Lecture 53

Editing file

Medicine Team

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CNS Infections

Objectives:

- ★ To be familiar with the most common CNS infections world-wide and in Saudi Arabia.
- ★ To understand the approach for meningitis treatment.
- ★ To be familiar with the different investigations for CNS infections.
- ★ To understand the prognosis and outcomes of the most common CNS infections.

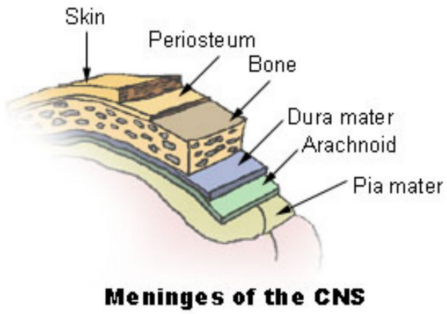
Color index:

Original text Females slides Males slides
Doctor's notes Textbook Important Golden notes Extra

Introduction to meningitis

Definition

- **Meningitis:**[1] inflammation of the (meninges) pia mater and the arachnoid mater **(dura mater is usually spared)**,with suppuration of the cerebrospinal fluid. Because CSF is located between the two inflamed layers of the meninges.
- **Leptomeninges:** the arachnoid and the pia mater



Meninges of the CNS

CSF is under the arachnoid mater (Subarachnoid space)

◀ Causes of meningitis

Infectious[2]

- Viral
- Bacterial
- Mycobacterial
- Brucella (common in SA)
- fungal[3]

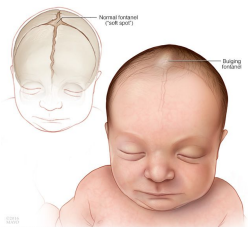
Non-infectious:

- Aseptic meningitis[4]
- Malignancy e.g. lymphoma
- Sarcoidosis
- Behcet disease
- SLE
- Mollaret's syndrome[5]

◀ S&S of Acute Bacterial Meningitis (ABM)

Classic triad: fever, neck stiffness and confusion.

The usual presenting features are:



- **Severe Headache**
- **Drowsiness**
- **High grade sudden fever**
- **Neck stiffness**
- **Vomiting**
- Seizures, rash
- Bulging fontanel in infants, sometimes with hydrocephalus.
- Altered level consciousness and irritability
- **Photophobia** (intolerance of light) and Phonophobia (intolerance to loud noises) can be specific to bacterial meningitis.
- Progressive drowsiness, lateralizing signs and cranial nerve lesions indicates the existence of a complication, e.g. venous sinus thrombosis, severe cerebral oedema or cerebral abscess.

Clinical symptoms

Note: When accompanied by sepsis, presenting signs may evolve rapidly, with abrupt onset of obtundation due to cerebral oedema.

Absence of all 3 signs of the classic triad of fever, neck stiffness, and an altered mental status virtually eliminates a diagnosis of meningitis, we can't eliminate completely but bacterial meningitis would be unlikely, could be viral.

1- Sometimes it's difficult to differentiate between meningitis and encephalitis as they occur together usually. **Focal neurologic deficit and seizures are more common in encephalitis.**

2- Microorganisms reach the meninges either by **direct extension** from the ears, nasopharynx, cranial injury or congenital meningeal defect, or by **bloodstream spread.**

3- Fungal meningitis (especially cryptococcosis)usually occurs in patients who are **immunosuppressed and is a recognised complication of HIV infection.** The CSF findings are similar to those of tuberculous meningitis, but the diagnosis can be **confirmed by microscopy or specific serological tests.**

4- Aseptic can be infectious (caused by viral) or noninfectious (caused by drugs)

5- In which the recurrent meningitis is associated with epithelioid cells in the spinal fluid ('Mollaret' cells). Recent evidence suggests that this condition may be due to herpes simplex virus type 2 and is therefore infective after all.

Bacterial meningitis

◀ S&S of Acute Bacterial Meningitis (ABM) *cont.*

- **Vital signs: Fever**
- **Papilledema** due to increased ICP
- **Nuchal rigidity**
- Neurological deficit esp when there's pus.
- **Don't forget source of infection:** ears, sinuses, chest..etc
- Petechiae, ecchymosis[1] In pediatrics, esp with N.meningitidis
- Changes in mental status are more common in bacterial than viral meningitis
- Bacterial infections are more severe than viral

Focal neurologic signs

- Isolated cranial nerve abnormalities (principally of cranial nerves III, IV, VI, VII and VIII).
- Focal cerebral signs as a result of ischemia from vascular inflammation and thrombosis. depends on location affected.

Clinical Signs

Table 22.20 Clinical clues in meningitis

Clinical feature	Possible cause
Petechial rash	Meningococcal infection
Skull fracture Ear disease Congenital CNS lesion	Pneumococcal infection
Immunocompromised patients	HIV opportunistic infection
Rash or pleuritic pain	Enterovirus infection
International travel	Malaria
Occupational (work in drains, canals, polluted water, recreational swimming) Clinical: myalgia, conjunctivitis, jaundice	Leptospirosis

Kernig's sign[2]	Brudzinski's neck sign
While patient is lying supine, with the hip and knee flexed to 90 degrees pain limits passive extension of the knee.	Flexion of the neck causes involuntary flexion of the knee and hip.
 The Kernig sign	 Brudzinski sign

Note:
In both tests you're stretching the meninges so the pt will flex the neck or the knee to minimize the stretch.
These signs were useful in the past when they didn't have LP and CT-scan etc. So they used to depend on these classic signs. However, these signs occur late in the course of the disease, so they are rarely seen nowadays, usually happens in a pt with untreated bacterial meningitis for days or weeks but nowadays we put patients on antibiotics from the first day.
(Low sensitivity, High specificity)

What's the most useful sign?

- **Jolt accentuation maneuver:** ask patient to rapidly rotate his or her head horizontally: Headache worsens, In healthy individuals it might be uncomfortable but a pt with meningitis will avoid doing it.
- **Sensitivity of 100%, specificity of 54% (Low, unlike kernig and Brudzinski signs),** positive likelihood ratio of 2.2, and negative likelihood ratio of 0 for the diagnosis of meningitis

1- In meningococcal septicaemia there is a non-blanching petechial and purpuric skin rash and signs of shock.
2- Patient with spontaneous intracranial hypotension can have chronic headache and one of the treatments is subdural blood patch, this can cause irritation of the meninges usually at the lumbosacral area so they can have a +ve Kernig's sign

Bacterial meningitis *cont.*

◀ Chronic Bacterial Meningitis

- **Tuberculous meningitis** (TBM) and **cryptococcal meningitis** commence typically with vague headache, lassitude, anorexia and vomiting.
- Acute meningitis can occur but is unusual.
- Meningitic signs often take some weeks to develop.
- Drowsiness, focal signs (e.g. diplopia, papilloedema, hemiparesis) and seizures are common. **Syphilis, sarcoidosis and Behçet's also cause chronic meningitis.**
- In some cases of chronic meningitis, an organism is never identified.

◀ Bacterial pathogens ★

Neonates

- **Group B Streptococci (MOST COMMON, and occurs ONLY in neonates)** 49%
- **Gram-negative bacilli (Escherichia coli, Proteus)**
- Enterococci
- Klebsiella
- Enterobacter
- Salmonella
- Serratia
- Listeria monocytogenes

Older infants and children

- **Neisseria meningitidis*** (subtypes B, C, Y, W)
- **S. pneumoniae (Most common)**
- M.tuberculosis **Less common**
- H. influenzae (Less common than before)

*Meningococcal meningitis and meningococcaemia (Medical emergency) ★

- Fulminate meningococcemia with purpura:
  - Overwhelming sepsis, DIC
- **Classic: Meningitis with rash (Petechiae)** + Headache + Fever
- Meningitis without rash
- Mortality 3 - 10 %
- Lumbar puncture **should not be performed** if meningococcal sepsis is suspected because coning of the cerebellar tonsils may follow – the organism is confirmed by blood culture.
- **Treatment and prophylaxis:**
  - **Droplet Isolation:** 48h post Abx
  - **Treatment: Ceftriaxone or Pen G** 7 days
  - **Eradicate nasopharyngeal carriage:**
    - House hold contact
    - Health care providers who examined patient closely
  - **Prophylaxis (Not done routinely):** Rifampin 600 mg for 2 d or Ciprofloxacin 500mg once or Ceftriaxone 125mg I.M once

Recall: Ceftriaxone is C.I in neonates, give cefotaxime instead.

Meningococcal meningitis and meningococcaemia: emergency treatment

Suspicion of meningococcal infection is a medical emergency requiring treatment immediately.

Clinical features:

- Petechial or nonspecific blotchy red rash
- Fever, headache, neck stiffness.

All these features may not be present – and meningococcal infection may sometimes begin like any apparently non-serious infection.

Immediate treatment for suspected meningococcal meningitis at first contact before transfer to hospital or investigation:

- Benzylpenicillin 1200 mg (adult dose) slow i.v. injection or intramuscularly
- Alternative if penicillin allergy – cefotaxime 1 g i.v.

In meningitis, minutes count: delay is unacceptable. On arrival in hospital:

- Routine tests including blood cultures immediately
- Watch out for septicaemic shock.

Bacterial meningitis *cont.*

◀ Bacterial pathogens *cont.* ★

Adults

- **Streptococcus pneumonia (MOST common)**.....37%
- **Neisseria meningitidis** (subtypes B, C, Y, W) 13%
- **Listeria monocytogenes** 10%
- Other strept.species....7%
- Gram negative…....4%
- Haemophilus influenzae 4%
- TB, Brucella (common in saudia arabia)

Keep in mind:

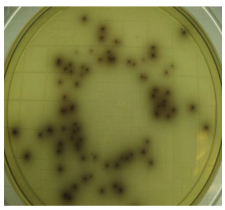
- Global emergence and prevalence of **Penicillin- Resistant Streptococcus pneumoniae**
- Dramatic Reduction in invasive Haemophilus influenzae disease secondary to use of conjugate Haemophilus Type B- vaccine.
- **Group B – Streptococci**: previously in neonate: **now emerging as disease of elderly**

Pneumococcal meningitis

- **The most common cause**
- Highest mortality 20 – 30%
- May be associated with other Focus:
  - Pneumonia, Otitis Media, Sinusitis
- Head Trauma & CSF Leak
- Splenectomy and Sickle cell disease
- Global emergence of Penicillin – Resistant

Listeria Monocytogenes meningitis

- **Pathology:** It causes brain stem, cerebellum inflammation (Rhombencephalitis) and meningitis
- **Risk groups:**
  - Age <1y or >50y
  - Alcoholics
  - Pregnancy: up to 30%
  - Immunocompromised 70 %



- **Routes of transmission:**
  - **Mainly food borne:** survives refrigeration
    - linked to poultry, hotdogs, cold cuts, coleslaw, ice-cream
  - **Cheeses,** particularly soft cheeses, have been implicated in listeriosis outbreaks worldwide.
  - Transplacental /vertical
  - Cross contamination(nursery)
  - Inoculation(skin) farmers
  - Colo/ sigmoidoscopy → bacteremia / meningitis (up to 5% healthy: Normal flora)
  - Inform micro lab: special media **(Mueller-Hinton agar)**

Note: Whenever you see a pt with changing signals in brain stem and cerebellum MRI , think of Listeria.

- **Treatment:**
  - **Ampicillin** 2gm IV Q4h +/- Gentamicin 2mg/kg loading dose then 1.7mg/kg Q8h
  - **21 day** duration
  - Penicillin allergy patients: **TMP-SMX or Meropenem**

Bacterial meningitis *cont.*

◀ Investigations:

How to manage a patient with meningitis?

- **Step 1:** Give empirical therapy!! Whenever you suspect meningitis or encephalitis, start empirical therapy! (In real life the pt will be started on empirical therapy in the ER, before you see him)
- **Step 2: CT** (To exclude herniation, supratentorial tumor, bleeding, pus collection (Subdural empyema) before doing LP bc it may kill the pt). **NEVER do LP before CT.**
- **Step 3:** LP.
  - **Contraindications to LP:** Herniation, Infection at the site of LP (e.g. Cellulitis), bleeding disorders, Low platelet count <100, anticoagulants . If one of these contraindication is present you can delay LP but **NEVER delay the treatment**

1 Radiological

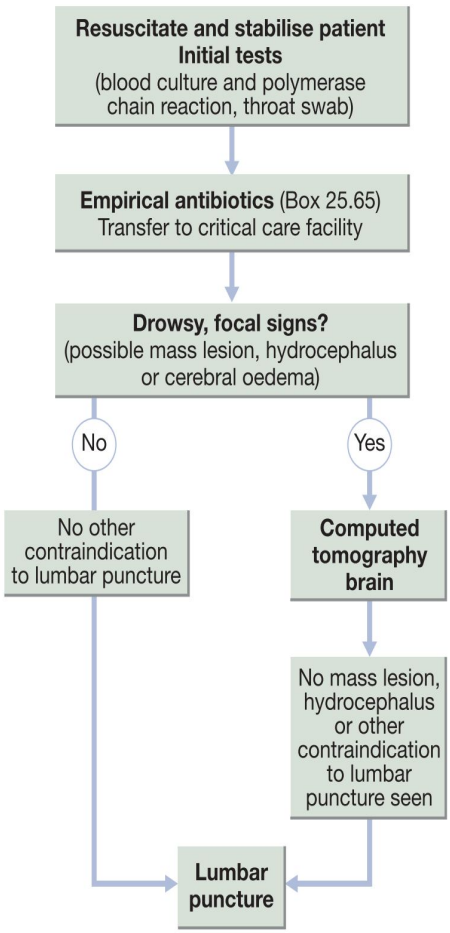
- **CXR** (To look for the source bc sometimes the pt may have pneumonia → Sepsis → Meningitis)
- **CT Head Without contrast : Generally, patients with suspected meningitis require brain imaging before the LP, warning signs that mandate an image:**
  - Has altered consciousness
  - Has focal neurological signs
  - Has seizures
  - Has papilledema[1] or cranial nerve palsies
  - Immunosuppressed, has undergone recent neurosurgery or has suffered a head injury.

2 Lumbar puncture

- **Start empirical antibiotics on suspicion and don't wait for the results of LP!** If lumbar puncture is deferred or omitted, it is essential to take blood cultures and to start empirical treatment.
- **CSF analysis, remember to be careful:**
  - Increased ICP may increase risk of herniation Lowering of CSF pressure from withdrawal of CSF could precipitate herniation of the brain.
  - Cellulitis at area of lumbar puncture
  - Bleeding disorder

3 Other

- CBC, Creatinine, electrolytes: Na
- Blood Culture



25.34 The investigation of meningitis.

1- Swelling of optic disc due to elevated intracranial pressure, can present with loss of visual acuity due to enlargement of blind spot. Do fundoscopy, you will see edematous, poorly defined, prominent optic disc with blurry margins, widened blind spot and radial hemorrhage around the disc margin.

Bacterial meningitis *cont.*

◀ CSF analysis

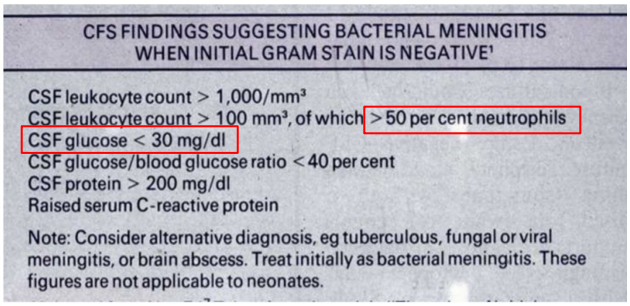
Tests from 1-6 are the standard tests, the rest are ordered based on suspicion. Although, in real life we ask for all of them.

1. Appearance, opening pressure[1]
2. Cell count with differential
3. Glucose, protein
4. CSF appearance
5. Gram stain
6. Culture
7. TB AFB smear PCR and culture
8. Brucella serology and PCR — Imp in our area
9. HSV PCR — If you suspect encephalitis
10. Multiplex viral PCR — for enterococcus
11. Cryptococcus antigen — in DM and immunocompromised

EXTRA

Typical CSF changes in viral, pyogenic and TB meningitis

	Normal	Viral	Bacterial	Tuberculosis
Appearance	Crystal clear	Clear/turbid	Turbid/purulent	Turbid/viscous
Mononuclear cells	<5/mm^3	10-100/mm^3	<50/mm^3	100-300/mm^3
Polymorph cells	Nil	Nil	200-300/mm^3	0-200/mm^3
Protein	0.2-0.4 g/L	0.4-0.8 g/L	0.5-2.0 g/L	0.5-3.0 g/L
Glucose	⅔ - ½ blood glucose	> ½ blood glucose	< ½ blood glucose	< ½ blood glucose



CFS FINDINGS SUGGESTING BACTERIAL MENINGITIS WHEN INITIAL GRAM STAIN IS NEGATIVE[1]

CSF leukocyte count > 1,000/mm³
CSF leukocyte count > 100 mm³, of which > 50 per cent neutrophils
CSF glucose < 30 mg/dl
CSF glucose/blood glucose ratio < 40 per cent
CSF protein > 200 mg/dl
Raised serum C-reactive protein

Note: Consider alternative diagnosis, eg tuberculous, fungal or viral meningitis, or brain abscess. Treat initially as bacterial meningitis. These figures are not applicable to neonates.

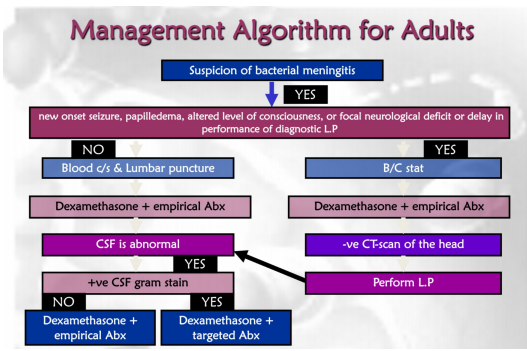
- **Bacterial meningitis** the predominant cells will be neutrophils
- **Viral meningitis:** it will be lymphocytes.
- **Partially treated meningitis:** there will be elevated white cells (mainly neutrophils but may have elevated lymphocytes as well), but glucose and protein may be normal or near borderline (Can be confusing with viral meningitis).
- **How to differentiate between partially treated bacterial meningitis and viral meningitis?** By history (e.g. if the pt has visited a hospital recently and taken abx considered partially treated meningitis) or by gram stain, you may get positive results in partially treated meningitis
- **Protein:** can be high in other inflammatory causes such as MS. It is not specific.

No need to remember the numbers as they vary from reference to another, just understand the picture

◀ Empirical Treatment for Gram negative bacterial meningitis

Details next page

- **The best initial treatment for bacterial meningitis is:**
  - **Ceftriaxone** (2gm IV Q12h)
    - High CSF levels
  - **Vancomycin** (500-750mg IV Q6h): Given to cover highly penicillin resistant pneumococcus
  - **Dexamethasone** (0.15mg/kg IV Q6h) for 2-4 days :
    - 1 st dose 15-20 min prior to or con-comitant with1st dose Abx to block TNF production
  - Listeria is resistant to all cephalosporins but sensitive to penicillins. **You must add ampicillin** to ceftriaxone and vancomycin if the case describes risk factors for **Listeria**.
  - If you suspect that it may have a viral component or encephalitis you can **add acyclovir**



1- Not useful in meningitis, but helpful in cases of idiopathic intracranial hyper/hypotension

Management[1] *cont'*

◄ Bacterial Meningitis - Empiric Treatment of unknown cause (Gram stain Negative)

- Ceftriaxone and vancomycin should always be administered

Comment	Recommended Treatment
Adults aged **18–50 years** with or without a typical meningococcal rash	• **Cefotaxime** 2g IV QID or • **Ceftriaxone** 2g IV Q12h (**High CSF levels)**
Patients in whom **highly penicillin resistant pneumococcus is suspected** , or in areas with a significant incidence of penicillin resistance in the community	As for (1) but add: • **Vancomycin** 500-750 mg IV Q6h or • Rifampicin 600 mg IV twice daily
Adults aged > 55 years and If **Listeria** suspected (brainstem signs, **immunosuppression**, diabetic, alcoholic)	As for (1) but add: • **Ampicillin** 2 g IV 6 times daily or • Co-trimoxazole 5 mg/kg IV daily in two divided doses
Patients with a clear history of anaphylaxis to **β-lactams**	• Chloramphenicol 25 mg/kg IV QID plus • Vancomycin 1 g IV twice daily
Adjunctive treatment (see pg7 management)	• **Dexamethasone** (to suppress acute inflammation not used in chronic**) (0.15mg/kg IV Q6h) for 2-4 days:**
- Management of ↑ICT : mannitol, glycerine, acetazolamide. - Tt of Seizures, pyrexia. - Treat shock, DIC if present. - Add Acyclovir for herpes Encephalitis. - Add amphotericin B or fluconazole for fungal infections.	

◄ Chemotherapy of bacterial meningitis when the cause is known

Pathogen	Regimen of choice	Alternative agents
Neisseria meningitidis	• **Benzylpenicillin** 2.4 g IV 6 times daily for 5–7 days	- **Cefuroxime**, **ampicillin** - **Chloramphenicol**[2]
Streptococcus pneumoniae (sensitive to β-lactams, MIC < 1 mg/L)	• **Cefotaxime** 2 g IV QID or • **Ceftriaxone** 2 g IV twice daily for 10–14 days	- **Chloramphenicol**[2]
Strep. pneumoniae (resistant to β-lactams)	As for sensitive strains but add: • **Vancomycin** 1 g IV twice daily or • **Rifampicin** 600 mg IV twice daily	- **Vancomycin** + **rifampicin**[2] - **Moxifloxacin** - **Gatifloxacin**
Haemophilus influenzae	• **Cefotaxime** 2 g IV QID or • **Ceftriaxone** 2 g IV twice daily for 10–14 days	- **Chloramphenicol**[2]
Listeria monocytogenes	• **Ampicillin** 2 g IV 6 times daily plus • **Gentamicin** 5 mg/kg IV daily	- **Ampicillin** 2 g IV 4-hourly plus - **Co-trimoxazole** 50 mg/kg daily in two divided doses
Streptococcus suis	• **Cefotaxime** 2 g IV 4 times daily or • **Ceftriaxone** 2 g IV twice daily for 10–14 days	- **Chloramphenicol**[2]

1- Early endotracheal intubation and mechanical ventilation protect the airway and may prevent the development of the acute respiratory distress syndrome. **Adverse prognostic features include:** hypotensive shock, a rapidly developing rash, a haemorrhagic diathesis, multisystem failure and age over 60 years.
2- For patients with a history of anaphylaxis to β-lactam antibiotics.

Management *cont'*

◀ Neurobrucellosis

- **General info:**
  - Brucellosis is an enzootic infection (i.e. endemic in animals) caused by Gram-negative bacilli.
  - Infected animals may excrete Brucella spp. in their milk for prolonged periods and human infection is acquired by ingesting contaminated dairy products (especially **unpasteurised milk**), uncooked meat or offal.
  - **B. melitensis causes the most severe disease**; B. suis is often associated with abscess formation.
- **Treatment:**
  - **Doxycycline** 100mg IV/po bid
  - **Plus** Rifampin 600-900mg po od
  - **Plus** Ceftriaxone 2gm IV q12h
  - **Duration?**
    - Continue until CSF is normal (3-12 months); duration vary based on symptoms and MRI changes

◀ Prevention of meningitis

Vaccination
• Vaccinate all adults >65 years for S. pneumoniae. • Vaccinate asplenic patients for S. pneumoniae, N. meningitidis, and H. influenzae (encapsulated organisms). • Vaccinate immunocompromised patients for N. meningitidis. • Vaccines are available for most meningococcal subgroups but not group B, which is one of the most common serogroups isolated in many countries.

Complications of meningitis

- **Hydrocephalus** (in pediatrics)
- Seizures
- Syndrome of inappropriate ADH secretion (SIADH)
  - present with refractory hyponatremia)
- Subdural effusions & empyema
- Septic sinus or cortical vein thrombosis
- Arterial ischemia / infarction (inflammatory vasculitis)
  - VZV and aspergillus infections can cause stroke + meningitis or encephalitis.
- **Most common:** CN Palsies (esp. **deafness**)
- **Septic shock / multi-organ failure from bacteremia (esp meningococcus & pneumococcus)**
- Risk of adrenal hemorrhage with hypo-adrenalism **(Waterhouse-Friderichsen syndrome)**

Tuberculous meningitis

Introduction

- **Most dreaded and dangerous form of TB**
- Tuberculous meningitis is now uncommon in developed countries except in immunocompromised individuals, although it is still seen in those born in **endemic areas** and in **developing countries**. It is seen more frequently as a secondary infection in patients with the acquired immunodeficiency syndrome **(AIDS).**
- **Risk factors:**
  - Young age
  - Household contact
  - Recent infection
  - Measles

Pathophysiology:

- Primary infection → bacillemia → hematogenous seeding of meninges (Rich's foci) → rupture.
- Thick exudates in basal cisterns
- Arteritis
- Tuberculous meningitis most commonly occurs shortly after a primary infection in childhood or as part of miliary tuberculosis.
- The usual local source of infection is a caseous focus in the meninges or brain substance adjacent to the CSF pathway.
- **The brain is covered by a greenish, gelatinous exudate, especially around the base, and numerous scattered tubercles are found on the meninges.**

Clinical features of tuberculous meningitis[1]

- **Symptoms:**
  - Headache, Vomiting, Low-grade fever, Lassitude.
  - Depression, Delirium, Behaviour changes
  - Decerebrate posturing, cranial nerve palsies, optic atrophy, extrapyramidal signs, hydrocephalus (communicating or obstructive) more common
- **Signs:**
  - Meningism (may be absent), Oculomotor palsies, Papilloedema
  - Depression of conscious level, Focal hemisphere signs
- **Staging of severity:**
  - **Stage I (early):** prodromal stage with nonspecific symptoms 1-4 weeks **(without alteration of consciousness)**
  - **Stage II (intermediate):** altered consciousness **without coma** or delirium plus neurological manifestations – seizures, deficits, meningeal signs
  - **Stage III (advanced):** stupor or **coma**, severe neurological deficits, seizures or abnormal movements

1- **Onset** is much slower than in other bacterial meningitis – over 2–8 weeks. If untreated, tuberculous meningitis is fatal in a few weeks but complete recovery is usual if treatment is started at stage I When treatment is initiated later, the rate of death or serious neurological deficit may be as high as 30%.

Tuberculous meningitis cont,

◀ Diagnosis

1 CSF[12] examination

- ↑pressure[3], **cells up to 500 /cu mm**, mostly lymphocytes but **can contain neutrophils.**
- ↑protein, sugar ↓upto ½ of concomitant blood sugar (**marked fall in glucose).**

2 Skin test , Newer Tests

- Tuberculostearic acid
- Adenosine deaminase test
- Bromide partition test
- NBT
- ELISA for antibody/antigen
- **PCR:** NAAT sensitivity %56 percent and specificity 98%
- Interferon gamma release assays
- Tuberculin test

3 Brain imaging

- may show hydrocephalus, brisk meningeal enhancement on **enhanced CT or MR**I and/or an **intracranial tuberculoma.**

4 Other

- AFB: diagnostic yield increase to 87% when four serial specimens examined
- Use last fluid & large volume (10-15mL)
- **Culture[4] :** gold standard
- CXR

◀ Treatment[5]

- **4 anti TB drugs for initial 2 months then 2 drugs for 9-12 months**
  - **Know that it's the same treatment as pulmonary TB but prolonged for up to a year.**
- CSF concentrations:
  - **INH**, **Pyrazinamidine**, pass freely into the CSF
  - **Rifampin** has 10% the concentration as in Plasma
  - **Streptomycin** or **ethionamide** do not pass BBB in absence of Inflammation.
  - ***Supplemental Pyrodoxine with INH Therapy**
- Give steroids initially for 6 weeks as it improves
- Shunt surgery for hydrocephalus

Drug	Daily dose		Route	Duration
	Children	Adults		
British Thoracic Society guidelines, 1998				
Isoniazid	5 mg/kg	300 mg	Oral	9–12 months
Rifampicin	10 mg/kg	450 mg (<50 kg) 600 mg (>50 kg)	Oral	9–12 months
Pyrazinamide	35 mg/kg	1·5 g (<50 kg) 2·0 g (>50 kg)	Oral	2 months
Ethambutol	15 mg/kg	15 mg/kg	Oral	2 months
or streptomycin	15 mg/kg	15 mg/kg (maximum 1 g)	Intramuscular	2 months
Guidelines of the joint committee of the ATS, IDSA, and CDC, 2003				
Isoniazid	10–15 mg/kg (MD 300 mg)	5 mg/kg (MD 300 mg)	Oral	9–12 months
Rifampicin	10–20 mg/kg (MD 600 mg)	10 mg/kg (MD 600 mg)	Oral	9–12 months
Pyrazinamide	15–30 mg/kg (MD 2000 mg)	40–55 kg person: 1000 mg 56–75 kg person: 1500 mg 76–90 kg: 2000 mg	Oral	2 months
Ethambutol	15–20 mg/kg (MD 1000 mg)	40–55 kg person: 800 mg 56–75 kg person: 1200 mg 76–90 kg person: 1600 mg	Oral	2 months

MD=maximum dose. ATS=American Thoracic Society; IDSA=Infectious Diseases Society of America; CDC=Centers for Disease Control.

Table 2: British and American guidelines for the treatment of TM[Rev]

An area for your notes

1- Lumbar puncture should be performed if the diagnosis is suspected.
2-The tubercle bacillus may be detected in a smear of the centrifuged deposit from the CSF but a negative result does not exclude the diagnosis.
3- **usually clear but, when allowed to stand, a fine clot ('spider web') may form.**
4- The CSF should be cultured but, as this result will not be known for up to 6 weeks.
5- treatment must be started without waiting for confirmation.

Viral meningitis

Introduction

- is most commonly caused by a variety of non bacterial pathogens, **Viruses are the most common cause of meningitis**, usually resulting in a benign and self-limiting illness requiring no specific therapy.
- It is much **less serious** than bacterial meningitis **unless** there is associated encephalitis.
- A number of viruses can cause meningitis, the most common being **enteroviruses**.
- Where specific immunisation is not employed, the **mumps** virus is a common cause.

Clinical features

- **acute onset of headache**
- **irritability**
- **the rapid development of meningism.**
- There may be a high **pyrexia** but focal neurological signs are rare.

Viral Pathogens

- Viral meningitis occurs mainly in children or young adult

children And young adults

- **Enteroviruses** (echo, Coxsackie, polio)
- **Mumps**
- Influenza
- **Herpes simplex** (usually causes encephalitis)
- Varicella zoster
- Epstein–Barr
- **HIV**
- Lymphocytic choriomeningitis
- **Mollaret's meningitis (herpes simplex virus type 2)**

Investigations

- The diagnosis is made by **lumbar puncture.**
- CSF usually contains an **excess of lymphocytes.**
- While **glucose** and **protein levels** are commonly normal, the latter may be raised.
- It is important to verify that the patient has not received antibiotics (for whatever cause) prior to the lumbar puncture, as CSF lymphocytosis can also be found in partially treated bacterial meningitis.

Viral meningitis *cont.*

Management

- There is no specific treatment and the condition is usually benign and self-limiting.
- The patient should be treated symptomatically in a quiet environment.
- Recovery usually occurs within days, although a lymphocytic pleocytosis may persist in the CSF.
- Meningitis may also occur as a complication of a systemic viral infection such as mumps, measles, infectious mononucleosis, herpes zoster and hepatitis.
- **Whatever the virus, complete recovery without specific therapy is the rule.**

Aseptic Meningitis

- **Definition:**
  - Inflammation of meninges with sterile CSF
- **CSF: pleocytosis 100s,** Normal Glucose, Protein normal, Neg Culture

Note: Pleocytosis is the hallmark of aseptic meningitis, since it's sterile inflammation usually it has **neutrophilic** pleocytosis (there might be some lymphocytes, but the main cells are neutrophils)

- **Causes:**
  - **Enteroviruses:** most common cause 80%
  - HSV-2 (HSV-1 can cause it but it usually causes encephalitis)
  - HIV
  - Dengue, Zika (can also cause PNS infections), Chikungunya, yellow fever.
  - **Partially treated bacteria** (Think of it when the pt has taken abx in the past 2-3 days. When you suspect viral meningitis it is important to verify that the patient has not received antibiotics (for whatever cause) prior to the lumbar puncture, as CSF lymphocytosis can also be found in partially treated bacterial meningitis.)
  - **Drugs: Metronidazole**, TMP-SMX, NSAIDs, carbamazepine (Given to epileptic pts), **IVIG-** headache is very common (Given to pts with myasthenia gravis and Guillain barre syndrome (GBS))
  - Rare: leptospirosis (spirochaete)

- **Clinical Features:**
  - Fever
  - Headache
  - Irritability
  - Vomiting
  - Convulsion (rare)
  - Meningeal signs

Box 26.60 Causes of sterile CSF pleocytosis

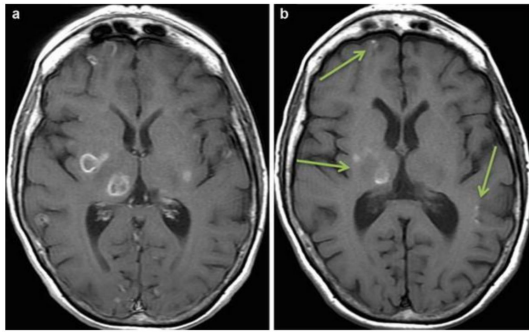
- Partially treated bacterial meningitis
- Viral meningitis
- Tuberculous or fungal meningitis
- Intracranial abscess
- Neoplastic meningitis
- Parameningeal foci, e.g. paranasal sinus
- Syphilis
- Cerebral venous thrombosis
- Cerebral malaria
- Cerebral infarction
- Following subarachnoid haemorrhage
- Encephalitis, including HIV
- Rarities, e.g. cerebral malaria, sarcoidosis, Behçet's syndrome, Lyme disease, endocarditis, cerebral vasculitis

- **Treatment:**

No specific therapy other than supportive care is required. The disease is self-limited.
Analgesics and fever reduction may be appropriate.

CNS Toxoplasmosis in HIV/AIDS

- Toxoplasmosis is the leading cause of focal central nervous system (CNS) disease in AIDS. It tends to cause brain abscess. CNS toxoplasmosis in HIV-infected patients is usually a complication of the late phase of the disease. Happens with CD4 less than 100, on CT it will have a ring enhancement Appearance.
- Can happen in pregnancy

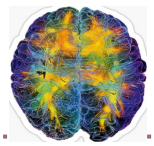


Treatment	Prophylaxis

• **Pyrimethamine** 200mg once po then 75mg od
• **Sulfadiazine** 1.5 gm po Q6h
• Folinic acid 25 mg po od
• Duration? Minimum 6 wks after resolution of signs/symptoms
	Primary prophylaxis
	• **TMP-SMX-DS** 1 tab po od
	• Sulfa allergy:
	  ○ **Dapsone** and **pyrimethamine** and **folinic acid**
	  ○ **Atovaquone** 1500 mg po od
	• Can stop if CD4 > 200 for 3 month
	Secondary prophylaxis
	• Chronic Suppression (**secondary prophylaxis**):
	  ○ **Sulfadiazine** 2-4gm po divided in 2-4 doses/day
	  ○ **Pyrimethamine** 25-50mg po od
	  ○ Folinic acid 10-25mg po od
	• When to stop? CD4 > 200 for 6 months

Parenchymal viral infections

◀ Introduction



- **Encephalitis**: means acute infection/inflammation of brain parenchyma, and is often seen simultaneously with meningitis, usually viral.
- **Meningoencephalitis:** inflammation of brain + meninges
- In viral encephalitis, fever (90%) and meningism are usual; in contrast to meningitis, however, the clinical picture is dominated by brain parenchyma inflammation.
- Personality and behavioural change is a common early manifestation, which progresses to a reduced level of consciousness and even coma.
- **Seizures** (focal and generalized) are very common and focal neurological deficits, such as speech disturbance, often occur (especially in herpes simplex encephalitis).

Parenchymal viral infections *cont.*

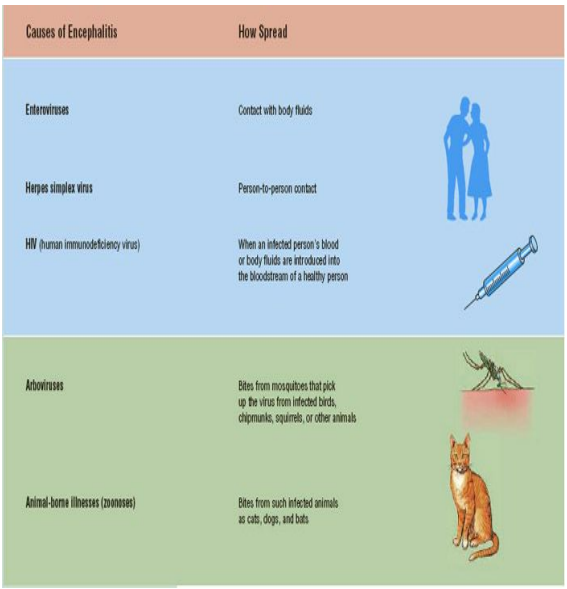
◄ Viral encephalitis Causes

- **Most common: Herpes simplex[1] (Either type 1 or 2)**:
  - How to confirm? Perform LP and PCR. MRI is also helpful (**The limbic system** and the medial temporal are its favourable place)
  - Treat with Acyclovir
- **Varicella zoster**
- Rabies
- Arboviruses[2]: e.g dengue
- **Zika virus**
- **HIV** [3]
- Nonviral infectious causes:
  - Toxoplasmosis
  - Cerebral aspergillosis
- Rare: Listeria, cat scratch disease, amebic

This pt probably had encephalitis, MRI showing an old insult appearing dark. Usually we look for hyper intensity.

Case of viral encephalitis: Elderly coming with new onset focal seizure and personality changes.

◄ Pathophysiology



- The infection provokes an inflammatory response that involves the cortex, white matter, basal ganglia and brainstem.
- The distribution of lesions varies with the type of virus.
- For example, in herpes simplex encephalitis, the temporal lobes are usually primarily affected, whereas cytomegalovirus can involve the areas adjacent to the ventricles (ventriculitis).
- Inclusion bodies may be present in the neurons and glial cells, and there is an infiltration of polymorphonuclear cells in the perivascular space.
- There is neuronal degeneration and diffuse glial proliferation, often associated with cerebral oedema.

An area for your notes

1- **Is the most serious cause of viral encephalitis In Europe ,which probably reaches the brain via the olfactory nerves.**
2- viruses transmitted by mosquitoes and ticks
3- may cause encephalitis with a subacute or chronic presentation but occasionally has an acute presentation with seroconversion.

Parenchymal viral infections *cont.*

◀ Clinical features

Viral encephalitis presents with:

- acute onset of headache
- fever
- focal neurological signs (aphasia and/or hemiplegia, visual field defects)
- and seizures.
- Disturbance of consciousness ranging from drowsiness to deep coma supervenes early and may advance dramatically.
- Meningism occurs in many patients.

◀ Investigations

1 Radiological

- **CT scan** may show low-density lesions in the temporal lobes.
- But **MRI** is more sensitive in detecting early abnormalities.

2 Lumbar puncture

- Should be performed once imaging has excluded a mass lesion.
- The CSF usually contains excess lymphocytes but polymorphonuclear cells may predominate in the early stages.
- The CSF may be normal in up to 10% of cases.
- Some viruses, including the West Nile virus, may cause a sustained neutrophilic CSF.
- The protein content may **be elevated** but the glucose is **normal**.
- **Virological investigations** of the CSF, including PCR, may reveal the causative organism but treatment initiation should not await this.

Parenchymal viral infections *cont.*

3

EEG

- **is usually abnormal in the early stages**, especially in herpes simplex encephalitis, with characteristic periodic slow wave activity in the temporal lobes.

Management

- Optimum treatment for **herpes simplex encephalitis** (**aciclovir** 10 mg/kg IV 3 times daily for 2–3 weeks) has reduced mortality from 70% to around 10%.
- This should be given early to all patients suspected of having viral encephalitis.
- Some survivors will have residual epilepsy or cognitive impairment.
- Antiepileptic treatment may be required and **raised intracranial pressure may indicate the need for dexamethasone.**

Brainstem encephalitis

- This presents with ataxia, dysarthria, diplopia or other cranial nerve palsies.
- The CSF is lymphocytic, with a normal glucose.
- The causative agent is presumed to be viral.
- However, Listeria monocytogenes may cause a similar syndrome with meningitis (and often a polymorphonuclear CSF pleocytosis) and requires specific treatment with ampicillin (500 mg 4 times daily)

Cerebral abscess

Definition

- Bacteria may enter the cerebral substance through penetrating injury, by direct spread from paranasal sinuses or the middle ear, or secondary to sepsis. **Untreated congenital heart disease** is a recognised risk factor.
- Initial infection leads to local suppuration followed by loculation of pus within a surrounding wall of gliosis, which in a chronic abscess may form a tough capsule.
- Haematogenous spread may lead to multiple abscesses.
- **Organisms:**
  - **Streptococci (60-70%),** Bacteroides (20-40%), Enterobacteriacea (25-33%), S.Aureus (10-15%), S.Milleri.
  - Rare: Nocardia, Listeria

Cerebral abscess *cont.*

Clinical features

Clinical symptoms

The usual presenting features are:

- Fever
- Headache
- Meningism
- Drowsiness

But more commonly presents over days or weeks as a cerebral mass lesion with little or no evidence of infection.

- Seizures, raised intracranial pressure and focal hemisphere signs occur alone or in combination.

Note: Distinction from a cerebral tumour may be impossible on clinical grounds.

Investigations

- Lumbar puncture is potentially hazardous in the presence of raised intracranial pressure **and CT should always precede it.**
- **CT with contrast:** reveals single or multiple low-density areas, which show ring enhancement with contrast and surrounding cerebral oedema
- **CT brain:** If abscess more than 2.5cm then **surgical drainage**. And if patient neurologically unstable or decrease LOC drain regardless of size

Management

- **Antimicrobials:** empirically Ceftriaxone with metronidazole, otherwise according to susceptibility . Start antimicrobial therapy and refer the pt to neurosurgery.
- Duration until response by neuroimaging

25.69 Aetiology and treatment of bacterial cerebral abscess

Site of abscess	Source of infection	Likely organisms	Recommended treatment
Frontal lobe	Paranasal sinuses Teeth	Streptococci Anaerobes	Cefotaxime 2–3 g IV 4 times daily *plus* Metronidazole 500 mg IV 3 times daily
Temporal lobe	Middle ear	Streptococci Enterobacteriaceae	Ampicillin 2–3 g IV 3 times daily *plus* Metronidazole 500 mg IV 3 times daily *plus either*
Cerebellum	Sphenoid sinus Mastoid/middle ear	*Pseudomonas* spp. Anaerobes	Ceftazidime 2 g IV 3 times daily *or* Gentamicin* 5 mg/kg IV daily
Any site	Penetrating trauma	Staphylococci	Flucloxacillin 2–3 g IV 4 times daily *or* Cefuroxime 1.5 g IV 3 times daily
Multiple	Metastatic and cryptogenic	Streptococci Anaerobes	Benzylpenicillin 1.8–2.4 g IV 4 times daily if endocarditis or cyanotic heart disease Otherwise cefotaxime 2–3 g IV 4 times daily *plus* Metronidazole 500 mg IV 3 times daily

*Monitor gentamicin levels.

Other parenchymal bacterial infections

◀ Subdural Empyema

- This is a rare complication of frontal sinusitis, osteomyelitis of the skull vault or middle ear disease. A collection of pus in the subdural space spreads over the surface of the hemisphere, causing underlying cortical oedema or thrombophlebitis.
- **In adults 60-90% are extension of:**
  - Sinusitis
  - Otitis media
- **Clinical features:**
  - Patients present with severe pain in the face or head and pyrexia, often with a history of preceding paranasal sinus or ear infection. The patient then becomes drowsy, with seizures and focal signs such as a progressive hemiparesis.
- **Diagnosis:**
  - The diagnosis rests on a strong clinical suspicion in patients with a local focus of infection.
  - Careful assessment with contrast-enhanced CT or MRI may show a subdural collection with underlying cerebral oedema.
- **Treatment:**
  - **Surgical emergency: Must drain;** requires aspiration of pus via a burr hole and appropriate parenteral antibiotics (Abx same as brain abscess)
  - If it's small and not causing seizures or cognitive impairment it will be absorbed by the body with time "no need for surgery"

◀ Spinal Epidural abscess (OBJ.)

Definition	• An infection that forms in the space between the bones of your spine and the lining membrane of your spinal cord • Main risk factor: IV drug misuse
Clinical features	• The characteristic clinical features are pain in a root distribution (Back pain) and progressive transverse spinal cord syndrome with paraparesis, sensory impairment and sphincter dysfunction.
Diagnosis	• X-ray changes occur late, if present, so **MRI (Gold standard)** or myelography should precede urgent neurosurgical intervention. • Decompressive laminectomy with abscess drainage relieves the pressure on the dura. Organisms may be grown from the pus or blood. N.B **LP is contraindicated in spinal epidural abscesses**
Treatment	• **Surgery, together with appropriate antibiotics**, may prevent complete and irreversible paraplegia.

Bacterial meningitis

Definition

- Inflammation of the (meninges) pia mater and the arachnoid mater (dura mater is usually spared),with suppuration of the cerebrospinal fluid

Signs and Symptoms

- **Classic triad: fever, neck stiffness and confusion.**
- **Severe Headache, Photophobia** (intolerance of light) and Phonophobia (intolerance to loud noises) can be specific to bacterial meningitis.
- Bulging fontanel in infants, sometimes with hydrocephalus

Kernig's sign	Brudzinski's neck sign
While patient is lying supine, with the hip and knee flexed to 90 degrees pain limits passive extension of the knee.  The Kernig sign	Flexion of the neck causes involuntary flexion of the knee and hip.  Brudzinski sign

What's the most useful sign?

- **Jolt accentuation maneuver:** ask patient to rapidly rotate his or her head horizontally: Headache worsens, In healthy individuals it might be uncomfortable but a pt with meningitis will avoid doing it.
- **Sensitivity of 100%, specificity of 54% (Low, unlike kernig and Brudzinski signs),**

Management (Based on Dr notes)

How to manage a patient with meningitis?

- **Step 1:** Give empirical therapy!! Whenever you suspect meningitis or encephalitis, start empirical therapy! (In real life the pt will be started on empirical therapy in the ER, before you see him)
- **Step 2: CT** (To exclude herniation, supratentorial tumor, bleeding, pus collection (Subdural empyema) before doing LP bc it may kill the pt). **NEVER do LP before CT.**
- **Step 3:** LP.
  - **Contraindications to LP:** Herniation, Infection at the site of LP (e.g. Cellulitis), bleeding disorders, Low platelet count <100, anticoagulants . If one of these contraindication is present you can delay LP but **NEVER delay the treatment**

What antibiotics should be given?

- **Ceftriaxone + Vancomycin (**to cover highly penicillin resistant pneumococcus)
- Add ampicillin if there's suspicion of listeria

  Note: **Dexamethasone should be given** concomitant with 1st dose Abx to block TNF production

EXTRA

Typical CSF changes in viral, pyogenic and TB meningitis

	Normal	Viral	Bacterial	Tuberculosis
Appearance	Crystal clear	Clear/turbid	Turbid/purulent	Turbid/viscous
Mononuclear cells	<5/mm^3	10-100/mm^3	<50/mm^3	100-300/mm^3
Polymorph cells	Nil	Nil	200-300/mm^3	0-200/mm^3
Protein	0.2-0.4 g/L	0.4-0.8 g/L	0.5-2.0 g/L	0.5-3.0 g/L
Glucose	⅔ - ½ blood glucose	> ½ blood glucose	< ½ blood glucose	< ½ blood glucose

Summary *(cont.)*

Special cases of bacterial meningitis

Meningococcal meningitis (Emergency)

Meningococcal meningitis and meningococcaemia: emergency treatment

Suspicion of meningococcal infection is a medical emergency requiring treatment immediately.

Clinical features:

- Petechial or nonspecific blotchy red rash
- Fever, headache, neck stiffness.

All these features may not be present – and meningococcal infection may sometimes begin like any apparently non-serious infection.

Immediate treatment for suspected meningococcal meningitis at first contact before transfer to hospital or investigation:

- Benzylpenicillin 1200 mg (adult dose) slow i.v. injection or intramuscularly
- Alternative if penicillin allergy – cefotaxime 1 g i.v.

In meningitis, minutes count: delay is unacceptable. On arrival in hospital:

- Routine tests including blood cultures immediately
- Watch out for septicaemic shock.

- Fulminate meningococcemia with purpura caused by **Neisseria meningitidis**
  - Overwhelming sepsis, DIC
- **Classic: Meningitis with rash (Petechiae) + Headache + Fever**

- Lumbar puncture **should not be performed** if meningococcal sepsis is suspected because coning of the cerebellar tonsils may follow – the organism is confirmed by blood culture.

- **Treatment and prophylaxis:**
  - **Droplet Isolation:** 48h post Abx
  - **Treatment: Ceftriaxone or Pen G** 7 days
  - **Eradicate nasopharyngeal carriage:**
    - House hold contact
    - Health care providers who examined patient closely
  - **Prophylaxis (Not done routinely):** Rifampin 600 mg for 2 d or Ciprofloxacin 500mg once or Ceftriaxone 125mg I.M once

Recall: Ceftriaxone is C.I in neonates, give cefotaxime instead.

Listeria Monocytogenes meningitis

- **Pathology:** It causes brain stem, cerebellum inflammation (Rhombencephalitis) and meningitis
- **Risk groups:**
  - Age <1y or >50y
  - Alcoholics
  - Pregnancy: up to 30%
  - Immunocompromised 70 %
- **Routes of transmission:**
  - **Mainly food borne:** survives refrigeration
    - linked to poultry, hotdogs, cold cuts, coleslaw, ice-cream
  - **Cheeses,** particularly soft cheeses, have been implicated in listeriosis outbreaks worldwide.
  - Inform micro lab: special media **(Mueller-Hinton agar)**

Note: Whenever you see a pt with changing signals in brain stem and cerebellum MRI , think of Listeria.

- **Treatment:**
  - **Ampicillin** 2gm IV Q4h +/- Gentamicin 2mg/kg loading dose then 1.7mg/kg Q8h
  - **21 day** duration
  - Penicillin allergy patients: **TMP-SMX or Meropenem**

Neuro Brucellosis

- **Treatment:**
  - **Doxycycline**
  - **Plus** Rifampin
  - **Plus** Ceftriaxone 2gm IV q12h

What's the most common organism in neonates?

- Group B Streptococci (occurs ONLY in neonates)

What's the most common organism in older infants and children?

- Streptococcus pneumonia

What's the most common organism in adults?

- Streptococcus pneumonia

What's the most common complication?

- CN palsies (esp. deafness)

Aseptic meningitis

Definition

- Inflammation of meninges with sterile CSF
- **CSF: pleocytosis 100s,** Normal Glucose, Protein normal, Neg Culture

Note: Pleocytosis is the hallmark of aseptic meningitis, since it's sterile inflammation usually it has **neutrophilic** pleocytosis (there might be some lymphocytes, but the main cells are neutrophils)

Causes

- **Enteroviruses:** most common cause 80%
- HSV-2 (HSV-1 can cause it but it usually causes encephalitis)
- **Partially treated bacteria** (Think of it when the pt has taken abx in the past 2-3 days. When you suspect viral meningitis it is important to verify that the patient has not received antibiotics (for whatever cause) prior to the lumbar puncture, as CSF lymphocytosis can also be found in partially treated bacterial meningitis.)
- **Drugs: Metronidazole**, TMP-SMX, NSAIDs, carbamazepine (Given to epileptic pts), **IVIG-** headache is very common (Given to pts with myasthenia gravis and Guillain barre syndrome (GBS))

Viral encephalitis

General info

- **Encephalitis**: means acute infection/inflammation of brain parenchyma, and is often seen simultaneously with meningitis, usually viral.
- **Meningoencephalitis:** inflammation of brain + meninges
- In viral encephalitis, fever (90%) and meningism are usual; in contrast to meningitis, however, the clinical picture is dominated by brain parenchyma inflammation.
- **Personality and behavioural change** is a common early manifestation, which progresses to a reduced level of consciousness and even coma.
- **Seizures** (focal and generalized) are very common and focal neurological deficits, such as speech disturbance, often occur (especially in herpes simplex encephalitis).

What's the most common organism?

- **Most common: Herpes simplex (Either type 1 or 2)**:
  - How to confirm? Perform LP and PCR. MRI is also helpful (**The limbic system** and the medial temporal are its favourable place)
  - Treat with Acyclovir

Cerebral abscess

General info

- Bacteria may enter the cerebral substance through penetrating injury, by direct spread from paranasal sinuses or the middle ear, or secondary to sepsis. **Untreated congenital heart disease** is a recognised risk factor.
- Initial infection leads to local suppuration followed by loculation of pus within a surrounding wall of gliosis, which in a chronic abscess may form a tough capsule.
- **Organisms:**
  - **Streptococci (60-70%),** Bacteroides (20-40%), Enterobacteriacea (25-33%),
- **S&S:**
  - Fever, Headache, Meningism, Drowsiness
  - Seizures, raised intracranial pressure and focal hemisphere signs occur alone or in combination.

Management

- Lumbar puncture is potentially hazardous in the presence of raised intracranial pressure **and CT should always precede it.**
- **CT with contrast:** reveals single or multiple low-density areas, which show ring enhancement with contrast and surrounding cerebral oedema
- **CT brain:** If abscess more than 2.5cm then **surgical drainage**. And if patient neurologically unstable or decrease LOC drain regardless of size
- **Antimicrobials:** empirically Ceftriaxone with metronidazole, otherwise according to susceptibility

Lecture Quiz

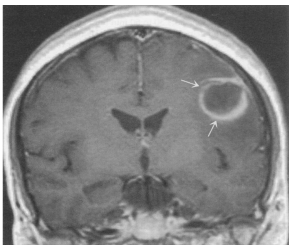
1- A man comes to the emergency department with fever, severe headache, neck stiffness, and photophobia. On physical examination he is found to have weakness of his left arm and leg. What is the most appropriate next step in the management of this patient?

A- Ceftriaxone, vancomycin, and steroids.
B- Head CT.
C- Ceftriaxone.
D- Neurology consultation.
E- Steroids.

2- A 52-year-old previously healthy woman presents with behavioral abnormalities and aphasia. Her husband reports that her symptoms began 3 days ago with fever and headache. On examination, she has a temperature of 38.4°C (101°F), mild nuchal rigidity, and agitation. When questioned, she repeats the question or responds with nonsense words. CT scan shows mild temporal hypodensity on the right; CSF examination shows 354 WBC with 75% lymphocytes. The CSF protein is elevated at 167 mg/dL, but the CSF glucose is normal at 112 (simultaneous peripheral glucose 142).

A- Pneumococcal meningitis
B- Cryptococcal meningitis
C- Coxsackievirus (aseptic) meningitis
D- Listeria monocytogenes meningitis
E- Herpes simplex encephalitis

3- A 28-year-old alcoholic has recently been treated for lung abscess. Three days before this admission, the patient develops headache, fever, and mild right-sided weakness. His MRI scan is shown in the following figure.



A- Pneumococcal meningitis
B- Coxsackievirus (aseptic) meningitis
C- Pyogenic brain abscess
D- Herpes simplex encephalitis
E- Cerebral cysticercosis

4- An 18 year old male student has been home from university for 3 days, during which time he has become increasingly drowsy. He is able to be roused but is disorientated. He has a temperature of 39°C, has marked neck stiffness and a positive Kernig's sign. He has developed a spotting, non-blanching rash over his anterior chest wall. He has no focal neurological deficit. What is the most appropriate next course of action?

A. Administer intravenous (IV) benzylpenicillin
B. Arrange for a computed tomography (CT) brain scan
C. Carry out a lumbar puncture
D. Puncture one of the purpuric lesions for microscopic analysis
E. Take blood for viral polymerase chain reaction (PCR) test

5- With regard to the patient in Question 4, IV benzylpenicillin has now been administered and his cerebral imaging has been shown to be normal. A lumbar puncture has been carried out. What is the most likely pattern of abnormality to emerge in cerebrospinal fluid (CSF)?

A- Normal white cells, normal protein, low glucose
B- Normal white cells, raised protein, normal glucose
C- Raised white cells (90% lymphocytes), raised protein, low glucose
D- Raised white cells (90% neutrophils), normal protein, normal glucose
E- Raised white cells (90% neutrophils), raised protein, low glucose

6- A 35 year old female presents with a 6-day history of delirium and disorientation. She is pyrexial but aside from being unable to answer questions or follow direction, exhibits no neurological deficit. After normal imaging has been carried out, a lumbar puncture is done, which shows the following results: white cell count 35 × 109/L; blood film – 90% lymphocytes; CSF protein 0.65 g/L; CSF glucose 4.2 mmol/L (76 mg/dL); serum glucose 6.0 mmol/L (108 mg/dL) (normal CSF glucose is > 60% of contemporary serum glucose). Which process would be a likely cause of this?

A- Brainstem encephalitis
B- Meningococcal meningitis
C- Subarachnoid haemorrhage
D- Tuberculous meningitis
E- Viral encephalitis

Answers: Q1:A | Q2:E | Q3:C | Q4:A | Q5:E | Q6:E

Answers Explanation File!

THANKS!!

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Send us your feedback:
We are all ears!