

MENINGITIS IN CHILDREN

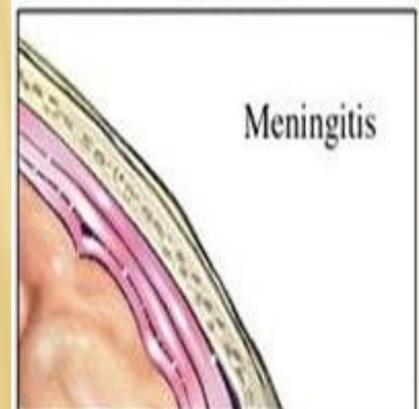
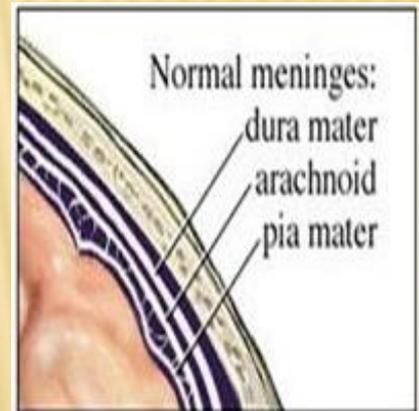
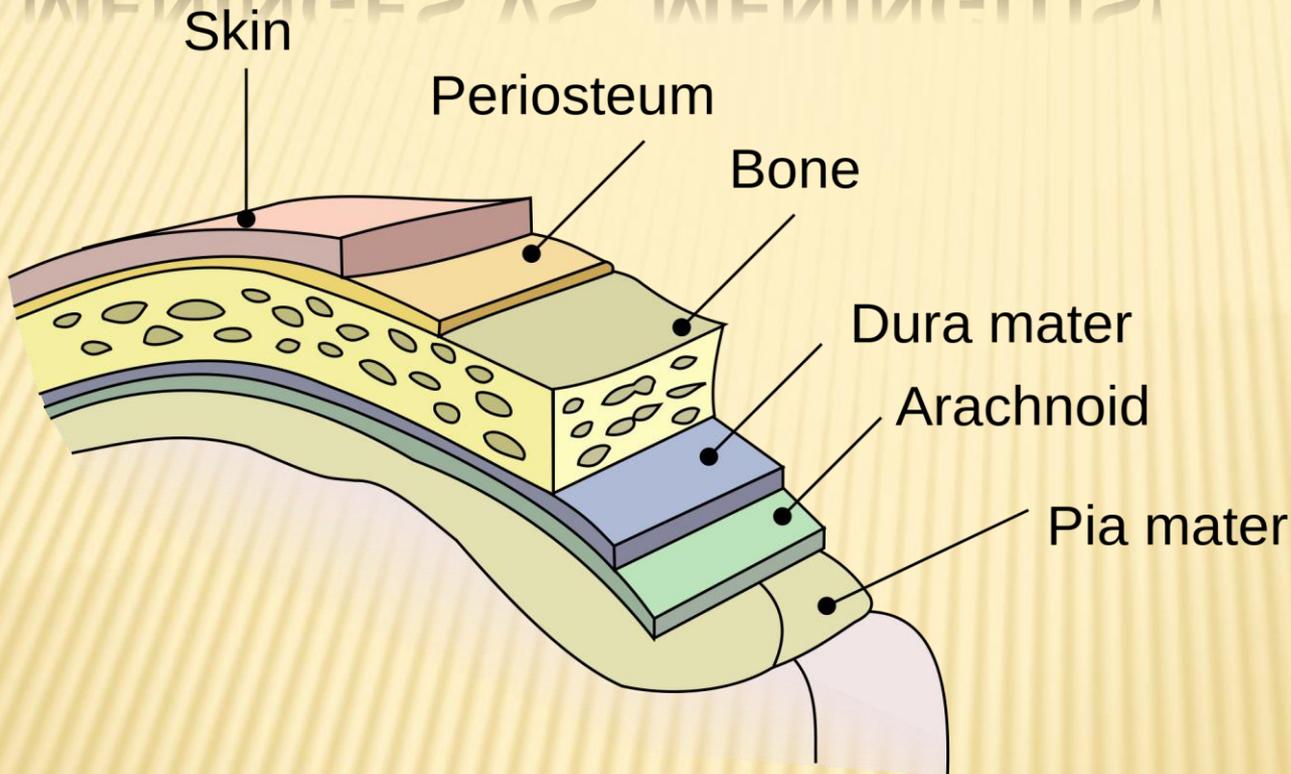
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MENINGES VS. MENINGITIS!



TERMINOLOGY

- ✘ **Meningitis:** inflammation of the meninges, manifest by cerebrospinal fluid (CSF) pleocytosis
- ✘ **Aseptic meningitis**
- ✘ **Encephalitis**
- ✘ **Isolated meningitis or encephalitis, or meningoencephalitis.**

CSF FINDINGS BEYOND NEONATAL PERIOD

CSF finding	Normal	Viral	Bacterial	Comment
WBC per HPF	0-5 all Lymphocytes	5-500 mainly lymphocytes	Usually >1000 mainly PMNs	In neonates, up to 25 cells is considered normal
Glucose	CSF:Serum ratio >2/3	Normal	CSF:Serum ratio <1/2	
Protein	<40 mg/dl	Normal or mildly elevated	Usually >100	
Appearance	Clear	Clear	Turbid	

ASEPTIC MENINGITIS: VIRAL MENINGITIS

- ✘ Very common. Late spring, summer and Fall
- ✘ Route of entry: mucosal surfaces of respiratory and GI tract → viral replication in regional LN's → viremia seeds the CNS
- ✘ Most common are enteroviruses (~90%)

CLINICAL FEATURES

- ✗ **Neonates and infants:**
- ✗ Fever and nonspecific symptoms (eg, poor feeding, vomiting, diarrhea, rash, respiratory etc)
- ✗ CNS manifestations: irritability, lethargy, nuchal rigidity or bulging fontanel, encephalitis, seizures, focal findings

- ✗ **Older children:**
- ✗ Fever, headache, vomiting, stiff neck, photophobia.

PHYSICAL FINDINGS:

- ✘ Nuchal rigidity, bulging fontanel, manifestations of particular viruses (e.g., rash, conjunctivitis, pharyngitis, diarrhea)
- ✘ In older children: +positive meningeal signs
- ✘ *Clinical features **cannot** reliably differentiate viral from bacterial meningitis; and CSF profiles may overlap, particularly during early bacterial meningitis*

VIRAL MENINGITIS: ENTEROVIRUSES (EV)

- ✘ Nonpolio-EV serotypes: Coxsackie A, B, echoviruses
parechoviruses
- ✘ Humans only
- ✘ Fecal-oral route, The incubation period is 3-6 days
- ✘ Conjunctivitis, pharyngitis, rash, herpangina, hand-foot-mouth disease

- ✘ Dx: CSF PCR

- ✘ Humoral immunodeficiency, especially X-linked agammaglobulinemia, are at risk for chronic EV meningoencephalitis



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VIRAL MENINGITIS: HSV

- ✘ More of a meningo-encephalitis picture
- ✘ Neonatal and Post-neonatal
- ✘ HSV-1 and HSV-2
- ✘ Incubation period ~4 days
- ✘ Dx: CSF PCR
- ✘ Others: EBV, CMV, VZV, Arboviruses, HHV6, Influenza A and B, mumps

ASEPTIC MENINGITIS: NONINFECTIOUS CAUSES

- ✗ **Drugs:** Ibuprofen, Azathioprine, IVIG
- ✗ **Malignancy:** Lymphoma, Leukemia
- ✗ **Autoimmune:** Sarcoid, Behcet's disease, SLE
- ✗ **Other causes:** Epidermoid cyst, Heavy metal poisoning, Intracranial hemorrhage

BACTERIAL MENINGITIS



The mortality rate of untreated bacterial meningitis approaches 100 percent

BACTERIAL MENINGITIS: COMMON CAUSES

- ✘ <3 months – Group B streptococcus (39 %), gram-negative bacilli (30% percent), *Strep pneumoniae* (14 %), *N. meningitidis* (12 %)
- ✘ ≥ 3 months and <10 years – *S. pneumoniae* (47 %), *N. meningitidis* (32 %)
- ✘ Adolescents: *N. meningitidis* (55 %)

CAUSES OF BACTERIA MENINGITIS

<i>Neisseria meningitidis</i>	Nasopharynx	All ages	Complement deficiency, Asplenia
<i>Streptococcus pneumoniae</i>	Nasopharynx, direct extension across skull fracture, close foci of infection	All ages	Asplenia, cochlear implants, CSF otorrhea from basilar skull fracture
GBS	Maternal vaginal tract	Neonates: Most common cause.	
Coagulase-negative staphylococci	Foreign body		Surgery and foreign body, especially ventricular drains
<i>Haemophilus influenzae</i>	Nasopharynx, contiguous spread from local infection		Un-vaccinated

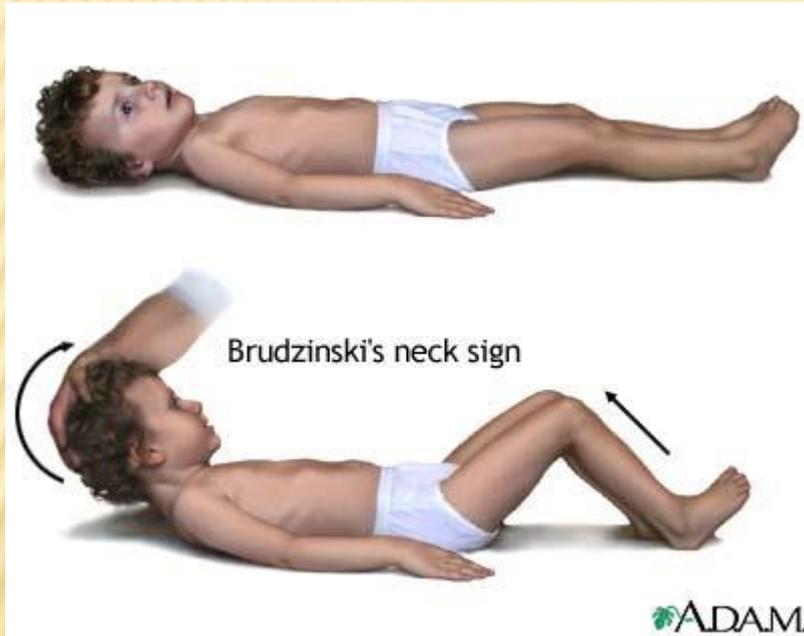
BACTERIAL MENINGITIS: CLINICAL FEATURES

- ✘ Fever and symptoms and signs of meningeal inflammation, often preceded by symptoms of upper respiratory infection
- ✘ In infants (none specific): fever, hypothermia, lethargy, respiratory distress, jaundice, poor feeding, vomiting, seizures, irritability, or bulging fontanel
- ✘ Petechiae and purpura with any of the bacterial pathogens but most commonly seen in *N. meningitidis*

MENINGEAL SIGNS:

- ✘ 1- Nuchal rigidity: active movement or passive neck flexion
- ✘ 2- Kernig sign
- ✘ 3- Brudzinski sign
- ✘ Signs are present in 80 percent of children > 2y of age with bacterial meningitis at the time of presentation

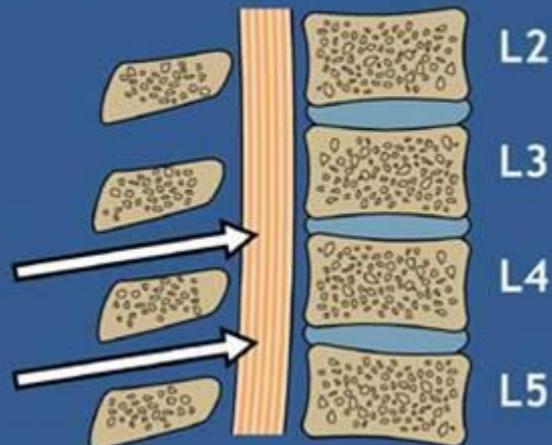
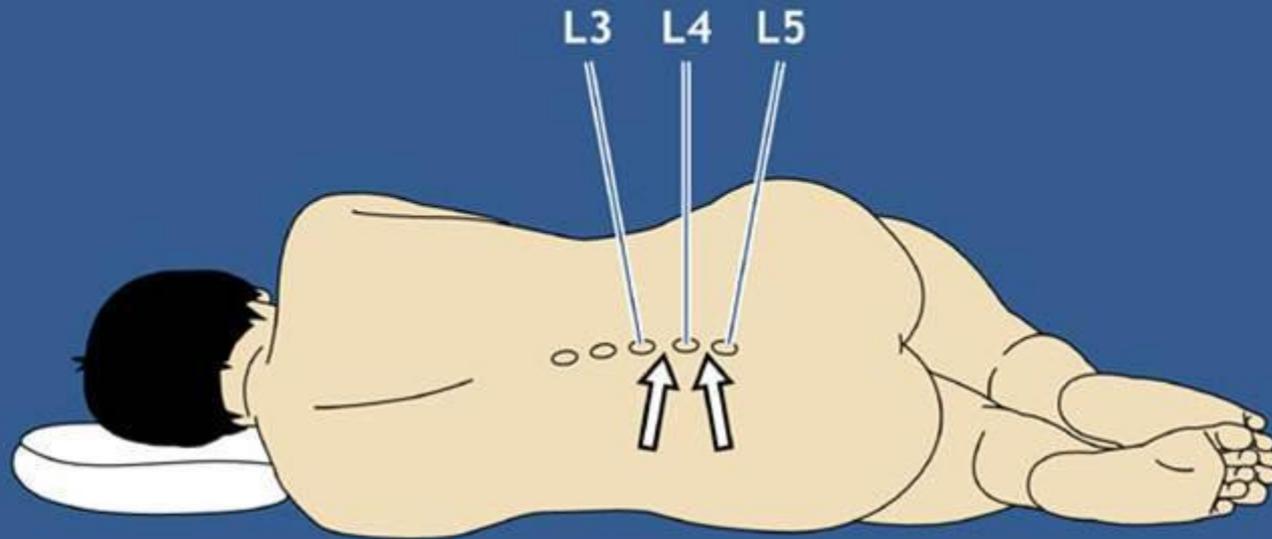
MENINGEAL SIGNS:



BACTERIAL MENINGITIS: EVALUATION

- ✘ Blood cultures are positive in 50% of patients with bacterial meningitis
- ✘ CSF examination: Lumbar puncture
- ✘ Contraindications: cardiopulmonary compromise, signs of increased ICP, papilledema, focal neurologic signs, and skin infection at site for LP
- ✘ *It is essential that antimicrobial therapy not be delayed if there is a contraindication to or inability to perform an LP, or if the LP is delayed by the need for cranial imaging*
- ✘ Send CSF for: cell count and differential, glucose and protein, Gram stain and culture. Send viral PCR as appropriate

Lumbar Puncture (Positioning)



INTERPRETATION OF CSF: SPECIAL SITUATIONS

- ✘ **Traumatic LP:** treated presumptively for meningitis pending CSF culture
- ✘ **Partially treated meningitis:** Minimal effects on CSF cytology, may sterilize culture quickly
- ✘ **Gram stain:** + in 90% of pneumococcal meningitis and 80% of meningococcal meningitis
- ✘ Gram-positive diplococci suggest *S. pneumoniae*
- ✘ **Gram-negative diplococci suggest *N. meningitidis***
- ✘ **Gram-negative coccobacilli suggest Hib**
- ✘ Gram-positive cocci suggest GBS
- ✘ **Rapid diagnostic tests and latex agglutination test?**

NEUROLOGIC FINDINGS

- ✘ Altered consciousness: from somnolence to coma
- ✘ Increased ICP: headache, bulging fontanel, palsies of the 3rd, 4th, and 6th cranial nerves. Papilledema takes several days to become apparent
- ✘ Hypertension, bradycardia, and resp depression (Cushing triad) is a late sign of increased ICP
- ✘ Seizures: typically generalized, first 48 hrs in 30 % of pts. Szrs later in the course often focal and may indicate cerebral injury
- ✘ Focal findings: hemiparesis, facial palsy

BACTERIAL MENINGITIS: NEUROIMAGING

CT is necessary before LP in patients with signs or symptoms of increased ICP. Other indications:

- × Altered mental status
- × Papilledema
- × Focal neurologic deficit
- × CSF shunt
- × Hydrocephalus (increased head circumference)
- × CNS trauma
- × History of neurosurgery or a space-occupying lesions
- × Persistently positive CSF cultures
- × Recurrent meningitis
- × Infants with Gram-negative meningitis to detect hydrocephalus or abscesses.

BACTERIAL MENINGITIS: COMPLICATIONS

- ✘ Intracranial abscesses, effusion, empyema, thrombosis etc.
- ✘ Impaired mental status
- ✘ Cerebral edema and increased ICP
- ✘ Seizures, Ataxia
- ✘ Focal deficits (e.g., hearing loss, cranial nerve palsies, hemiparesis)
- ✘ Developmental disability
- ✘ Hydrocephalus
- ✘ SIADH

BACTERIAL MENINGITIS: MANAGEMENT

Persistence/recurrence of fever causes:

- ✗ Inadequate treatment
- ✗ Nosocomial infection
- ✗ Discontinuation of dexamethasone
- ✗ Development of a suppurative complication
- ✗ Drug fever (a diagnosis of exclusion)

- ✗ **Repeat CSF analysis:**
- ✗ Poor clinical response despite 48 hrs of appropriate therapy.
- ✗ Persistent or recurrent fever.
- ✗ GBS and Gram-negative bacillary meningitis



BACTERIAL MENINGITIS MANAGEMENT

- ✗ Avoidance of delay
- ✗ Bactericidal agents
- ✗ **Drug entry into CSF:** BBB blocks macromolecule, with small, lipophilic molecules penetrating most easily.
- ✗ The peak concentration of drugs in CSF increases with inflammation of the blood-brain barrier.
- ✗ Should be always intravenous antibiotics.

BACTERIAL MENINGITIS: MANAGEMENT

- ✘ ABC (hypovolemic or septic shock?)
- ✘ Administration of first dose of empiric antibiotics
- ✘ Complete CNS examination daily
- ✘ Head circumference daily if <18 months.

BACTERIAL MENINGITIS: MANAGEMENT

- ✘ Major pathogens : *S. pneumoniae* and *N. meningitidis*
- ✘ third-generation cephalosporin (e.g., cefotaxime, ceftriaxone) and vancomycin
- ✘ Use of dexamethasone and timing

BACTERIAL MENINGITIS: MANAGEMENT

- ✘ Specific therapy and duration:
- ✘ *S. pneumoniae* : 10 to 14 days.
- ✘ *N. meningitidis* : penicillin or a third-generation cephalosporin. 5-7 days
- ✘ *H. influenzae b*: Ceftriaxone/cefotaxime 7-10 days.

BACTERIAL MENINGITIS: PREVENTION

- ✘ Isolation: Standard precautions, plus
- ✘ Droplet precautions for *N. meningitidis* and *H. influenzae* type b (Hib) meningitis until they have received 24 hours of effective therapy
- ✘ Vaccines
- ✘ Chemoprophylaxis

CHEMOPROPHYLAXIS

- ✘ For meningococcal and H.Flu, not strep pneumonia
- ✘ For meningococcal:
 - ✘ House hold contacts
 - ✘ Child care or pre-school in the past 7 days
 - ✘ Direct exposure to secretions in the past 7 days
 - ✘ Frequently slept in the same room in the past 7 days
 - ✘ Passengers sat next to index case in an airplane flight lasted >8 hrs.
- ✘ Antibiotics: (for children) Rifampin and ceftriaxone (safe in pregnancy).

CHEMOPROPHYLAXIS

- ✘ For H.flu:
- ✘ House hold contact with one child younger 4 yo of age who is incompletely immunized or with one immune-compromised child
- ✘ Antibiotic: Rifampin

Thank you