Meningitis in Hospitalized Patients

Meningitis is an inflammation of the meninges, the protective membranes covering the brain and spinal cord, often caused by infectious agents such as bacteria, viruses, fungi, or parasites. This guide provides students with a comprehensive framework to evaluate, diagnose, and manage meningitis in the hospital setting, with case scenarios to apply the knowledge.

Introduction and Pathophysiology

Meningitis results from infection or inflammation of the meninges, typically involving the subarachnoid space. The most common etiologies include bacterial, viral, fungal, and, less commonly, parasitic or non-infectious causes (e.g., malignancy, autoimmune). Pathogens gain access to the meninges via hematogenous spread (e.g., bacteremia), direct extension (e.g., sinusitis, otitis media), or penetrating trauma.

The inflammatory response in meningitis involves cytokine release, leading to increased blood-brain barrier permeability, cerebral edema, and elevated intracranial pressure (ICP). This can result in neuronal damage, seizures, or death if untreated. The type of meningitis influences the clinical course:

Prompt diagnosis and treatment are critical to prevent severe neurological sequelae or death in hospitalized patients

- **Bacterial Meningitis:** Acute, life-threatening; common pathogens include Streptococcus pneumoniae, Neisseria meningitidis, and Haemophilus influenzae.
- **Viral Meningitis:** Generally milder; often caused by enteroviruses, herpes simplex virus (HSV), or varicella-zoster virus (VZV).
- **•Fungal Meningitis:** Chronic, often in immunocompromised patients; Cryptococcus neoformans is a frequent cause in HIV patients.
- **Tuberculous Meningitis:** Insidious onset, associated with Mycobacterium tuberculosis, common in endemic areas or immunocompromised individuals.
- Severe Manifestations:
    - **Bacterial Meningitis:** High fever, altered mental status, seizures, or focal neurological deficits requiring IV antibiotics and monitoring.
    - **Fungal/Tuberculous Meningitis:** Chronic symptoms (e.g., headache, confusion) in immunocompromised patients, often needing prolonged IV therapy.

- Complications**:** Elevated ICP, cerebral edema, hydrocephalus, or stroke requiring ICU care.
    - Neurological Impairment:
        - **Altered Mental Status:** Glasgow Coma Scale (GCS) <13, confusion, or coma.
        - **Seizures:** Status epilepticus or recurrent seizures necessitating anticonvulsants and monitoring.
        - **Focal Deficits:** Cranial nerve palsies, hemiparesis, or sensory loss indicating CNS involvement.

- Systemic Complications:
    - **Sepsis/Septic Shock:** Hypotension, tachycardia, or multi-organ failure (e.g., in N. meningitidis infection).
    - **Disseminated Infection:** Meningococcemia with purpura fulminans, endocarditis, or arthritis.
- Other:
    - **Immunocompromised State:** HIV, transplant patients, or chemotherapy recipients with suspected fungal or TB meningitis.
    - **Inability to Take Oral Medications:** Severe nausea/vomiting or altered consciousness requiring IV therapy.

Evaluation

History:

• **Symptoms:** Fever, headache, neck stiffness, photophobia, nausea/vomiting, altered mental status.

• **Risk Factors:** Recent respiratory infection, otitis media, sinusitis, travel to endemic areas (e.g., TB, fungal), immunosuppression (e.g., HIV, steroids), or exposure to meningitis cases (N. meningitidis).

• **Systemic Symptoms:** Rash (petechial in meningococcemia), seizures, focal neurological deficits, or hearing loss.

• **Vaccination History:** S. pneumoniae, H. influenzae type b (Hib), N. meningitidis vaccination status.

Physical Exam:

• **General:** Fever, tachycardia, signs of shock (hypotension, poor perfusion).

• **Neurologic:** Meningeal signs (Kernig's, Brudzinski's), altered mental status, cranial nerve deficits (e.g., CN VI palsy), papilledema (elevated ICP).

• **Skin:** Petechial/purpuric rash (meningococcemia), vesicular rash (VZV, HSV).

• **ENT:** Otitis media, sinus tenderness (source of infection).

• **Lungs:** Signs of TB (e.g., crackles, consolidation).

Initial Labs:

• **CSF Analysis:** Lumbar puncture (LP) for cell count, glucose, protein, Gram stain, culture.

• **Blood Tests:** CBC (leukocytosis/leukopenia), blood cultures, inflammatory markers (CRP, ESR).

• **Specific Tests:** CSF PCR (HSV, enterovirus), cryptococcal antigen (CrAg), TB PCR, fungal culture.

• **HIV Testing:** Co-infection increases risk of fungal/TB meningitis.

Imaging/Other:

• **CT/MRI Brain:** Before LP if focal deficits, papilledema, or altered mental status (to rule out mass effect).

• **CXR/CT Chest:** For TB (e.g., miliary pattern, cavitary lesions).

• **EEG:** If seizures or encephalopathy.

Interpreting Labs

CSF Analysis:

• **Bacterial Meningitis:** High WBCs (>1000/µL, PMN predominant), low glucose (<40 mg/dL), high protein (>200 mg/dL), Gram stain/culture often positive.

• **Viral Meningitis:** Moderate WBCs (10-500/µL, lymphocyte predominant), normal glucose, mildly elevated protein (50-100 mg/dL), PCR for viruses (e.g., HSV, enterovirus).

• **Fungal Meningitis:** Moderate WBCs (lymphocyte predominant), low glucose, high protein, CrAg+ (cryptococcus), fungal culture.

• **Tuberculous Meningitis:** Moderate WBCs (lymphocyte predominant), very low glucose, high protein, AFB smear/culture, TB PCR.

Blood Cultures:

• Positive in 50-90% of bacterial meningitis cases (e.g., S. pneumoniae, N. meningitidis).

Inflammatory Markers:

• Elevated CRP/ESR in bacterial/TB meningitis; less pronounced in viral meningitis.

Table: CSF Findings in Meningitis

Type	WBC (cells/µL)	Glucose (mg/dL)	Protein (mg/dL)	Specific Tests
Bacterial	>1000, PMN predominant	<40	>200	Gram stain+, culture+
Viral	10-500, lymphocytes	Normal	50-100	PCR (HSV, enterovirus)
Fungal	20-500, lymphocytes	<40	>100	CrAg+, fungal culture
Tuberculous	50-500, lymphocytes	<30	>200	AFB smear/culture, TB PCR

Treatment

General Principles:

• Initiate empiric therapy immediately after LP (or blood cultures if LP delayed) in suspected bacterial meningitis.

• Tailor therapy based on culture/PCR results and clinical response.

• Monitor for complications (e.g., elevated ICP, seizures) in the hospital.

Specific Treatments:

- **Bacterial Meningitis:**
  - **Empiric Therapy (Age 18-50):** Ceftriaxone 2 g IV q12h + vancomycin 15-20 mg/kg IV q8-12h (covers S. pneumoniae, N. meningitidis).
    - **Age >50 or Immunocompromised:** Add ampicillin 2 g IV q4h (for Listeria monocytogenes).
    - **Duration:** 10-14 days for S. pneumoniae, 7 days for N. meningitidis, 21 days for Listeria.

        - **Adjunctive Therapy:** Dexamethasone 0.15 mg/kg IV q6h x 2-4 days (start before or with first antibiotic dose; reduces mortality in S. pneumoniae).
- **Viral Meningitis:**
    - **Supportive Care:** Most cases (e.g., enterovirus) are self-limiting; manage symptoms (e.g., antipyretics, fluids).
    - **HSV Meningitis:** Acyclovir 10 mg/kg IV q8h x 14-21 days.
- **Fungal Meningitis:**
    - **Cryptococcal Meningitis:** Amphotericin B 0.7-1 mg/kg/day IV + flucytosine 100 mg/kg/day PO x 2 weeks, then fluconazole 400 mg PO daily x 8 weeks.
        - **Duration:** At least 10 weeks total; longer in immunocompromised patients.
- **Tuberculous Meningitis:**
    - **Treatment:** RIPE (rifampin 10 mg/kg/day, isoniazid 5 mg/kg/day, pyrazinamide 15-30 mg/kg/day, ethambutol 15-25 mg/kg/day) x 2 months, then rifampin + isoniazid x 7-10 months.
    - **Adjunctive Therapy:** Dexamethasone 0.4 mg/kg/day IV, taper over 6-8 weeks.

• Complications:

o Elevated ICP: Mannitol 0.5-1 g/kg IV, hyperventilation, or CSF drainage (if hydrocephalus).

o Seizures: Lorazepam 0.1 mg/kg IV, followed by levetiracetam 1000-1500 mg IV loading dose.

Prophylaxis:

• Close Contacts (N. meningitidis): Ciprofloxacin 500 mg PO x 1 dose or rifampin 600 mg PO BID x 2 days.

• Hib Contacts: Rifampin 20 mg/kg/day PO x 4 days (if unvaccinated household contacts).

Table: Meningitis Treatment Guidelines

Type	Treatment Agent/Dose	Notes
Bacterial	Antibiotics, Ceftriaxone 2 g IV q12h + vancomycin	Add ampicillin if >50 years or immunocompromised
Viral (HSV)	Antiviral Acyclovir 10 mg/kg IV q8h x 14-21 days	Supportive care for enterovirus

Type	Treatment Agent/Dose	Notes
Fungal (Cryptococcus)	Antifungals Amphotericin B 0.7-1 mg/kg/day IV + flucytosine x 2 weeks	Fluconazole consolidation phase
Tuberculous	Antituberculous drugs, steroids RIPE x 2 months, then rifampin + isoniazid	Dexamethasone taper over 6-8 weeks

Complications

Acute:

• **Elevated ICP/Cerebral Edema:** Can lead to herniation, coma, or death.

• **Seizures:** Occur in 20-30% of bacterial meningitis cases; risk of status epilepticus.

• **Sepsis/Septic Shock:** Common with N. meningitidis (meningococcemia), leading to multi-organ failure.

• **Stroke:** Due to vasculitis or septic emboli.

Chronic:

• **Neurological Sequelae:** Hearing loss (20-30% in bacterial meningitis), cognitive impairment, cranial nerve deficits.

• **Hydrocephalus:** Obstructive or communicating, requiring ventriculoperitoneal shunt.

• **Chronic Headache:** Post-infectious inflammation or CSF flow obstruction.

Other:

• **Disseminated Infection:** Meningococcemia with purpura fulminans, arthritis, or endocarditis.

• **Immune Reactions:** Post-infectious syndromes (e.g., reactive arthritis, Guillain-Barré syndrome).

Key Pearls

• **Types:** Bacterial (acute, severe), viral (milder), fungal/TB (chronic, immunocompromised).

• **Diagnosis:** CSF analysis is key; bacterial (PMN, low glucose), viral (lymphocytes, normal glucose), fungal/TB (lymphocytes, very low glucose).

• **Empiric Therapy:** Start ceftriaxone + vancomycin for bacterial meningitis; add dexamethasone for S. pneumoniae.

• **Hospital Indications:** Altered mental status, seizures, systemic complications, or immunocompromised state.

• **Complications:** Elevated ICP, seizures, hearing loss; monitor closely in hospital.

• **Prophylaxis:** Essential for close contacts of N. meningitidis or Hib cases.

References

• **UpToDate:** “Bacterial Meningitis: Diagnosis and Management” (2025). UpToDate Meningitis

• **CDC:** “Meningococcal Disease: Prevention and Control” (2024). CDC Meningococcal

• **IDSA:** “Guidelines for the Management of Bacterial Meningitis” (2023). IDSA Meningitis Guidelines

• **NEJM:** “Cryptococcal Meningitis in HIV: Advances in Treatment” (2024). NEJM Cryptococcus

Case Scenarios

Case 1: A 35-Year-Old Male with Fever and Headache

- Presentation: A 35-year-old male presents with a 2-day history of fever (39°C), severe headache, and neck stiffness. He reports recent sinusitis. Exam shows T 39.2°C, nuchal rigidity, Kernig’s sign positive, no rash.
- Labs:**CSF:** WBC 1200/µL (90% PMNs), glucose 20 mg/dL, protein 250 mg/dL, Gram stain shows gram-positive diplococci. Blood cultures pending.
- Diagnosis: Bacterial Meningitis (S. pneumoniae) → Classic triad (fever, neck stiffness, altered mental status), CSF findings.
- Management: Admit to ICU. Start ceftriaxone 2 g IV q12h + vancomycin 15-20 mg/kg IV q8-12h. Dexamethasone 0.15 mg/kg IV q6h x 4 days (before antibiotics). Monitor for seizures, elevated ICP. Duration: 10-14 days. Contact precautions; no prophylaxis needed for pneumococcus.

Case 2: A 28-Year-Old Female with Headache and Rash

- Presentation: A 28-year-old female presents with fever, headache, and a petechial rash on her trunk. She reports photophobia and nausea. Exam shows T 38.5°C, nuchal rigidity, petechial rash, altered mental status (GCS 13).
- Labs: **CSF:** WBC 1500/µL (PMNs), glucose 15 mg/dL, protein 300 mg/dL, Gram stain shows gram-negative diplococci. Blood cultures grow N. meningitidis.
- Diagnosis: Meningococcal Meningitis → Petechial rash, CSF findings, blood culture confirmation.
- Management: Admit to ICU. Start ceftriaxone 2 g IV q12h x 7 days. Dexamethasone 0.15 mg/kg IV q6h x 4 days. Droplet precautions x 24 hours after antibiotics. Prophylaxis for close contacts (ciprofloxacin 500 mg PO x 1). Monitor for septic shock, purpura fulminans.

Case 3: A 40-Year-Old Male with HIV and Confusion

- Presentation: A 40-year-old male with HIV (CD4 30 cells/µL) presents with a 1-week history of headache, fever, and confusion. Exam shows T 38°C, altered mental status, nuchal rigidity, no focal deficits.
- Labs: **CSF:** WBC 200/µL (lymphocytes), glucose 30 mg/dL, protein 150 mg/dL, CrAg positive, India ink shows budding yeast. Serum CrAg positive.
- Diagnosis: Cryptococcal Meningitis → Chronic symptoms, HIV with low CD4, CSF findings.
- Management: Admit for IV therapy. Start amphotericin B 0.7-1 mg/kg/day IV + flucytosine 100 mg/kg/day PO x 2 weeks, then fluconazole 400 mg PO daily x 8 weeks. Monitor for IRIS (worsening symptoms post-ART). Consult ID for ART initiation timing (delay 4-6 weeks). Follow-up CSF analysis at 2 weeks.