Bacterial Meningitis

- More common in very young and old
- Epidemic Meningitis due to meningococcus
- Hematogenous or direct inoculation
- Causes injury by vascular compromise and toxic effects of bacteria and PMNs

Bacterial Meningitis-Signs

- Subacute presentation, rapid progression
- Headache
- Neck stiffness
  - Brudzinski sign—Reflex flexion of knees upon flexing neck of supine patient
  - Kernig sign—pain in neck experience when extending leg of seated patient
- Fever, nausea, photophobia
- Delirium, seizures and focal deficits
- Purpuric rash with meningococcus
Bacterial Meningitis-Signs

- Neonatal Presentation
  - Classic signs may be absent
  - May have irritability, unconsolable crying
  - Decreased/absent feeding
  - Fever

Bacterial Meningitis-Complications

- Cerebritis or abscess
- Subdural effusions/empyema
- Venous sinus thrombosis
- Hydrocephalus
- Arteritis/infarcts

Bacterial Meningitis-Diagnosis

- CT head usually normal (occasional hydrocephalus)
- MRI- meningeal enhancement
- LP
  - Increased protein
  - Decreased glucose
  - Neutrophilic pleocytosis
  - Organisms on gram stain
  - Bacterial antigen testing: S Pneumo, N Meningitidis, H Influenza, Group B Streptococcus
- Increased peripheral WBC count

Bacterial Meningitis-Treatment

- Early treatment following blood cultures
- Empiric therapy depends on age*
  - Neonates- 3rd generation cephalosporin and ampicillin
  - Infants thru Adults- 3rd generation cephalosporin
  - Ampicillin added when immunocompromise suspected for coverage of Listeria
  - Vancomycin added for instrumentation-associated meningitis
  - Metronidazole added when anaerobes suspected (trauma)
- * Local preferred therapy may vary based on organism prevalence and sensitivity
Bacterial Meningitis-Treatment

- Steroids
  - Reduces inflammation and vasogenic edema
  - Improves outcome and reduces mortality in children and adults
  - Anticoagulation of septic sinus thrombosis controversial; may increase bleed risk

Bacterial Meningitis-Prevention

- Pneumococcus vaccine- age >65 and immunocompromised
- *H Influenza* vaccine- all infants
- Meningococcus vaccine- children aged 11-12
- Chemoprophylaxis with Rifampin for contacts of meningococcus patients

Brain Abscess- Bacterial

- Mechanism- Hematogenous or contiguous
- Organisms- Streptococci and Anaerobes
- Clinical presentation
  - Headache, fever, focal signs, seizures
  - +/− leukocytosis; LP may be contraindicate
  - MRI with hypointense T1, hyperintense T2 early; later with ring-enhancing lesion (can be seen on CT as well)
- Treatment
  - Antibiotics if early
  - May need drainage or surgical debridement if encapsulated
Cranial Epidural Abscess

- Mechanism: Local Spread
- Organisms: *S. aureus*, anaerobes, gram neg bacteria
- Clinical presentation
  - Headache, fever, focal signs, seizures
- Studies
  - MRI with hyperintense T1 and T2, dural enhancement,
- Treatment
  - Surgical drainage plus antibiotics

Subdural Empyema

- Mechanism: Local spread from cranial infection (often dental)
- Organisms: Often anaerobic *Streptococcus* species
- Clinical presentation
  - Headache, fever, focal signs, seizures, decreased LOC
- Studies
  - MRI with crescentic hyperintense T1 and T2
- Treatment
  - Surgical drainage plus antibiotics

Spinal Epidural Abscess

- Mechanism: Local spread (osteomyelitis) vs hematogenous
- Organisms: Most *S. aureus*; also gram – and *Streptococcus* species
- Clinical presentation
  - Localized back pain, fever, radiculitis, myelopathy
  - Often Thoracic
- Studies
  - MRI with enhancing epidural fluid collection
- Treatment
  - Emergent surgical decompression plus antibiotics
Viral Meningitis

- Acute onset meningeal signs and symptoms
- CSF showing lymphocytic pleocytosis, normal glucose and protein
- Negative CSF cultures

Viral Meningitis

- Enterovirus
  - Poliovirus, coxsackie, echo
- Mumps virus
- Other viruses
  - Arbo, Herpes simplex and zoster, Varicella, CMV

Fungal Meningitis

- Immunocompromised:
  - Cryptococcus meningitis, cryptococcoma
  - Hydrocephalus, blindness
  - Mucoraceae- especially in diabetes; Rhinocerebral
- Non-immunocompromised:
  - Histoplasmosis- GI primary focus
  - Blastomycosis- thick membrane, spinal invasion
  - Coccidioides- Hydrocephalus
  - Aspergillus- vasculitic invasion; Rhinocerebral
Tuberculous Meningitis

- Hematogenous seeding of meninges
- Meningeal exudate, superficial encephalitis
- Endarteritis, microinfarcts
- Blockage of CSF flow
- Tuberculomatous abscesses

Diagnosis
- CSF: increased WBC, low glucose, elevated protein
- CSF AFB positive in 10-30%
- CSF PCR 50-100% sensitive, 95-100% specific

Treatment:
- INH, rifampin, ethambutol, pyrazinamide, streptomycin

Viral Encephalitis-HSV

- Herpes Simplex (HSV1 adults, HSV2 neonates)
  - Acute sporadic disease, often fatal
- Fever, headache, altered LOC, acute behavioral changes, +/- seizures
- Lymphocytic infiltrate and necrosis of (most often) temporal and inferior frontal lobes
- MRI- T2 hyperintense often with hemorrhage
- CSF PCR sensitive and specific
- Treatment: IV acyclovir ASAP

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Viral Encephalitis-CMV
- Immunocompromised Host
- Can present as meningitis, encephalitis, or myeloradiculopathy
- CSF often polymorphonuclear pleocytosis, elevated protein and low glucose
- CSF PCR most sensitive and specific
- Treatment with gancyclovir

Viral Encephalitis- other
- Arboviruses
  - Common cause of summer encephalitis
  - Japanese, St Louis, West Nile, Eastern and Western equine encephalitis
  - Dengue; often with hemorrhage or shock
- Mumps
- Varicella
- Epstein Barr
- Adenovirus

West Nile Virus
- Mosquito-borne, Bird reservoir
- Infection
  - Asymptomatic
  - Fever only
  - Neuroinvasive-Meningoencephalitis and other patterns

West Nile Virus
- Neurological patterns
  - Meningitis
  - Encephalitis
  - Polio-like anterior horn syndrome
  - Guillain-Barre- syndrome
  - CSF often shows neutrophillic predominance
Parasitic Disease-Malaria

- Protozoan - *Plasmodium falciparum*
- Focal deficits, delerium, seizures, retinal hemorrhages; due to sludging/microvascular ischemia
- Diagnosis: Blood smear
- Treatment: Quinine derivatives

Neurocysticercosis

- *Taenia solium*, pork tapeworm
- Ingestion of ova; larvae migrate to:
  - Eyes, Brain, and Muscle
- Epilepsy in 50%
- Racemous form- obstructive hydrocephalus

Schistosomiasis

- *Schistosoma japonicum*
- Encephalitis
- Transverse myelitis
Transverse Myelitis

- Many viruses:
  - VZV, HSV, CMV, adenoviruses
  - CMV lumbosacral radiculopathy - cauda equina
  - HIV
- HTLV1 (chronic)
  - Tropical spastic paraparesis

Poliomyelitis

- Immunization reduced incidence in developed countries
- Fever, followed by bulbar or somatic paralysis
- Rare encephalitis
- Post polio syndrome - later anterior horn cell degeneration

HIV Complications

- Encephalopathy
- Polyradiculopathy
- Vacuolar myelopathy
- Neuropathy; GBS, CIDP, autonomic neuropathy
- Myopathy - HIV and protease inhibitors
- Opportunistic infections
  - Toxo, lymphoma (EBV), cryptococcus, coccidiodes, CMV, aggressive neurosyphilis

HIV encephalitis

- Common
- May lead to dementia
- Glutamate toxicity
Toxoplasmosis
- Cats are host
- Ring-enhancing lesions on CT and MRI
- Immunocompromised
- Prophylactic Bactrim

PML
- Progressive Multifocal Leuкоphalopathy
- JC Virus
- White matter lesions, encephalopathy, focal signs
- Immunocompromised host
  - HIV
  - Transplant immunosuppression
  - Natalizumab (α4-integrin MAb)

Spongiform Encephalopathy
- Prion Disease, proteinaceous infectious particle
- Jacob-Creutzfeld, Kuru, Familial Fatal Insomnia
- Subacute dementing illness
- Dementia, ataxia, myoclonus, periodic sharp waves on EEG, Extrapyramidal signs
- BSE-contaminated beef- younger cohort
SSPE

- Subacute, sclerosing, Pan-encephalitis
- Measles virus; 2-12 years after acute illness
- Aberrant viral gene expression
- Age at onset 6-8 years old
- School decline, spasticity, epilepsy, retinopathy, ataxia and dystonia
- Burst Suppression EEG pattern

Other Bacterial CNS Disease

- Cerebral Abscess
- Epidural abscess, spinal
- Subdural empyema
- Intracranial Thrombophlebitis

Syphilis

- Treponema Pallidum
- Primary- Chancre and lymphadenopathy
  - 1-6 weeks
- Secondary- Hematogenous spread
  - 6-12 weeks
  - Generalized rash
  - CSF abnormal in 40%

Syphilis

- Latent- early
  - One year
  - Asymptomatic
  - CSF abnormal in 20%
- Latent- late
  - Over one year
Syphilis

- Tertiary
  - Obliterative endarteritis
  - Gumma
  - Aortitis
  - CNS Vasculitis
  - CSF abnormal in most

Syphilis

- Early Meningitis
  - Lymphocytosis, inc. protein, nl glucose
  - Cranial neuropathies
- Meningovascular
  - Strokes
- Paretic Neurosyphilis
  - Behavioral change and dementia
  - Argyll-Robertson pupils
- Tabes Dorsalis
  - Squint
  - Loss of coordination and balance

Rabies

- Bite or scratch by rabid animal
- Transneuronal spread
- Fever, encephalitis, bulbar or spinal segmental degeneration
Neuroinfectious Disease

Section 4a

Brucellosis
- Unpasteurized Milk
- Relapsing fever
- Chronic meningitis in 5%
- Cranial neuropathies
- Lumbosacral polyradiculitis (Cauda Equina Syndrome)

Tularemia
- Contact with wild animals
- Relapsing fever, lymphadenopathy
- Meningitis, encephalitis
- Flaccid Paralysis due to GBS

Leptospirosis
- Contact with wild animals
- Fever, lymphadenopathy
- Hepatosplenomegaly (liver and renal abnormalities)
- Aseptic Meningitis
- Flaccid Paralysis due to GBS

Lyme Disease
- Tick bite
- Stage 1: 3-32 Days Erythema Migrans “Target Lesion”
- Stage 2: 6-8 weeks; Migratory arthralgias, systemic disease
  - Meningitis, cranial and radiculoneuritis
- Stage 3: Months later; arthritis, neurological symptoms
  - Behavioral changes, depression, impaired memory and concentration
  - Seizures
  - White matter lesions on MRI
Lyme Disease

- **Diagnosis**
  - Serology often negative early; empiric treatment for classic skin lesions
  - ELISA high false positive; confirmed with Western Blot
  - CSF: lymphocytic pleocytosis; normal of increased protein, normal glucose; Oligodendral banding may persist after treatment. CSF PCR highly specific.
- **Treatment**
  - Doxycycline for non-neurologic presentations
  - IV Ceftriaxone for neurological lyme

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Nocardiosis

- Gram pos, branching filaments
- Immunocompromised host
- Pulmonary Disease, CNS disease common
- Brain abscess, meningitis

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Actinomycosis

- Anaerobic, branching filaments
- Normal host immunity
- Skin/oral disease
- Brain abscess, meningitis rare
- “Sulfur granules”
Rickettsia/Ehrlichiosis

- Intracellular coccidioides or bacilli parasites
- Spotted fever, typhus
  - Tick bite
- Q fever
  - Pulmonary
- Encephalitis due to intravascular thrombosis, DIC

Whipple’s Disease

- Gram positive bacillus
- Arthralgias, weight loss, diarrhea, abdominal pain
- Dementia, supranuclear ophthalmoplegia, palatal and oculofacial-skeletal myoclonus

Leprosy

- Mycobacterium Leprae
- Skin and peripheral nerves
- Palpable nerves, anesthetic skin
1. The likely organism causing this diabetic woman’s ophthalmoplegia and meningitis is what?

A. Mucormycosis
B. Streptococcus
C. Staphylococcus
D. Nocardia
E. Herpes Zoster

A. This is orbital cellulitis due to mucormycosis

2. A renal transplant patient presents with 5 week history of headache, stiff neck and decreased vision. His LP reveals an elevated opening pressure, normal glucose, 40 WBC and a protein of 60. What is a likely organism?

A. Listeria
B. Brucella
C. Cryptococcus
D. JC virus
E. HSV
2. A renal transplant patient presents with 5 week history of headache, stiff neck and decreased vision. His LP reveals an elevated opening pressure, 40 WBC and a protein of 60. What is a likely organism?

C. This is the picture of chronic meningitis due to cryptococcus in an immunocompromised host. Bacteria would be expected to have a low glucose and along with HSV be more acute in presentation. JC virus causes PML, not meningitis.

3. A man with HIV presents with progressive proprioceptive difficulty and a steppage gait. He has profound dorsal column dysfunction. What organism might have cause this problem?

A. Toxoplasmosis
B. Treponema Pallidum
C. HSV
D. Ebola virus
E. Cryptococcus

3. A man with HIV presents with progressive proprioceptive difficulty and a steppage gait. He has profound dorsal column dysfunction on exam. What organism might have cause this problem?

B. This is tabes dorsalis due to neurosyphilis. The other organisms would not cause such a focal spinal cord lesion.

4. A 40 year old man presents with fever, agitation and a stiff neck. Lumbar puncture reveals 200 RBCs, xanthochromia, and 12 lymphocytes. What organism might be causing his delerium?

A. HSV
B. JC virus
C. S. Pneumoniae
D. Prions
E. M. Tuberculosis
4. A 40 year old man presents with fever, agitation and a stiff neck. Lumbar puncture reveals 200 RBCs, xanthochromia, and 12 lymphocytes. What organism might be causing his delerium?

A. This is meningoencephalitis due to Herpes Simplex virus. Xanthochromia and RBCs would not be expected in the other processes.

5. A 26 year old woman from El Salvador presents with a first seizure. CT scan reveals a ring-enhancing mass in her occipital lobe? She is immunocompetent. What might be the cause of her lesion?

A. HSV
B. Cryptococcus
C. Prions
D. Arbovirus
E. Cysticercosis

E. The mass is due to neurocysticercosis. The other organisms do not typically present with such lesions.

6. A 35 year old IV drug user presents with fever, severe back pain and urinary retention. What is going on and what should be done?

A. Malingering; send back to shelter
B. HSV encephalitis; admit for acyclovir
C. Pott’s disease; start multi-drug TB treatment
D. Epidural Abscess; call neurosurgery STAT
E. Epidural Abscess; call ID consult
6. A 35 year old IV drug user presents with fever, severe back pain and urinary retention. What is going on and what should be done?

D. Epidural Abscess; call neurosurgery STAT

This is epidural abscess with impending myelopathy and requires emergent decompression, coincident with antibiotics.

7. A 20 year old college student returns from school on the East coast with two weeks of arthralgias, a stiff neck and recent Bell’s Palsy. What does she need?

D. IV ceftriaxone

This is neuroborreliosis (Lyme) that requires IV antibiotics.

7. A 20 year old college student returns from school on the East coast with two weeks of arthralgias, a stiff neck and recent Bell’s Palsy. What does she need?

D. IV ceftriaxone

This is neuroborreliosis (Lyme) that requires IV antibiotics.

8. A pregnant woman presents with acute photophobia, stiff neck, fever and headache. What is a likely organism?

D. P. falciparum

E. Cryptococcus
8. A pregnant woman presents with acute photophobia, stiff neck, fever and headache. What is a likely organism?

C. Listeria

Pregnancy results in host immunity changes that predispose to infection with Listeria. Cryptococcus is another possibility, but the acute nature of the meningitis suggests a bacterial etiology.

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The End