims to answer the following guiding question: "What are the initial signs and symptoms of bacterial meningitis in children and what treatment is applied?" In addition, it seeks to provide solid and up-to-date scientific evidence that can be applied in clinical practice, with the purpose of optimizing the initial diagnosis and providing guidance for effective treatment and improving outcomes for pediatric patients.

The search was carried out in the PubMed, Medline and Lilacs databases, and in these three platforms, the following descriptors in English were chosen: Meningitis, Bacterial; Pediatrics; Clinical Diagnosis joined via the Boolean operator AND. For the selection of the articles that make up this publication, the inclusion criteria used were: full texts available in full, articles that address case reports, as long as they are in pediatric populations. Publications written in English, Spanish and Portuguese were selected.

The exclusion criteria consist of the following: research that addresses viral meningitis, studies that do not directly address the topic or with adult populations, studies in animals or cell models, duplicate articles or articles of low methodological quality.

The 5-year-old filter was chosen for the bases. In the PubMed database, 73 articles were initially identified, Lilacs 24 articles and Medline 21 articles. In total, 118 articles were added, of which 25 were withdrawn due to the duplicity of titles. Of the remaining 93, 49 were excluded after a detailed analysis of the title and did not correspond to the central theme of the article. After reading the abstracts, 20 articles were subtracted, and later, with the reading of the full text, 4 were removed, leaving 20 articles selected from the total value.

3 RESULTS AND DISCUSSION

The case reports chosen for the composition of this review were categorized as follows: Author of the publication, Year, etiological agent evidenced in the studies, age of the patients, main signs and symptoms, as well as a comprehensive synthesis of the clinical evolution and treatment proposed in each case. These elements have been carefully arranged in the Table in order to provide an orderly and clear structure.

Table 1

Main information from the case reports selected for the writing of the review

AUTHOR	AGENT	AGE	SIGNS AND SYMPTOMS	TREATMENT/EVOLUTION
Horiba, Kazuhiro et al 2021.	*Group B streptococcus* (GBS) / *Streptococcus agalactiae*	NB, 22 days	**Case 1:** Fever for 7 hours (38.6 °C), vomiting, bulging anterior fontanelle, and peripheral cyanosis.	Empirical treatment with ampicillin and cefotaxime, associated with the administration of intravenous immunoglobulin on the second day of hospitalization. Favorable clinical evolution.
		NB, 51 days	**Case 2:** Fever for 4 hours (38.9 °C), irritability, tachycardia (HR 214) and RR 48, SpO_2 99%.	Empiric treatment with ampicillin and cefotaxime. Favorable clinical evolution.
Cahn RT, et al 2023.	*Pasteurella multocida*	NB, 33 days	Fever was 38.9°C, physical examination normal,	Empiric treatment with vancomycin, ceftriaxone, and

			fontanelle without protrusions, patient agitated but comfortable.	acyclovir. Favorable clinical evolution.
Alosaimi, Hadeel et al, 2023.	*Streptococcus pneumoniae*	8 years	Fever 38.9°C, severe headache, vomiting, photophobia, neck stiffness, positive Brudzinski and Kernig signs, Glasgow 11, and focal seizures.	Treated with ceftriaxone and vancomycin, followed by neurosurgical drainage of the subdural empyema. Complicated by persistent seizures (controlled with anticonvulsants). Progressive laboratory and neurological improvement. Favorable evolution.
Gutiérrez-Gaitán et al., 2022	*Acinetobacter johnsonii*	15 years	Headache globalis, fever persistent for 11 days, vomiting, blurred vision, diplopia, nystagmus, and paresthesia.	Treatment was initiated with ampicillin/sulbactam, evolving with progressive improvement. After 21 days of antibiotics, he was discharged from the hospital, with satisfactory motor recovery.
Vrenna et al. 2025	*Non-K1* Escherichia coli	8 months	Initial fever and diarrhea, progressing to seizures and severe general condition on arrival at the reference hospital.	Treatment was initiated with ceftriaxone, later replaced by meropenem after confirmation of E. coli ESBL. Despite targeted therapy, there was rapid clinical worsening with the need for ICU and intubation, evolving to death within five days.
Zou, Dan et al. 2024	*Streptococcus gallolyticus* subspecies *pasteurianus* (SGSP)	Infant, 45 days old	High fever (up to 39.5 °C), generalized seizures, and previous umbilical infection.	Treatment was performed with vancomycin after discontinuation of ceftriaxone due to an allergic reaction, with progressive clinical improvement, resolution of seizures and fever. He was discharged without complications and without sequelae.

Xi M, et al	*Mycoplasma hominis*	RN, 10 days	Fever for 3 h (38.0 °C), HR 150 bpm, RR 42/min.	After failure of the initial empirical regimen with ampicillin and meropenem, treatment with doxycycline and moxifloxacin was initiated for six weeks, resulting in clinical improvement and normalization of the cerebrospinal fluid. He was discharged with partial motor deficit, but with preservation of auditory and visual responses.
Sherman G,et al 2022	*Group B streptococcus* / *Streptococcus agalactiae* (GBS)	14 week old twins	Fever in both, a few hours apart	Treatment was performed with penicillin G for six weeks (with 10 extra days for twin B) and antiepileptics to control seizures. Fever resolution was resolved within five days, seizure control, and imaging findings progressively improved.
Mizuno S,et al 2023	*Staphylococcus haemolyticus*	15 years	Fever (40.0°C) on the 13th day after the start of chemotherapy.	Treatment started with vancomycin followed by dose adjustment and addition of oral rifampicin in the face of persistence of infection. Due to the low concentration of vancomycin in the CSF, it was switched to linezolid, resulting in cerebrospinal fluid sterilization, clinical improvement, and uncomplicated discharge after 72 days of therapy.
Almatrafi MA,et al 2021	*Streptococcus viridans*	14 months	Fever and irritability for 2 weeks.	Treatment was initiated with vancomycin and ceftriaxone, and only ceftriaxone was maintained after confirmation of sensitivity. There was a good clinical response, with no neurological complications, and the patient was

				discharged after 14 days in good general condition, with normal audiometry.
Nguyen TLT, Bista B,et al 2023	*Listeria monocytogenes*	School age	Frontal headaches, vomiting, subjective fever and chills.	Antimicrobial treatment with vancomycin, ceftriaxone, and acyclovir, subsequently adjusted with the addition of ampicillin and then high-dose ampicillin plus gentamicin. After surgical interventions, including ventricular drainage and ventriculoperitoneal shunting, he showed progressive improvement, being extubated on the 11th day and achieving clinical stabilization with partial neurological recovery.
Brisca G,et al 2020.	*Listeria monocytogenes*	11 months	3 days of high fever (40.1 °C), vomiting, diarrhea, sudden onset of lethargy, and uncontrollable movements of the right leg.	Empirical therapy with ceftriaxone and acyclovir, later replaced by ampicillin and gentamicin for 15 days, followed by TMP-SMX, totaling 30 days of antibiotic therapy. The patient showed progressive neurological improvement after ventricular drainage and antibiotics, and was discharged in good condition, with mild residual paralysis of the right lateral rectus muscle and functional ventriculoperitoneal shunt.
Ansari NS,et al 2021	*Mycoplasma hominis*	Extremely premature (25+6 weeks)	Grade III bilateral intraventricular hemorrhage, progressive ventriculomegaly, right fronto-parietal hemorrhagic venous infarction with cystic	Treatment with empiric antibiotics with ampicillin and gentamicin, replaced by vancomycin and cefotaxime, and then definitive treatment with moxifloxacin and doxycycline was instituted for 6 weeks. There was progressive improvement of CSF, negative

			evolution, and clinical and subclinical seizures.	cultures and stability of ventriculomegaly, and he was discharged in good neurological condition, but with risk of long-term sequelae.
Cotran-Lenrow A, et al 2023	*Pseudomonas aeruginosa*	13 months	Two days of high fever and seizure activity.	Initial treatment with phenytoin, ceftriaxone, and artesunate, later replaced by meropenem for 21 days after culture results. The patient showed rapid clinical improvement, with resolution of fever and seizures, and was discharged in good general condition, but with neurological sequelae of hearing and visual deficit.
Guernsey D, et al 2022.	*Streptococcus pneumoniae*	9 years	Neck pain and stiffness for 1–2 days, with a positive Brudzinski sign	Initial treatment with ceftriaxone and vancomycin, maintaining only ceftriaxone after confirmation of *pansensitive Streptococcus* pneumoniae. She completed two weeks of antibiotic medication without complications, resumed corticosteroids for nephrotic syndrome, and had controlled hypertension, being discharged in good condition with prednisolone, enalapril and amlodipine.
Uejima Y, et al 2024.	*Ureaplasma parvum*	91st day of life	Recurrent fevers, elevated CRP. Seizures on day 125 of life. Progressive hydrocephalus associated with previous intraventricular hemorrhage.	Initial treatment was performed with intravenous erythromycin and ciprofloxacin for 61 days, with bacterial eradication and CSF normalization. She was discharged on the 345th day of life and, at 4 years of age, she presented residual hydrocephalus and

				developmental delay, under physical therapy follow-up.
Barnawi Al, et al 2020.	*Chryseobacterium (Elizabethkingia) meningoseptic*	2nd day of life	Tachypnea since birth, fever of 38.7°C for a day and lowered level of consciousness.	Empirical treatment was initiated with ampicillin and cefotaxime, replaced by ciprofloxacin and vancomycin for 6 weeks, associated with rifampicin for the first 2 weeks. The patient had a negative blood culture within 96 hours. At discharge, the patient was in good clinical condition, but with persistent posthemorrhagic ventricular dilatation.
Thomas M,et al 2025.	*Haemophilus influenzae* serotype A (Hia).	10 weeks of life	Decreased feeding, Increased irritability. Fever (38.8°C). No infectious focus evident at initial evaluation.	Received initial antimicrobial treatment with vancomycin, ampicillin, and cefepime, adjusted to ceftriaxone for 14 days after pathogen identification. The patient evolved with CSF normalization, good neurological recovery and, in two years of follow-up, normal development without deficits or recurrence of seizures.
Minato S, et al 2021.	*Streptococcus pneumoniae* Serotype 10A Penicillin-Resistant	17 months	5 days of fever and mild respiratory symptoms On examination: paradoxical irritability, mild neck stiffness, temperature of 40.7°C	Initial treatment was performed with vancomycin and ceftriaxone, later associated with levofloxacin due to the severity and resistance profile. After 10 weeks of antibiotic therapy, the patient developed sequelae of paralysis of the right oculomotor nerve and hearing loss.
Kachuei M, et al 2024.	*Streptococcus pneumoniae*	7 years	High fever (39 °C), vomiting, loss of consciousness, tonic-clonic	Initial treatment with ceftriaxone, vancomycin and rifampicin, in the face of suspected bacterial meningitis. After four weeks of

			seizures, and difficulty breathing; hypertonia, increased tendon reflexes, neck stiffness with positive Brudzinski and Kernig signs, and bilateral extensor plantar reflex.	hospitalization, there was clinical improvement, with hospital discharge and residual ataxia, which was referred for rehabilitation.

Among the 20 cases of bacterial meningitis analyzed, 11 distinct genera were identified. *Streptococcus pneumoniae*, including resistant serotypes, accounted for 4 cases (20%). *Streptococcus agalactiae* (Group B) was present in 2 cases (10%), mainly affecting neonates and can cause early or late meningitis. Two cases (10%) were attributed to *Listeria monocytogenes* and another 2 (10%) to *Mycoplasma hominis* , both with risk of neurological complications. The other agents, with one case each (5%), included *Streptococcus gallolyticus*, *Pasteurella multocida*, *Acinetobacter johnsonii*, *Escherichia coli* non-K1, *Staphylococcus haemolyticus*, *Streptococcus viridans*, *Pseudomonas aeruginosa*, *Ureaplasma parvum*, *Chryseobacterium (Elizabethkingia) meningoseptic* and *Haemophilus influenzae* serotype a (HIA), comprising opportunistic, emerging and resistant bacteria, some associated with a higher risk of neurological complications. The relative frequency of each agent was calculated considering a total of 20 cases, evidencing the etiological diversity of bacterial meningitis in this study.

The analysis of the data confirms that children under 12 months of age (60% of cases) remain the most vulnerable to bacterial meningitis, in line with the literature that points to immunological immaturity and greater perinatal exposure to severe pathogens as determining factors (Miura et al., 2001; Zou et al., 2020). The predominance of GBS and *L. monocytogenes* in neonates highlights the need for preventive strategies aimed at pregnant women and the perinatal period, especially in situations of prematurity and low birth weight, conditions associated with higher morbidity and mortality. In children under five years of age, the relevance of *S. pneumoniae* and *H. influenzae* highlights the positive impact of conjugate vaccines, while highlighting the persistent risk in unvaccinated or immunocompromised individuals. These findings suggest that the prevention and

management of meningitis should go beyond universal vaccination, incorporating the early identification of individual risk factors and the implementation of clinical protocols targeted to specific age groups and conditions of vulnerability (WANG et al., 2023).

In the case analysis, it was observed that most patients were neonates (0–28 days), corresponding to 4 cases, followed by infants aged 1 to 12 months, with 8 cases. Children aged 1–5 years accounted for 3 cases, school-age children (6–12 years) 4 cases, and 15-year-old adolescents presented 2 cases. Among neonates, the most frequent risk factors included extreme prematurity, umbilical cord infection, and a history of recent delivery. In infants, immature immunity and pre-existing comorbidities stood out. Among children aged 1 to 12 years, there was a higher occurrence of meningitis associated with immunosuppression or chronic conditions, such as chemotherapy or systemic diseases.

The epidemiological analysis reinforces the importance of considering the age group and risk factors in the prevention and management of bacterial meningitis. According to the World Health Organization, children under 5 years of age are more vulnerable to the disease, especially neonates, due to the immaturity of the immune system. In addition, factors such as incomplete vaccination schedule, presence of chronic diseases, immunosuppression, and exposure to crowded environments significantly increase the risk of infection. These data corroborate the findings of this review, indicating that early recognition of clinical signs and the implementation of prevention measures, such as vaccination and close monitoring of risk groups, are essential to reduce morbidity and mortality associated with bacterial meningitis (WORLD HEALTH ORGANIZATION, 2025).

The clinical manifestations of bacterial meningitis, described in the 20 clinical cases analyzed, were quite heterogeneous, varying according to the patient's age and etiological agent. In general, the most repeated symptom was fever, present in 17 of the 20 cases (85%), often with temperatures above 39–40 °C. Seizures occurred in 7 cases (35%), ranging from generalized to focal. Vomiting, in turn, was recorded in 6 cases (30%) and irritability in 4 cases (20%). The classic signs of meningismus (neck stiffness and Brudzinski/Kernig signs) also occurred in 4 cases (20%), usually associated with severe headache, photophobia and decreased level of consciousness. In neonates and infants, nonspecific manifestations such as fontanel bulging, lethargy, hyporexia, tachypnea, and peripheral cyanosis have been reported less frequently. Among the less common

manifestations observed are involuntary limb movements, nystagmus, diplopia, and focal motor deficits.

This clinical variability, evidenced in the different case reports, reinforces the diagnostic challenges: in neonates and preterm infants, the signs are subtle and easily confused with other systemic infections; In older patients, although the findings are more typical, they may overlap with other neurological or infectious conditions. In this sense, when comparing the classic conditions with the atypical ones, it is noted that the former, more common in older age groups, tend to quickly direct the suspicion of meningitis due to the presence of typical meningeal symptoms and evident neurological signs, favoring an early diagnosis. On the other hand, atypical conditions, predominant in neonates and infants, present nonspecific and discrete manifestations, which often leads to delays in clinical recognition and increases the risk of complications and neurological sequelae. As described in the literature, symptoms of bacterial meningitis are nonspecific and patients who are not diagnosed early may present with a wide variety of infectious or noninfectious medical conditions. Thus, the detailed analysis of the clinical picture, combined with complementary tests such as cerebrospinal fluid, neuroimaging, and blood culture, is essential to ensure early suspicion and confirmation, directly impacting the conduction and prognosis (HOVMAND, et al 2023).

Considering the treatment described in the selected cases, the most used empirical regimen was the association of third-generation cephalosporin (ceftriaxone/cefotaxime), present in 13 cases (65%), with vancomycin in 11 cases (55%) and, in 7 cases (35%), also with ampicillin, reflecting the need to cover the main agents according to age and risk of *L. monocytogenes*. However, in 14 of the 20 cases (70%) there was a need for therapeutic adjustment, motivated by culture/antibiogram, including resistance (such as *E. coli*, which required carbapenem), low drug penetration into the cerebrospinal fluid (with replacement of vancomycin by linezolid) or adverse reactions (such as allergy to ceftriaxone). Other changes using culture/antibiogram involved the adoption of quinolones, doxycycline and moxifloxacin.

In this context, these findings reinforce that targeted antibiotic therapy plays a fundamental role in allowing the adequacy of treatment according to the etiological agent and its sensitivity profile, reducing unnecessary exposure to broad-spectrum antimicrobials and, consequently, the risks of toxicity, high costs, and selection of resistant strains. Early initiation of empirical therapy is essential given the severity of

bacterial meningitis, and should be replaced by a targeted regimen as soon as culture and antibiogram results are available, which ensures greater therapeutic efficacy and better clinical outcomes (WANG et al., 2023). Continuous surveillance of antimicrobial resistance, both at the institutional and global levels, is critical to updating empirical protocols, identifying emerging patterns, and guiding policies for rational use of antibiotics. Thus, the growing incidence of resistant bacteria, associated with the inappropriate use of these drugs, reinforces the need for strategies that optimize antibiotic therapy, such as the use of rapid microbiological diagnostics, inflammatory markers to guide the initiation and duration of treatment, reduction of the standard time of use, and individualization of therapies based on pharmacokinetic and pharmacodynamic parameters. In addition, antibiotics with a lower potential to induce resistance should be prioritized and administration programs that support clinical reasoning should be invested, promoting a more rational and safe use (BASSETTI S, et al 2022).

The analysis of the described case reports shows that, although most patients evolved satisfactorily after adequate antimicrobial treatment, a portion presented relevant complications. In 11 cases, the clinical evolution was favorable, with no neurological deficits or subsequent complications, including infections by *S. agalactiae*, *P. multocida*, *S. gallolyticus*, *S. haemolyticus*, *S. viridans*, *H. influenzae* serotype A, among others. On the other hand, 9 reports documented evolution with neurological sequelae, such as partial motor deficit, hearing loss, visual deficit, cranial nerve palsy, residual hydrocephalus, and ataxia, generally associated with agents such as *M. hominis*, *P. aeruginosa*, *L. monocytogenes,* and *penicillin-resistant S.* pneumoniae. There was also 1 fatal case, resulting from non-K1 *E. coli* infection, even after targeted therapy.

Even with the proper use of antimicrobials, a portion of patients affected by bacterial meningitis still develop important neurological complications. As described in the literature, about half of the survivors may present focal neurological deficits, such as hearing loss, epileptic seizures, cognitive impairment, cranial nerve palsy, residual hydrocephalus, and ataxia. The frequency and severity of these sequelae vary according to the infectious agent, being higher in cases caused by resistant *S. pneumoniae*, *L. monocytogenes,* and gram-negative bacilli, such as *P. aeruginosa* and *non-K1 E. coli*, which are also associated with higher mortality, even after specific therapy. In contrast, infections with *S. agalactiae*, *P. multocida*, *S. gallolyticus*, *S. haemolyticus*, *S. viridans,*

and *H. influenzae* tend to have a more favorable outcome, without persistent neurological deficits, especially when treatment is instituted early (VAN DE BEEK et al., 2021).

The most effective strategy to reduce complications associated with bacterial meningitis is the prevention of infection through childhood immunization programs. In the cases analyzed, microorganisms for which vaccination is highly efficient were highlighted, evidencing their role in reducing morbidity and mortality. *S. pneumoniae*, present in four episodes, can be prevented by pneumococcal conjugate vaccines, already included in the children's calendar, in addition to the polysaccharide vaccine indicated for risk groups. *H. influenzae* type B, identified in one case, is covered by the Hib vaccine, whose inclusion in national programs caused a significant drop in the incidence of the invasive disease. Although no cases of *N. meningitidis were observed* in this sample, the agent remains relevant in public health, with vaccines available for the main serogroups (C, A, B, W, and Y), which are fundamental in the prevention of meningococcal meningitis (BRASIL, MINISTRY OF HEALTH, 2025). In addition, routine vaccination contributes to herd immunity, indirectly reducing the transmission of the disease within the population. Since the introduction of pneumococcal conjugate vaccines, the incidence of invasive pneumococcal disease has dropped significantly, including among unvaccinated children, evidencing the indirect effects of immunization (SADARANGANI et al., 2021).

4 CONCLUSION

The analysis of clinical cases of pediatric bacterial meningitis shows the wide etiological diversity involved in the disease, emphasizing the importance of early recognition of clinical signs, which vary significantly according to the age group and the pathogen responsible. Although many patients had a favorable outcome with appropriate and timely treatment, it was observed that infections with more virulent or resistant agents, such as *S. pneumoniae*, *E. coli,* and *U. parvum*, were associated with a higher risk of neurological complications and, in isolated cases, death. The findings reinforce that immediate empirical antibiotic therapy, followed by targeted management according to etiological identification, is essential to reduce morbidity and mortality. In addition, the impact of individual immunological conditions, the presence of comorbidities, and antimicrobial resistance on the evolution of cases is highlighted. Thus, this study contributes to the improvement of clinical practice by synthesizing recent evidence on clinical presentation, treatment, and outcomes, reinforcing the need for continuous

surveillance, therapeutic updating, and strengthening of prevention strategies, especially through the expansion of vaccination coverage.

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