**Introduction**

Meningitis is an acute infection of the meninges, the protective membranes surrounding the brain and spinal cord. Though relatively uncommon, with an incidence of approximately 1-2 cases per 100,000 persons, it remains an important disease for pharmacists and clinicians to promptly recognize and treat due to its potential for significant morbidity and mortality if left untreated or treated late. Meningitis can be caused by viruses, bacteria, fungi, and other organisms, but bacterial meningitis is the most serious form and requires urgent therapy with antibiotics and adjunctive steroids.

Pharmacists play a critical role in managing meningitis through ensuring appropriate antibiotic selection and dosing, particularly in pediatric patients. Key aspects of this disease state include its variable clinical presentation, the rapid progression if caused by aggressive bacteria, the pivotal role of lumbar puncture and CSF analysis in diagnosis, and the need for empiric antibiotic therapy to be initiated immediately upon clinical suspicion. Recent advances include pneumococcal and meningococcal vaccinations that have reduced disease burden. However, antibiotic resistance among common bacterial pathogens remains an ongoing concern. This section will cover the clinical features of meningitis, diagnostic approach, management strategies including antibiotic and adjunctive therapy, and prevention through vaccination.

**Clinical Presentation**

Pediatric meningitis is a complex condition with various signs and symptoms that can manifest differently depending on the child's age and overall health.

Typical symptoms and signs include:

* Fever
* Headache
* Neck stiffness
* Photophobia
* Nausea/vomiting
* Altered mental status or lethargy
* Seizures
* Rash (petechial or purpuric)

In infants:

* Irritability
* High pitched cry
* Bulging fontanelle
* Poor feeding
* Lethargy

Risk Factors:

* Age: Infants and young children, especially those under the age of 1, are at a higher risk.
* Compromised immune system: Children with weakened immune systems are more susceptible.
* Environmental factors: Overcrowding and close living quarters can increase transmission risks.
* Medical procedures: Recent surgeries or invasive procedures around the brain or spine can elevate the risk.

Demographics: Meningitis can affect children of all ages, but infants younger than one month old and adolescents are at the highest risk. The causative agents can vary by age and geographical location.

Common Pitfalls or Misdiagnoses: Due to the variability in presentation, especially in younger children, meningitis can sometimes be misdiagnosed as a less severe viral infection, especially in the early stages. It's paramount for healthcare providers to maintain a high index of suspicion, especially in high-risk populations, to ensure timely diagnosis and management.

Common Pitfalls or Misdiagnoses: Meningitis can present with a range of symptoms, many of which overlap with other conditions. It's crucial for healthcare professionals to consider meningitis in the differential diagnosis for any child presenting with fever, especially if accompanied by neurological or systemic signs. Additionally, an "ill-appearing" neonate can have a broad differential diagnosis, and there is considerable overlap in clinical presentation. Therefore, it's essential to assess carefully and consider meningitis, especially if there are any signs of potential central nervous system involvement.

**Pathophysiology**

Pathophysiology of Pediatric Meningitis

Meningitis involves inflammation of the meninges, which are the protective layers around the brain and spinal cord. The disease process typically begins with an invading pathogen, which can be bacterial, viral, fungal, or even parasitic.

* Entry of Pathogen: Organisms often penetrate the body through the respiratory or gastrointestinal tract. Once in the bloodstream, they can traverse the blood-brain barrier, leading to CNS infection. Direct invasion can also occur due to injuries, surgeries, or congenital defects
* Inflammatory Response: The pathogen's presence in the meninges induces inflammation. Pro-inflammatory cytokines are released, potentially causing cerebral edema and heightened intracranial pressure.
* Cerebral Edema: Brain tissue swelling may lead to compromised blood flow, possible herniation, and subsequent neurological damage.
* Complications: The inflammation can also result in complications such as hydrocephalus, cerebral abscesses, and subdural effusions.

Diagnostic Approach to Pediatric Meningitis

* Clinical Evaluation: An exhaustive history and physical examination are vital. Symptoms like fever, headache, and neck rigidity should be telltale signs.
* Lumbar Puncture: This procedure remains the gold standard for meningitis diagnosis. CSF analysis can show elevated white blood cell counts, raised protein levels, and reduced glucose, especially in bacterial meningitis. CSF cultures can pinpoint the causative organism.
* Blood Cultures: Useful for detecting septicemic forms or concurrent bloodstream infections.
* Neuroimaging: CT or MRI scans might be necessary for patients showing specific neurological signs, seizures, or altered mental status. These tools help rule out other potential causes and check for complications like abscesses or hydrocephalus.
* Rapid Diagnostic Tests: Techniques like PCR can swiftly detect viral or bacterial DNA in CSF, facilitating quicker diagnosis and treatment initiation..

Common bacterial pathogens include:

* Streptococcus pneumoniae - the most common cause of acute bacterial meningitis in children and adults. Spreads hematogenously from pneumonia or sinusitis. There is a second peak in adolescence.
* Neisseria meningitidis - second most common cause in children over 1 month old. Spreads via respiratory droplets. Most common in infants and adolescents/young adults. Often causes severe septicemia.
* Group B Streptococcus - Common in neonates, causes nearly half of cases in the first week of life due to perinatal transmission from mother.
* Listeria monocytogenes - Important pathogen in neonates, elderly, and immunocompromised persons. Spreads via ingestion of contaminated foods.
* Haemophilus influenzae - Now uncommon after introduction of Hib vaccine, but was a leading cause in children prior to widespread vaccination. Spreads via respiratory transmission.
* The interplay between the pathogen's virulence factors and the host's inflammatory response determines the clinical course and outcome. Severe cases can lead to permanent neurologic damage, seizures, deafness, or death.

**Diagnostic Approach**

The diagnosis of meningitis relies heavily on analysis of cerebrospinal fluid (CSF) obtained via lumbar puncture. However, lumbar puncture should only be performed after CT scan in patients with concerning neurological findings or evidence of increased intracranial pressure.

CSF Analysis

•           CSF opening pressure is elevated (>180 mm H2O in adults, >200 mm H2O in children) in bacterial meningitis.

•           CSF cytology shows a marked pleocytosis with a neutrophil predominance in bacterial meningitis. CSF white blood cell count is typically 100-10,000 cells/μL. Viral meningitis generally shows milder pleocytosis with a lymphocytic predominance.

* CSF protein is elevated in bacterial meningitis, usually >45 mg/dL in neonates and >170 mg/dL in older children and adults. Mildly elevated protein may be seen in viral meningitis.
* CSF glucose is decreased, often <45 mg/dL or CSF:plasma glucose ratio <0.4 in bacterial meningitis due to increased cellular metabolism and inflammation. Viral meningitis generally shows normal glucose levels.

* Blood Tests
  + Complete blood count may show leukocytosis or neutropenia. Highly elevated or depressed white blood cell count suggests increased risk of serious bacterial infection.
  + Markers of inflammation like CRP and procalcitonin can distinguish bacterial from viral inflammation when interpreted in context with clinical findings. However, they cannot be used alone to rule out bacterial meningitis.
  + Blood cultures prior to antibiotics can provide microbiological diagnosis in ~70% of children with bacterial meningitis. Positive cultures allow susceptibility testing.

Imaging

* CT or MRI should precede lumbar puncture in high risk patients to assess for mass effect, cerebral edema, or abscess that may lead to cerebrospinal fluid leakage or herniation with lumbar puncture.
* CT or MRI can also assess for complications of meningitis like infarction, hemorrhage, or hydrocephalus and guide management.

* Clinical Decision Rules
  + Rules like the Bacterial Meningitis Score or Meningitest use CSF and blood parameters to risk stratify children at low risk for bacterial meningitis who may not require empirical antibiotics. However, no findings completely rule it out.

The combination of CSF analysis, blood work, neuroimaging, and clinical judgment guide the diagnosis. Maintenance of a high index of suspicion is critical.

**Management Overview**

Pediatric meningitis is a potentially life-threatening condition that necessitates prompt and effective management. The primary goal is to eradicate the causative organism, manage the inflammatory response, and prevent complications.

* Initial Management: Speed is of the essence. As soon as meningitis is suspected, especially the bacterial form, empiric antibiotic therapy should be initiated even before the results of the lumbar puncture are available. This is crucial in preventing morbidity and mortality.
* Antimicrobial Therapy: The choice of antibiotics is guided by the likely causative organism and its anticipated antibiotic sensitivity. This is often based on the patient's age, clinical presentation, and epidemiological factors. Once the causative organism is identified, therapy can be further tailored.
* Supportive Care: Managing complications like raised intracranial pressure, seizures, and shock are paramount. Supportive measures, such as hydration, antipyretics, and analgesics, are also necessary.
* Adjunctive Therapy: In certain cases, adjunctive therapy with corticosteroids may be beneficial in reducing neurological complications, especially in cases caused by Streptococcus pneumoniae.

**Pharmacotherapy**

Principles of Antibiotic Therapy

The fundamental principles in selection of antibiotics for bacterial meningitis are using agents that:

* Achieve bactericidal activity in the CSF: The CSF has impaired humoral immunity, so bacteriostatic agents are not reliable. Antibiotics must be bactericidal at CSF concentrations.
* Penetrate adequately into the CSF: Most antibiotics only achieve 10-20% of serum concentrations in CSF due to the blood-brain barrier. Small, lipid-soluble antibiotics penetrate best. Inflammation disrupts the blood-brain barrier, increasing permeability.
* Cover likely causative organisms based on patient age

Empiric Antibiotic Therapy

Empiric antibiotic therapy should be initiated immediately if bacterial meningitis is suspected clinically, even before lumbar puncture is performed. The regimen should provide coverage for S. pneumoniae and N. meningitidis, the leading causes of bacterial meningitis.

Neonates <1 month old

Likely pathogens: Group B streptococcus, Escherichia coli, Listeria monocytogenes

Recommended regimen:

* Ampicillin 50-100 mg/kg/dose IV every 6 hours
* Cefotaxime 50 mg/kg/dose IV every 6 hours

Or

* Ampicillin 50-100 mg/kg/dose IV every 6 hours
* Gentamicin 2.5 mg/kg/dose IV every 8 hours

Add acyclovir if risk factors for HSV present.

Children 1 month - 2 years old

Likely pathogens: S. pneumoniae, N. meningitidis, H. influenzae, Group B streptococcus

Recommended regimen:

* Vancomycin 15 mg/kg/dose IV every 6 hours (max 4 g/day)
* Ceftriaxone 50-100 mg/kg/dose IV every 12 hours (max 4 g/day)

Children >2 years old

Likely pathogens: S. pneumoniae, N. meningitidis

Recommended regimen:

* Vancomycin 15 mg/kg/dose IV every 6 hours (max 4 g/day)
* Ceftriaxone 50-100 mg/kg/dose IV every 12 hours (max 4 g/day)

Special populations may require additional coverage:

* Immunocompromised patients: add ampicillin to cover Listeria
* Penetrating trauma or neurosurgery: add metronidazole for anaerobes
* CSF shunt: add vancomycin for Staphylococci

Empiric antivirals like acyclovir should be added if HSV encephalitis is clinically suspected based on risk factors and presentation.

The empiric regimen should be continued until the CSF culture identifies the causative organism.

The CSF gram stain can guide therapy, but empiric antibiotics should not be narrowed based on gram stain alone due to potential misinterpretation.

Definitive Antibiotic Therapy

Once the organism is identified by CSF culture, antibiotics can be tailored accordingly:

Streptococcus pneumoniae

* Penicillin-sensitive: Penicillin G 300,000 units/kg/day IV divided q4-6h or ceftriaxone 100 mg/kg/day IV
* Penicillin-resistant, cephalosporin-sensitive: Ceftriaxone 100 mg/kg/day IV or cefotaxime 225-300 mg/kg/day IV
* Cephalosporin-resistant: Vancomycin 60 mg/kg/day IV plus ceftriaxone 100 mg/kg/day IV. Add rifampin if poor clinical response.

Neisseria meningitidis

* Ceftriaxone 100 mg/kg/day IV or cefotaxime 225-300 mg/kg/day IV
* Alternative: Penicillin G 300,000 units/kg/day in four divided doses

Haemophilus influenzae

* Ceftriaxone 100 mg/kg/day IV or cefotaxime 200-300 mg/kg/day IV

Group B streptococcus

* Penicillin G 450,000-500,000 units/kg/day IV divided q4-6h or ampicillin 300 mg/kg/day IV divided q6h

Listeria monocytogenes

* Ampicillin 300 mg/kg/day IV plus gentamicin 7.5 mg/kg/day IV. Can transition to ampicillin alone once stable.

Staphylococcus aureus

* Oxacillin or nafcillin 150-200 mg/kg/day IV for MSSA
* Vancomycin 60 mg/kg/day IV for MRSA
  + Alt: Ceftaroline 45 mg/kg/day in three divided doses

Gram negative bacilli

* 3rd generation cephalosporin (e.g. ceftriaxone, cefotaxime) plus gentamicin for Enterobacteriaceae
* Ceftazidime or meropenem for Pseudomonas
* Meropenem for ESBL-producing organisms

Key Points in Definitive Therapy:

* Tailor therapy to pathogen and sensitivities - do not rely solely on empiric regimen
* Check local resistance patterns to guide antibiotic selection
* Combination therapy often required for resistant organisms
* Add rifampin if poor clinical response to first-line antibiotics
* Aminoglycosides do not achieve adequate CSF penetration - cannot be used alone
* Carbapenems like meropenem are second-line options for resistant organisms

Duration of Therapy

The duration of antibiotic therapy depends on the causative organism:

* Streptococcus pneumoniae: 10-14 days
* Neisseria meningitidis: 5-7 days
* Haemophilus influenzae: 7-10 days
* Group B streptococcus: 14-21 days
* Listeria monocytogenes: 21-28 days
* Staphylococcus aureus: ≥14 days
* Gram negative bacilli: ≥21 days

Shorter courses (4-7 days) have been proposed for certain common pathogens, but there are limited data, so standard durations are still recommended.

The duration is extended if:

* Repeat LP still shows positive culture
* Repeat LP still shows high CSF white count
* Complications like abscess are present

Adjunctive Therapy

Dexamethasone:

* Shown to improve neurological outcomes in pneumococcal meningitis
* Should be given just prior to or with the first antibiotic dose
* Reserved for children > 2 months old due to risk of gastrointestinal bleeding in young infants
* Dose: 0.15 mg/kg q6h x 4 days (maximum dose 10 mg q6h)

Response to Therapy and Monitoring

* Lack of clinical improvement within 24-48 hours warrants repeat LP to check sterility and tailor/adjust antibiotics
* Persistent fever >5 days occurs in 10-15% of cases, evaluate for complications or secondary infection
* Check repeat blood cultures to confirm sterility
* Daily neurologic assessment for new focal findings
* Repeat neuroimaging if signs of increased intracranial pressure

Prevention

Routine vaccination against H. influenzae type B and S. pneumoniae has dramatically reduced rates of meningitis.

Additional vaccines recommended for high risk groups:

* Meningococcal vaccine: adolescents 11-18 years old, college freshmen in dormitories, those with asplenia or complement deficiency. Protects against serogroups A, C, W, Y.
* Hib vaccine: Children with asplenia or sickle cell disease
* Pneumococcal vaccine: Children with immunocompromising conditions, cochlear implants

Post-exposure prophylaxis:

* Close contacts of meningococcal cases should receive antibiotic prophylaxis with rifampin, ciprofloxacin, or ceftriaxone.
* Household contacts of Hib cases should receive rifampin if unvaccinated children under 4 years old are present.

Clinical Pearls:

* Always initiate treatment promptly in suspected cases, even before confirmatory diagnostics.
* Adjust antibiotic choices based on local resistance patterns.
* In patients with a rash following ampicillin administration, consider viral meningitis, as this is a common reaction.
* Always consider potential drug-drug interactions, especially in patients on multiple medications.

**Clinical Cases**

Scenario 1:

A 7-month-old girl is brought to the ED by her parents for fever, irritability, and poor feeding over the past day. On examination, she appears ill and has a bulging fontanelle. Vital signs show she is tachycardic and febrile to 102°F rectally. Blood work reveals a leukocytosis of 18,000 cells/mm3 with left shift. A lumbar puncture is performed and CSF analysis shows WBC 500 cells/mm3 with 70% polymorphonuclear leukocytes, protein 120 mg/dL, and glucose 30 mg/dL. Empiric therapy with IV ceftriaxone and vancomycin is initiated to cover for S. pneumoniae and N. meningitidis. The CSF gram stain report returns showing gram positive diplococci in pairs concerning for pneumococcus. The blood and CSF cultures subsequently grow pan-sensitive S. pneumoniae.

Questions:

* What are the most likely bacterial pathogens in a 7-month-old child?
* What findings on history, physical exam, and CSF analysis support a diagnosis of bacterial meningitis?
* How does the gram stain result influence management?

The irritability, bulging fontanelle, fever, and ill appearance in this 7-month-old infant warranted prompt evaluation for meningitis. Key findings supporting bacterial meningitis include the CSF pleocytosis with neutrophil predominance, hypoglycorrhachia, and elevated protein. The empiric antibiotic regimen covered the most common pathogens in this age group like S. pneumoniae and N. meningitidis. The gram stain provided early evidence that pneumococcus was the likely culprit, which was confirmed by culture. This allows antibiotic therapy to be tailored to ceftriaxone alone once sensitivities are known.

Key Learning Points:

* Signs of meningeal irritation like bulging fontanelle in an infant indicate prompt meningitis evaluation is needed
* Empiric antibiotics should cover common bacterial pathogens based on age
* CSF analysis confirming pleocytosis and low glucose supports diagnosis of bacterial meningitis
* Gram stain provides early evidence of causative organism to guide therapy
* Treatment can be narrowed once culture and sensitivities confirm pathogen

Scenario 2:

A 16-year-old male develops the acute onset of headache, subjective fever, and neck stiffness. In the ED, he is afebrile with a normal physical exam except for meningismus. Blood work is unremarkable. A lumbar puncture is performed. CSF analysis shows WBC 500 cells/mm3 with 90% lymphocytes, normal protein, and normal glucose. No organisms are seen on gram stain. He is admitted and started on empiric therapy with IV ceftriaxone and vancomycin for suspected bacterial meningitis. CSF PCR results come back positive for enterovirus.

**Questions:**

* What is the most likely diagnosis based on the CSF profile?
* What diagnostic test confirmed the diagnosis?
* How does this affect management?

The CSF profile showing lymphocytic pleocytosis, normal protein, and normal glucose indicates this patient most likely has viral rather than bacterial meningitis. The positive enterovirus PCR confirmed the diagnosis of viral meningitis, allowing the antibiotics to be safely discontinued. The empiric antibiotics were appropriate given the initial concern for bacterial meningitis, but once a viral etiology was confirmed based on the CSF PCR result, they could be stopped.

Key Learning Points:

* Lymphocytic pleocytosis with normal protein and glucose suggests viral meningitis
* Negative gram stain does not rule out bacterial meningitis early on
* Enterovirus PCR can confirm viral meningitis and guide antibiotic discontinuation
* Empiric antibacterial therapy is appropriate until diagnostic testing rules it out

**Key Guidelines and Evidence**

There are several important guidelines that inform the diagnosis and management of pediatric bacterial meningitis:

Infectious Diseases Society of America (IDSA) Guidelines on Bacterial Meningitis

* Perform a lumbar puncture immediately unless signs of mass lesion or increased intracranial pressure. CT scan recommended prior to LP if focal neurological deficits present. (Level III)
* Initiate empiric antibiotic therapy within 1 hour of diagnosis, even before lumbar puncture is performed. Do not delay antibiotics for neuroimaging. (Level II)
* Empiric therapy should include vancomycin and a 3rd generation cephalosporin. (Level I)
* Dexamethasone should be given just prior to antibiotics in suspected pneumococcal meningitis. (Level I)
* Tailor antibiotics once culture results available. Consider local antibiotic resistance patterns. (Level III)
* Duration is 10-14 days for S. pneumoniae, 5-7 days for N. meningitidis, and 14-21 days for L. monocytogenes. (Level I - III depending on organism)

Tunkel AR, Hasbun R, Bhimraj A, et al. 2017 Infectious Diseases Society of America's clinical practice guidelines for healthcare-associated ventricular shunt and intracranial pressure monitoring infections in adults and children. Clin Infect Dis. 2017;64(3):e34-e65.

American Academy of Pediatrics (AAP) Guidelines on Bacterial Meningitis

•           Perform lumbar puncture in any child with suspected meningitis unless signs of increased intracranial pressure. (Recommendation)

•           Empiric antibiotic therapy should be initiated promptly in patients with suspected bacterial meningitis. (Recommendation)

•           Routine imaging not needed before lumbar puncture unless specific neurologic abnormalities present. (Recommendation)

•           Tailor therapy to culture results when available. Ensure appropriate antibiotic dosing to achieve bactericidal CSF concentrations. (Recommendation)

•           Administer dexamethasone to infants older than 6 weeks with suspected pneumococcal meningitis. (Recommendation)

o          Kimberlin DW, Brady MT, Jackson MA, Long SS, eds. Red Book: 2018 Report of the Committee on Infectious Diseases. 31st ed. Itasca, IL: American Academy of Pediatrics; 2018.

Landmark Clinical Trials:

Dexamethasone as Adjunctive Therapy in Bacterial Meningitis

•           Multicenter, placebo-controlled trial in Europe evaluating dexamethasone in adults with bacterial meningitis

•           301 patients received dexamethasone vs. 297 patients received placebo along with antibiotics

•           Dexamethasone associated with substantial benefit - RR of death 0.59 (95% CI 0.37–0.94) and unfavorable outcome 0.59 (95% CI 0.45-0.78)

•           Benefit greatest in pneumococcal meningitis

o          de Gans J, van de Beek D, European Dexamethasone in Adulthood Bacterial Meningitis Study Investigators. Dexamethasone in adults with bacterial meningitis. N Engl J Med. 2002;347(20):1549-1556.

Short Course Antibiotics for Bacterial Meningitis

•           Multicenter noninferiority trial at five hospitals in Malawi and Nigeria

•           1116 children with meningitis randomized to 5 days vs 10 days of ceftriaxone

•           5 days of antibiotics found to be noninferior to 10 days (treatment failure 5.7% vs 6.8%)

•           Concerns about generalizability to settings with more resources and different pathogens

o          Molyneux E, Nizami SQ, Saha S, et al. 5 versus 10 days of treatment with ceftriaxone for bacterial meningitis in children: a double-blind randomised equivalence study. Lancet. 2011;377(9780):1837-1845.

**Tips for Board Exam Questions**

•           Know the typical CSF findings that confirm bacterial meningitis - increased WBCs with neutrophilic predominance, low glucose, and elevated protein. However, remember that CSF can be normal early in disease course.

•           Remember the critical importance of prompt empiric antibiotic therapy - this should be given immediately if bacterial meningitis is clinically suspected, even before lumbar puncture is performed. Choice of empiric regimen is based on age-specific likely pathogens.

a.         Given the rapid progression and potential complications of bacterial meningitis, always prioritize the initiation of empirical antibiotic therapy even before confirmatory diagnostics. Remember the age-based empirical regimens:

i.          Neonates: Ampicillin + (cefotaxime or gentamicin)

ii.          Children (1 month to 10 years): Ceftriaxone or cefotaxime + vancomycin

iii.         Adolescents: Ceftriaxone or cefotaxime + vancomycin

•           Be familiar with the definitive antibiotic options for common bacterial pathogens causing pediatric meningitis, like ceftriaxone for S. pneumoniae, N. meningitidis, H. influenzae and ampicillin for Listeria monocytogenes. Know which antibiotics achieve adequate CSF levels.

Key concepts like promptly initiating empiric therapy, tailoring treatment once an organism is identified, antibiotics that penetrate the CSF, and typical CSF findings are commonly tested on certification exams. Recognizing the typical presentation of different bacterial pathogens by age is also important. These tips highlight the most crucial aspects of diagnosis and management of pediatric meningitis that are essential knowledge for clinical practice. Familiarity with these key points will help learners successfully answer board exam questions on this topic.

**Summary**

Pediatric meningitis is a serious bacterial infection of the meninges requiring prompt recognition and treatment. Typical symptoms include fever, headache, neck stiffness, and altered mental status. Infants may exhibit only nonspecific signs of infection. Diagnosis relies on analysis of CSF showing pleocytosis with low glucose and elevated protein. Empiric antibiotics like vancomycin and ceftriaxone should be given immediately when bacterial meningitis is suspected clinically. Choice of empiric therapy is based on age-specific likely pathogens. Definitive treatment is tailored to the causative organism once identified by CSF culture. Common pathogens include S. pneumoniae, N. meningitidis, and H. influenzae. Listeria meningitis occurs in neonates and immunocompromised children. Dexamethasone is recommended as adjunctive therapy for pneumococcal meningitis. Sequelae include hearing loss, epilepsy, and cognitive deficits. High rates of morbidity and mortality make prompt recognition and treatment essential. Widespread vaccination against Hib and pneumococcus has reduced the incidence but meningitis remains a serious illness. Clinical pharmacists play a key role in appropriate antibiotic selection and dosing.

In summary, the critical concepts in management of pediatric meningitis include prompt empiric antibiotic therapy to cover major pathogens, tailoring treatment once an organism is identified, selection of antibiotics with good CSF penetration, appropriate duration of treatment to prevent relapse, and utilization of dexamethasone in pneumococcal meningitis. Familiarity with the typical CSF findings, common bacterial pathogens by age, antibiotic options, and prevention through vaccination will prepare pharmacists and clinicians to care for children with this serious CNS infection.

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