Meningitis

🌡️ Clinical Manifestations of CNS Infections

This section focuses on the signs and symptoms of CNS infections, emphasizing the differences between acute and chronic presentations and variations based on age and causative agent.

Meningitis: The Classic Triad

- **Fever:** A hallmark of both bacterial and aseptic meningitis, though absent in some cases, particularly in neonates. *Advanced Note:* Fever's absence doesn't rule out meningitis, especially in immunocompromised individuals.
- **Headache:** Often severe and sudden in onset in acute meningitis. *Advanced Note:* The character of the headache (e.g., throbbing, constant) can offer clues to the underlying cause.
- **Altered Mental Status:** Ranges from subtle confusion to coma. *Advanced Note:* The specific changes in mental status (e.g., lethargy, disorientation, hallucinations) can be indicative of the infection's location and severity.

Meningismus: Signs of Meningeal Irritation

- **Nuchal Rigidity:** Stiff neck, resistance to passive flexion. *Advanced Note:* May be absent in neonates and some adults.
- **Brudzinski's Sign:** Passive flexion of the neck elicits hip and knee flexion. *Advanced Note:* Sensitivity and specificity vary.
- **Kernig's Sign:** Inability to fully extend the knee with the hip flexed at 90°. *Advanced Note:* Similar sensitivity and specificity limitations as Brudzinski's.
- **Jolt Accentuation of Headache:** Head rotation worsens headache. *Advanced Note:* Not specific to meningitis.

Other Important Symptoms

- **Seizures:** Common in bacterial meningitis, less so in aseptic. *Advanced Note:* Focal seizures suggest localized brain involvement.

- **Vomiting:** Frequent, often projectile. *Advanced Note:* Can be a nonspecific symptom.
- **Focal Neurological Deficits:** Weakness, paralysis, sensory loss, depending on the area of the brain affected. *Advanced Note:* Indicates localized infection or inflammation.
- **Papilledema:** Swelling of the optic disc, a sign of increased intracranial pressure. *Advanced Note:* Develops later in the course of the disease.

Age-Specific Manifestations

- **Neonates:** May present with nonspecific symptoms like temperature instability, poor feeding, lethargy, high-pitched cry, and bulging fontanelles. *Advanced Note:* Early-onset neonatal meningitis is often severe.
- **Young Children:** Bulging fontanelles, seizures (outside the febrile convulsion age range), and reduced food intake are common. *Advanced Note:* Meningismus may be less pronounced.
- **Adults:** The classic triad may be incomplete; atypical presentations are common. *Advanced Note:* Prior antibiotic use can mask symptoms.

🦠 Causative Agents of Meningitis

This section outlines the most common bacteria and viruses causing meningitis, highlighting their epidemiology and risk factors.

Bacterial Meningitis

- **Streptococcus pneumoniae:** Most common cause in adults, often preceded by sinusitis or otitis media. *Advanced Note:* Penicillin resistance is a significant concern.
- **Neisseria meningitidis:** Common in children and young adults; epidemics occur. *Advanced Note:* Petechiae are a warning sign.
- **Haemophilus influenzae type b (Hib):** Less common due to vaccination. *Advanced Note:* Primarily affects children.
- **Listeria monocytogenes:** Affects newborns, pregnant women, elderly, and immunocompromised individuals; foodborne. *Advanced Note:* Can cause both bacterial and aseptic meningitis.

- **Other Bacteria:** Staphylococcus aureus (post-neurosurgery), Gram-negative Enterobacteriaceae (hospitalized patients). *Advanced Note:* These are less common causes.

Aseptic Meningitis

- **Enteroviruses (Coxsackievirus, Echovirus):** Most common viral cause. *Advanced Note:* Seasonal variation in incidence.
- **Arboviruses (West Nile virus, etc.):** Mosquito-borne. *Advanced Note:* Geographic variation in incidence.
- **Herpes Simplex Virus (HSV):** Can cause severe encephalitis. *Advanced Note:* Requires specific antiviral treatment.
- **Other Viruses:** Mumps, measles, varicella-zoster. *Advanced Note:* Less common causes.

🔬 Diagnostic Approach to Meningitis

This section covers the key diagnostic tests and their interpretation.

Lumbar Puncture (LP)

- **Procedure:** Withdrawal of CSF for analysis. *Advanced Note:* Contraindicated in patients with increased intracranial pressure (ICP) without prior imaging.
- **CSF Analysis:** Opening pressure, appearance (clear vs. cloudy), cell count (WBC, RBC), glucose, protein, Gram stain, culture, PCR. *Advanced Note:* Interpretation requires clinical correlation.

Imaging Studies

- **CT scan:** Before LP to rule out mass lesions that could cause brain herniation. *Advanced Note:* MRI is superior for visualizing brain parenchyma.

Other Diagnostic Tests

- **Blood cultures:** To identify bacteremia. *Advanced Note:* Positive blood cultures support the diagnosis of meningitis.
- **Viral PCR:** For detection of viral agents. *Advanced Note:* Can be used on CSF or other samples.

- **Bacterial antigen tests:** Rapid detection of bacterial antigens in CSF. *Advanced Note:* High specificity but lower sensitivity than PCR.

💊 Treatment and Prophylaxis of Meningitis

This section summarizes treatment strategies and preventative measures.

Bacterial Meningitis Treatment

- **Empiric antibiotics:** Ceftriaxone (or Cefotaxime), often with Vancomycin (for penicillin-resistant *S. pneumoniae*). *Advanced Note:* Ampicillin/Amoxicillin added for Listeria coverage in high-risk groups.
- **Duration of treatment:** 10-14 days (longer for Listeria). *Advanced Note:* Treatment duration may be adjusted based on clinical response and culture results.
- **Corticosteroids:** Dexamethasone may reduce complications (hearing loss, neurological sequelae). *Advanced Note:*Administered before or with antibiotics.

Aseptic Meningitis Treatment

- **Supportive care:** Rest, hydration, analgesics. *Advanced Note:* Antiviral therapy may be considered in severe cases or specific viral infections (e.g., HSV encephalitis).

Prophylaxis

- **Close contacts of *N. meningitidis*:** Rifampin or Ciprofloxacin. *Advanced Note:* Prophylaxis is crucial to prevent outbreaks.
- **Close contacts of *H. influenzae*:** Rifampin. *Advanced Note:* Less common due to vaccination.

📊 Epidemiology and Risk Factors

This section briefly covers the epidemiology and risk factors for meningitis.

Epidemiology

- **Bacterial meningitis:** Incidence varies geographically; lower in high-income countries due to vaccination. *Advanced Note:* Outbreaks can occur in specific populations or settings.

- **Aseptic meningitis:** More common than bacterial meningitis; seasonal variation. *Advanced Note:* Risk factors can influence incidence.

Risk Factors

- **Immunocompromised states:** HIV, diabetes, splenectomy, etc. *Advanced Note:* Increased susceptibility to various pathogens.
- **Age:** Newborns and elderly are at higher risk. *Advanced Note:* Different pathogens predominate in different age groups.
- **Skull base fractures:** Direct entry point for pathogens. *Advanced Note:* Trauma increases risk.
- **Recent neurosurgery:** Increased risk of infection. *Advanced Note:* Strict sterile techniques are crucial.

🧠 CNS Peculiarities Relevant to Infection

This section briefly touches upon the unique features of the CNS that influence infection.

- **Blood-Brain Barrier (BBB):** Protects the CNS from pathogens; can be compromised in infection. *Advanced Note:*Inflammation can disrupt the BBB.
- **Blood-CSF Barrier:** Similar protective function at the choroid plexus. *Advanced Note:* More permeable than the BBB.
- **Meninges:** Layers of protective tissue surrounding the brain and spinal cord; site of inflammation in meningitis. *Advanced Note:* Inflammation can affect neurotransmission.
- **CSF:** Circulates around the brain and spinal cord; its analysis is crucial for diagnosis. *Advanced Note:* Changes in CSF composition reflect the infection's severity.
- **Lymphatics:** Newly discovered lymphatic vessels in the meninges play a role in immune surveillance. *Advanced Note:* Their role in CNS infection is still being investigated.

Important Facts to Memorize

1. The classic triad of meningitis: fever, headache, altered mental status.

2. Meningismus: nuchal rigidity, Brudzinski's sign, Kernig's sign.
3. *S. pneumoniae* is the most common cause of bacterial meningitis in adults.
4. *N. meningitidis* is common in children and young adults; petechiae are a warning sign.
5. Enteroviruses are the most common cause of aseptic meningitis.
6. Lumbar puncture (LP) is crucial for diagnosis; contraindicated in patients with increased ICP without prior imaging.
7. CSF analysis includes cell count, glucose, protein, Gram stain, culture, and PCR.
8. Empiric antibiotic treatment for bacterial meningitis typically includes Ceftriaxone (or Cefotaxime) and Vancomycin.
9. Dexamethasone may reduce complications in bacterial meningitis.
10. Prophylaxis is crucial for close contacts of *N. meningitidis* and *H. influenzae*.
11. Immunocompromised individuals and newborns are at increased risk of meningitis.
12. Skull base fractures and neurosurgery increase the risk of CNS infections.
13. The BBB and blood-CSF barrier protect the CNS from pathogens.
14. CSF analysis is essential for diagnosis and monitoring of CNS infections.
15. Atypical presentations of meningitis are common, especially in adults and immunocompromised individuals.
16. Early diagnosis and treatment are crucial for improving outcomes in CNS infections.
17. Always consider the age of the patient when interpreting clinical manifestations.
18. Understanding the epidemiology of different pathogens is crucial for appropriate empiric therapy.
19. The presence or absence of meningismus is not always reliable in diagnosing meningitis.
20. Always consider non-infectious causes when evaluating patients with suspected CNS infections.

Table: Comparison of Bacterial and Aseptic Meningitis

Feature Bacterial Meningitis Aseptic Meningitis CSF Appearance Cloudy, purulent Clear, colorless Cell Count High, predominantly neutrophils and granulocytes Elevated, predominantly lymphocytes and monocytes Glucose Low Normal Protein Elevated Elevated (usually less than in bacterial) Gram Stain Often positive Negative Culture Often positive Negative Common Causes *S. pneumoniae*, *N. meningitidis*, *L. monocytogenes* Enteroviruses, arboviruses, HSV Treatment Antibiotics, corticosteroids Supportive care, antiviral therapy (in some cases)