- HIV (refer)
- Subdural Empyema
- Epidural Abscess
- Bacterial Abscess (from septic emboli or contiguous focus esp ear/sinuses, Dx: stereotactic aspiration of ring enhancing lesion, Tx: surgery esp if >2.5cm, abx w/ ceftriaxone AND flagyl b/c of anaerobic risk, avoid LP b/c of high ICP)
- Encephalitis (consider if a meningitis pt has focal neurologic S/S, main thing is to differentiate encephalitis from encephalopathy)
    - Bacterial
        - Zoonosis (refer)
        - TB (refer)
        - Neurosyphilis (refer)
        - Lyme (refer)
        - Nocardia (refer)
    - Viral (big three)
        - HSV
            - trigeminal ganglion to meninges (hemorrhagic meningitis) to temporal lobe (necrotizing, hemorrhagic, encephalitis) resulting in constitutional S/S + mengismus + memory disturbances, olfactory hallucinations, speech disturbances, seizures
            - Dx: MRI (mesial temporal lobe hyperinsensity), EEG (Periodic Lateralizing Epileptiform Discharges aka PLEDS)
            - Tx: acyclovir
        - Arborvirus
            - Epidemiology: summertime, reservoir (Blue Jays), vector (mosquitos, blood transfusions, organ transplant, breast feeding)
            - Types: Eastern/Western/California/Venezuelan **Equine, La Cross, St. Louis** (transient tremor due to substantia nigra involvement)**, West Nile** (first case in 1999 in New York now widespread in US but was present in Middle East/Europe for several years)
            - S/S: young (subclinical) → adult (meningoencephalitis w/ variable neurologic Sx) → elderly (fatal or w/ significant morbidity)
            - Dx: serum/CSF serology
            - Px: mosquito repellant, no vaccines except for Japanese encephalitis
            - Tx: no effective Tx just supportive care
        - Rabies
            - Unvaccinated Animal Bite / Scratch (dogs, cats, ferrets, raccoons, foxes, skunks, coyotes, bats BUT NOT rodents and non-mammals) or Corneal Transplant → Virus Present in Saliva Infects Human Skin → Pain/Paresthesia at Site → Enters Neuron w/in minutes but Sx do not manifest anywhere from 1d to 1yr w/ avg of 1mo → Prodromal Symptoms (sore throat, fatigue, H, N, V) → Encephalitis (increased excitation of CNS, confusion, combativeness, hyperactivity, seizures, violent muscle contractions) → Hydrophobia (inability to drink water, laryngeal spasm with drinking, hypersalivation resulting in foaming at mouth) → Quadraplegia and Coma → Death (ONCE SYMPTOMS PRESENT DEATH IS INVARIABLE EXCEPT FOR 4 KNOWN CASES)
            - Diagnosis: serum/CSF serology, DFA of Bx of animal, **Negri bodies** (eosinophilic intracytoplasmic inclusions in the Hippocampus and Purkinje Cells)
            - Pre-Exp Px w/ Vaccine (anyone who deals w/ animals and spelunkers)
            - Post-Exp Px/Tx (If WILD animal capture, destroy, and perform immunofluorescence on brain and always Tx vs If DOMESTICATED animal capture and observe for 10d and consider Tx if head/neck otherwise no Tx!!!)
                - Passive Immunization aka Human Rabies Immune Globulin (into wound and gluteal region)
                - Active Immunization aka Vaccine (IM)
        - Other: Enterovrius (Polio, Echo, Coxsackie), VZV, CMV/EBV, HIV, Adenovirus
    - Parasites
        - Neurocysticercosis (ingestion of uncooked pork contaminated w/ *Taenia solium* with tape worm in intestine aka "taeniasis" and then larvae invade various tissues including liver, eye, muscle and CNS creating multiple calcified cysts "cysticercosis", Dx: CSF serology)
        - Baylisascaris (nematode parasite found in raccoon feces, causes an eosinophilic meningoencephalitis, no Tx)
    - Fungi
        - Aspergillus Abscess
        - Candida Encephalitis/Abscess
    - Prion (refer)
    - Post-Vaccination: especially MMR w/in 3mo
    - Systemic: sarcoidosis, vasculitis, paraneoplastic, CVD, etc
- Meningitis

- Microbe colonizes nasopharyngeal mucosa → Invades into CNS via (1) hematogenous, (2) retrograde transport along cranial and peripheral nerves (viral), and (3) contiguous spread from sinusitis, otitis media, surgery, trauma → Leptomeninges (arachnoid and pia mater)
- S/S ("mengismus")
  - Constitutional Sx
  - HA (due to increased ICP 2/2 shear presence of inflammatory and bacterial cells and open communicating hydrocephalus from fibrosis, the same nerves that innervate the meninges are the same nerves that innervate the neck muscles)
  - AMS
  - Photophobia (b/c CN II is the only CN that is bathed in CSF)
  - Focal Deficits (CN Palsy esp deafness, hemiparesis, aphasia, visual field deficits)
  - Seizures
  - **Jolt Accentuation** (turn head = pre-existing H worsens or new H develops)
  - **Nuchal Rigidity** (flex neck = chin cannot touch sternum or pain or resistance is elicited)
  - **Brudzinski Neck Sign** (flex neck = hip flexion)
  - **Kernig Sign** (flex hip then extend knee = pain or resistance is elicited)
- Complications
  - Deafness, Hydrocephalus, Seizures, SIADH, Increased ICP, Abscess, Subdural Empyema (consider if focal neurologic deficits), Epidural Abscess, DIC, Leptomeningeal Venulitis (venous occlusion and hemorrhagic infarcts), Reactive Fibroblastic Arachnoiditis (scarring and obliteration of subarachnoid space resulting in hydrocephalus)
- Dx/Tx Approach
  - Blood Cx (NB once you start abx Gram Stain sensitivity drops from 80% to 50% and Culture sensitivity drops from 75% to 50%)
  - Decadron 10mg IV QID x4days ideally 15min b/f starting abx (steroids attenuate the subarachnoid inflammatory response that occurs after bacteria are killed by abx leading to decreased risk of hearing loss)
  - Empiric Abx (–cidal and good CSF penetration) based on Age/Comorbidities (essentially **Ceftriaxone+Vanc** and **if young/old add Amp** w/ duration varying for 7-21d (NB if pcn allergy cont vanc and d/c ceftriaxone and use **bactrim**, **change ceftriaxone to ceftazidime if immunocompromised or recent surgery**, 10% of Strept is ceftriaxone resistant hence the additional use of vanc)
    - **If >60yo, immunocompromised, new onset seizure, h/o CNS dz, focal deficit, AMS then do a CT before LP to assess increased ICP (hydrocephalus) to reduce r/o herniation (NB herniation can still occur if pt is at high risk and you don't do an LP). Otherwise just proceed w/o CT (NB in most cases CT is already done in ER prior to a doctor doing an LP as part of protocol for any type of CNS problem)**
  - Aseptic Meningitis (culture negative but pleocytosis)
    - Infectious: endemic mycoses, TB, neurosyphillis, Lyme
    - Medications: bactrim, NSAIDs, penicillin, isoniazid, etc
    - Parameningeal Infection: brain abscess, epidural abscess, etc
    - Partially treated septic meningitis
    - NB recurrent aseptic meningitis is called Mollaret's and is usually 2/2 virus esp HSV/HIV/EBV
  - MRI can show meningeal enhancement
  - Chronic meningitis characterized by mild headaches and dementia is often caused by TB, Fungi, Sarcoid, Malignancy, etc
  - GNRs: Klebsiella, Escherichia, Serratia, Psuedomonas (immunocompromised)
  - Staph (recent surgery or head trauma, immunocompromised)

<1mo
Strept. agalactiae (Ceftriaxone/Ceftazidime) *E. coli* (Amp) *Listeria* (Amp)
1mo-50yo
Strept. pneumonia (Ceftriaxone/Ceftazidime/Vanc) • Look for endocarditis/airway infection esp pneumonia, 23% mortality • +vaccination • -prophylaxis *N. meningitides* (Ceftriaxone/Ceftazidime) • Look for Meningoccemia and Waterhouse Friderichsen Syndrome, 8% mortality • +vaccination • +prophylaxis for those w/ intimate oral contact (rifampin/cipro/ceftriaxone) *H. influenza* (Ceftriaxone/Ceftazidime) • Rare • +vaccination • +prophylaxis for those w/ ? (rifampin)
>50yo/Immunocompromised

Strept. Pneumonia (Ceftriaxone/Ceftazidime/Vanc)
N. meningitides (Ceftriaxone/Ceftazidime)
Listeria (Amp)

- Look for recent ingestion of milk products, also associated w/ alcoholism, malignancy, DM, hepatic dz, renal dz, iron overload, pregnancy, HIV
- -vaccination
- -prophylaxis

	Normal	Septic	Fungal	Aseptic	TB
Appearance Blood • Constant Over 4 Tubes / Xanthochromic Supernatant (SAH) • Decreases Over 4 Tubes / Clear Supernatant (Traumatic Tap) also RBC:WBC is <1000:1	Clear	Purulent	Purulent	Clear	Purulent
Consistency • Viscous: Meningitis, Elevated Protein	Thin	Viscous	Viscous	Viscous	Viscous
WBC • >200 = turbid • High: tumor, sarcoid, lupus, seizure, peds pts	<5	100-10,000	<300	<300	<500
Differential	Lymph/Monocytic	Neutrophilic Pleocytosis	Lymphocytic Pleocytosis	Lymphocytic Pleocytosis	Lymphocytic Pleocytosis
RBC (>400 = turbid) • High: HSV Encephalitis, MS, SAH, Traumatic Tap	<5	Normal	Normal	Normal High (HSV)	Normal
Opening Pressure (must do w/ pt laying flat) • Low: Dehydration, Dural Leak, Hyperosmolality, peds pts • High: CHF, Hyposmolality, Masses, Meningitis, Psuedotumor Cerebri, SAH, Venous Sinus Thrombosis	9-18 cmH_2O	>18	>18	Normal	>18
Glucose • Low: bacteria, fungus, TB, SAH carincomatous meningitis • High: DM, Traumatic Tap	2/3 of serum level	<40	<40	Normal	<40
Protein • Low: Dural Leak • High: Meningitis, Mass, Polyneuropathy, DM, GBS, ICH, SAH, peds pts	15-45 mg/dL	100-1000	45-300	50-100	100-200