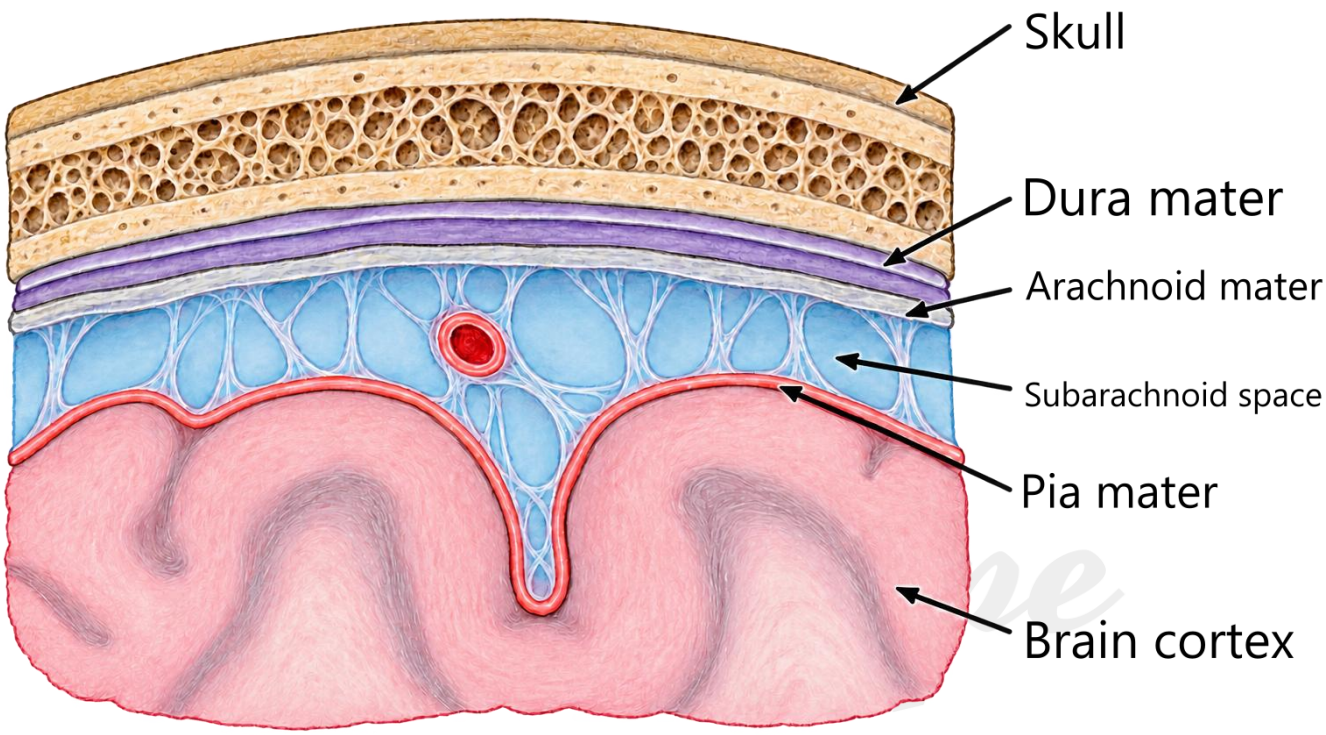
Pediatrics - Topic 27 - Systemic Pediatrics-Central Nervous system

Acute Bacterial Meningitis

- Meningitis is inflammation of the membranes around the brain and spinal cord.

Mechanism and Recognition

- Bacteria usually reach the meninges through the bloodstream, although an ear infection, trauma or a congenital defect can provide another route.



The subarachnoid space lies between arachnoid and pia and contains CSF around the brain

Likely Organisms

- Group B streptococci and Gram-negative bacilli are important causes in newborns.
- Pneumococcus and meningococcus are important beyond early infancy, while Hib remains relevant when immunization is incomplete.
- Age, immune status, neurosurgical devices and local resistance influence the likely organism and empirical treatment.

Clinical Features

- Older children may have fever, severe headache, vomiting, photophobia and neck stiffness.
- Infants may instead have poor feeding, irritability, a weak cry, lethargy, temperature instability or a bulging fontanelle.
- The absence of neck stiffness does not exclude meningitis in an infant.
- A non-blanching rash with shock suggests meningococcal disease and requires immediate treatment.

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- Seizures, focal deficits or reduced consciousness suggest complicated meningitis or associated encephalitis.

Assessment and Emergency Management

1. Stabilize the Child

- Assess the airway, breathing, circulation, consciousness and bedside glucose immediately.
- Treat hypoxaemia, shock, hypoglycaemia and ongoing seizures while arranging urgent hospital care.
- Use careful, reassessed fluid therapy rather than routine fluid restriction for every child.

2. Obtain Samples Without Delaying Antibiotics

- Send blood cultures before treatment if this can be done promptly.
- Perform lumbar puncture only when the child is stable and no contraindication is present.
- If lumbar puncture must be delayed, start antibiotics immediately and obtain CSF later when it is safe.
- A normal CT scan does not make lumbar puncture safe when clinical signs suggest dangerous raised intracranial pressure.

3. Start Appropriate Antimicrobial Treatment

Initial Regimen and Local Protocol

- Give a meningitis-dose intravenous third-generation cephalosporin to an older infant or child, according to the local hospital protocol.
- One paediatric guideline uses ceftriaxone 100 mg/kg intravenously once daily, up to 4 g, for children aged two months or older.
- Other protocols use divided doses or a different maximum, so confirm the local meningitis regimen and resistance pattern.

Additional Cover, Neonates and Targeted Treatment

- Add appropriate resistant-pneumococcal cover when local resistance, Gram stain or clinical findings indicate it.
- Newborns require a separate neonatal regimen and specific precautions about ceftriaxone.
- Adjust treatment to the organism and susceptibility result, with duration determined by the pathogen and complications.
- Consider intravenous aciclovir as well when herpes encephalitis is suspected.

4. Use Adjunctive Treatment and Monitor Complications

- In non-epidemic suspected bacterial meningitis, start indicated intravenous corticosteroid treatment with the first antibiotic dose.

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- A commonly used regimen beyond early infancy is dexamethasone 0.15 mg/kg every six hours, up to 10 mg per dose, for up to four days.
    - Review the need to continue after CSF and organism results, and follow age-specific and epidemic guidance.
- Do not delay antibiotics while obtaining dexamethasone.
- Monitor for seizures, raised intracranial pressure, electrolyte disturbance, hydrocephalus, stroke and subdural collections.

Prevention and Follow-up

- Hib and pneumococcal vaccination reduce important causes of childhood meningitis.
- Meningococcal vaccination is used according to individual risk and public-health recommendations.
- Arrange prompt public-health assessment for chemoprophylaxis of eligible close contacts of meningococcal or Hib disease.
- Assess hearing and neurological development after recovery, even when the child appears well at discharge.

Tuberculous Meningitis

Pathogenesis and Presentation

- Tuberculous meningitis develops when a focus of tuberculosis releases organisms into the subarachnoid space.
- Basal inflammatory exudate can obstruct CSF flow, damage cranial nerves and cause vasculitic cerebral infarction.
- Young children and children with impaired immunity have a high risk of severe disease after infection.

Clinical Progression

- Early symptoms may be persistent fever, poor appetite, irritability, reduced activity and headache.
- Vomiting, meningism, cranial nerve palsies, altered consciousness and focal weakness may develop gradually.
- Seizures, hydrocephalus and coma suggest advanced disease.
- Ask about household tuberculosis exposure, weight loss, previous treatment and immune compromise.

Investigations

- Send CSF for cell count, protein, glucose, a rapid molecular tuberculosis test and mycobacterial culture when lumbar puncture is safe.

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- A negative molecular test or smear does not exclude tuberculous meningitis because the organism burden may be low.
- Brain imaging may show basal enhancement, hydrocephalus, infarction or tuberculomas.
- Investigate tuberculosis elsewhere and obtain drug-susceptibility information from the child or an identified source case.

Treatment Principles

Antituberculosis Regimen Selection

- Begin multidrug antituberculosis treatment promptly when clinical suspicion is strong, without waiting for culture confirmation.
- Use the current national paediatric CNS tuberculosis regimen with specialist supervision and weight-based dose adjustment.
- India's 2022 paediatric NTEP guideline retains ethambutol in the continuation phase and extends that phase to ten months for neurological tuberculosis, giving 2HRZE followed by 10HRE for drug-susceptible disease.
- The standard WHO option is two months of isoniazid, rifampicin, pyrazinamide and ethambutol followed by ten months of isoniazid and rifampicin.
- A distinct six-month intensified WHO option exists for selected children, but it is not simply a shortened version of the standard regimen and must follow programme eligibility.

Adjunctive Care and Prevention

- Give adjunctive corticosteroids with a planned taper according to the CNS tuberculosis protocol.
- Treat seizures, assess sodium disturbances and involve neurosurgery when hydrocephalus threatens brain function.
- BCG vaccination reduces the risk of severe disseminated tuberculosis and tuberculous meningitis in young children.
- Contact evaluation and preventive treatment reduce progression from infection to disease.

CSF Interpretation and Lumbar Puncture

Comparing Meningitis Patterns

Feature	Acute bacterial	Viral	Tuberculous
Usual course	An acute illness may progress rapidly.	An acute illness is often milder, but severe disease occurs.	A subacute progressive illness is typical.

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Feature	Acute bacterial	Viral	Tuberculous
Cells	Neutrophils commonly predominate.	Lymphocytes commonly predominate after the early phase.	Lymphocytes commonly predominate.
Protein	Protein is usually clearly raised.	Protein is normal or moderately raised.	Protein is often markedly raised.
Glucose	Glucose and the CSF-to-blood ratio are often low.	Glucose is usually preserved.	Glucose is often low.
Confirmation	Send Gram stain, bacterial culture and appropriate PCR.	Use targeted viral PCR when indicated.	Send rapid molecular testing and mycobacterial culture.

- These are typical patterns rather than absolute diagnostic rules.
- Early bacterial disease may have a low cell count, and early viral disease may show neutrophils.
- Previous antibiotics can reduce culture yield without making an abnormal CSF result reassuring.
- Use the child's age, clinical condition, blood glucose and microbiology together when interpreting results.

A Practical Interpretation Sequence

Initial Measurements and Age-specific Interpretation

- Check the sample appearance, white-cell count and differential before interpreting protein and glucose.
- Compare CSF glucose with a blood glucose sample taken close to lumbar puncture.
- A low CSF-to-blood glucose ratio supports bacterial, tuberculous or fungal infection in the correct setting.
- Neonates normally have higher CSF protein and cell-count limits than older children.
- Beyond one month, illustrative normal CSF values are no more than 5 white cells/µL, protein below 0.4 g/L and a CSF-to-blood glucose ratio of at least 0.6.

Diagnostic Limits and Additional Testing

- Use the laboratory's age-specific ranges, and remember that apparently normal microscopy cannot exclude meningitis when clinical suspicion remains high.
- A traumatic tap introduces blood, but a mathematical correction alone must not be used to exclude meningitis.
- Send appropriate culture and molecular tests even when the initial Gram stain is negative.

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