Coma & Meningitis

Learning Objectives

- Definitions & terminology
- Etiologies
- Evaluation
- Initial management

What is coma?

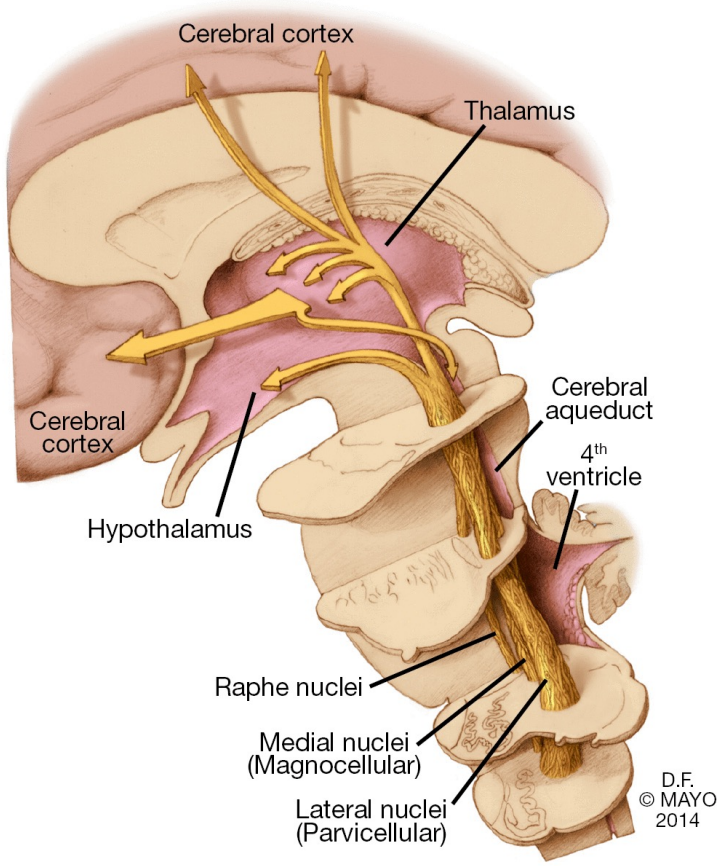
- Greek (koma) → deep sleep
- Definition → unarousable unresponsiveness + eyes closed

States of Arousal

- Alert → aware of self and surroundings
- Avoid "Confusion," "Lethargy," "Stupor"
  - Be descriptive
- **Coma → cannot be aroused by external stimuli or inner need**

→ Acute alteration in arousal → emergency

Anatomy of Arousal



Coma → dysfunction of:

- Upper brainstem
- B/L thalami
- B/L cerebral hemispheres

Chapter: Impaired Consciousness and Coma
Author(s): S. Arthur Moore and Eelco F. M. Wijdicks
From: Mayo Clinic Neurology Board ReviewClinical Neurology for Initial Certification and MOC: Clinical Neurology for Initial Certification and MOC

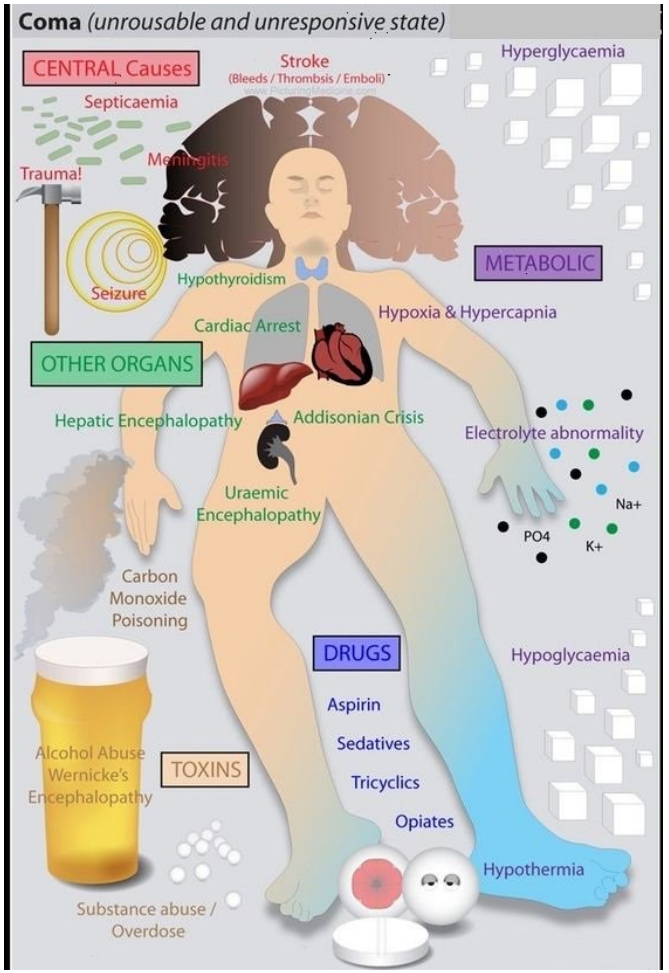
Etiologies of Coma

- **Non-Structural: Toxic/Metabolic/Infectious**
  - >50%
  - symmetric presentation
- **Structural**
  - cerebral lesion
  - asymmetric (focality)

- Psychiatric
  - Diagnosis of exclusion

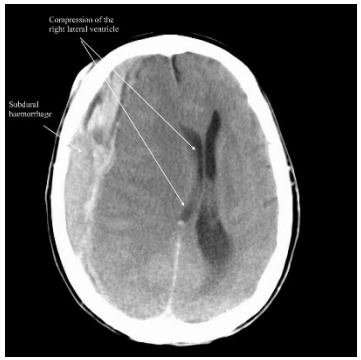
→ History/exam (& repeat exams) → differentiate between causes

→ Multifactorial

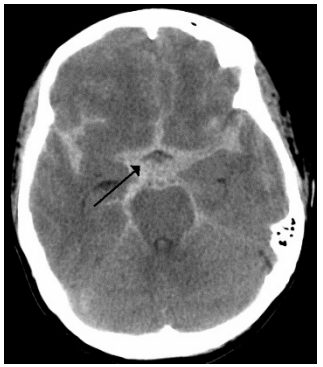


Non-Structural

- Toxic
  - Sedatives
  - Anticholinergics
  - Opiates, Barbituates
  - ETOH
  - Poisoning
    - Lead, CO, Methanol
- Infections
  - Meningoencephalitis
  - Sepsis
    - UTI
    - PNA
- Metabolic
  - ↑ or ↓ Temp
  - Hypoxia
  - Hypercapnia
  - ↑ or ↓ Glucose, Na, Ca
  - ↑ Mg
  - Uremia, ↑ Ammonia
  - Hypothyroidism



Structural



- Asymmetric Presentation
  - Unilateral hemispheric mass lesion + herniation
  - Brainstem lesion
  - ➢ Ischemic stroke, ICH/SDH
- Symmetric Presentation
  - ➢ SAH***
  - ➢ Hydrocephalus***
  - ➢ Cerebral venous thrombosis***
  - ➢ Basilar occlusion
  - ➢ Midline brainstem lesion

Approach to Coma

- ABCs + Glucose

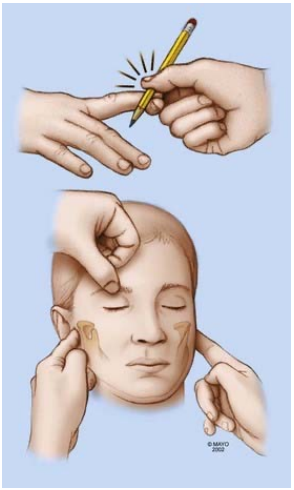
- History
  - Collateral
  - Time course of LOC? (abrupt, gradual, fluctuating)
  - Focal symptoms/signs precede LOC?
  - Prior neurologic hx? Recent illness? PMH?
  - Med list? Toxic habits?

Exam

- General Exam
  - Vitals
    - Ventilation pattern
  - Neck stiffness
  - HEENT, skin/mucosal, CV, pulm, abd
- Neuro
  - LOC
  - Brainstem reflexes
  - Sensorimotor response
  - Reflexes

Level of consciousness

- Describe spontaneous behavior + responses to stimuli
  - Stimulation
    1. Loud vocal commands
    2. Shoulder shaking, trapezius squeeze
    3. Noxious stimulation
       - Supraorbital ridge pressure
       - TMJ compression
       - Nailbed pressure



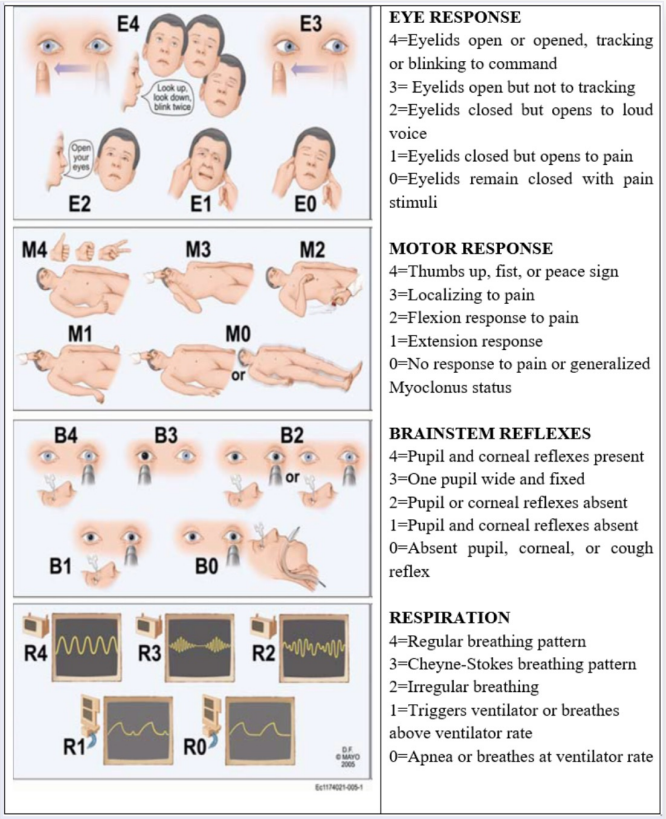
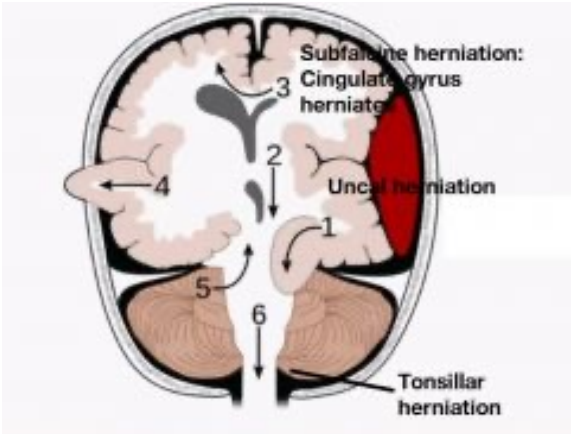


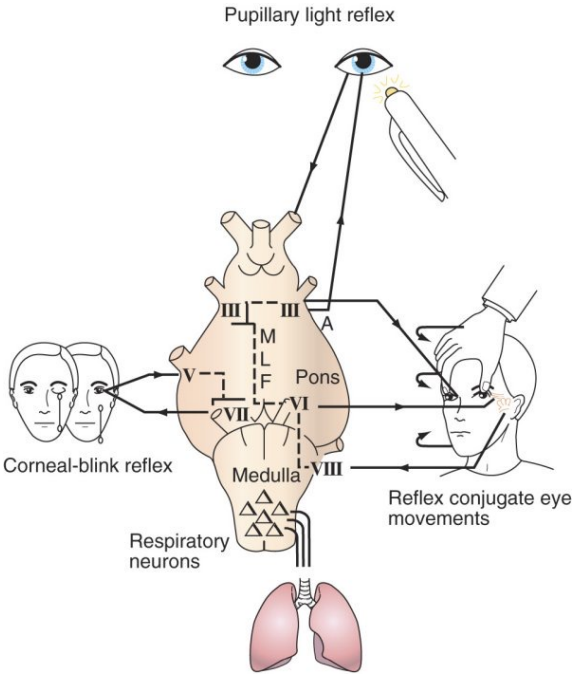
Figure 1: **The FOUR scale.**

Ann Neurol. 2005 Oct;58(4):585-93.

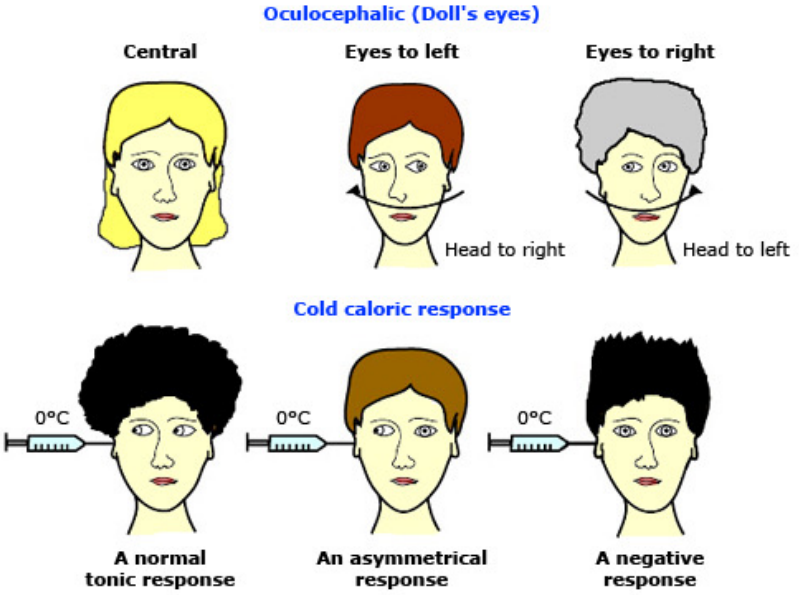
Brainstem Reflexes

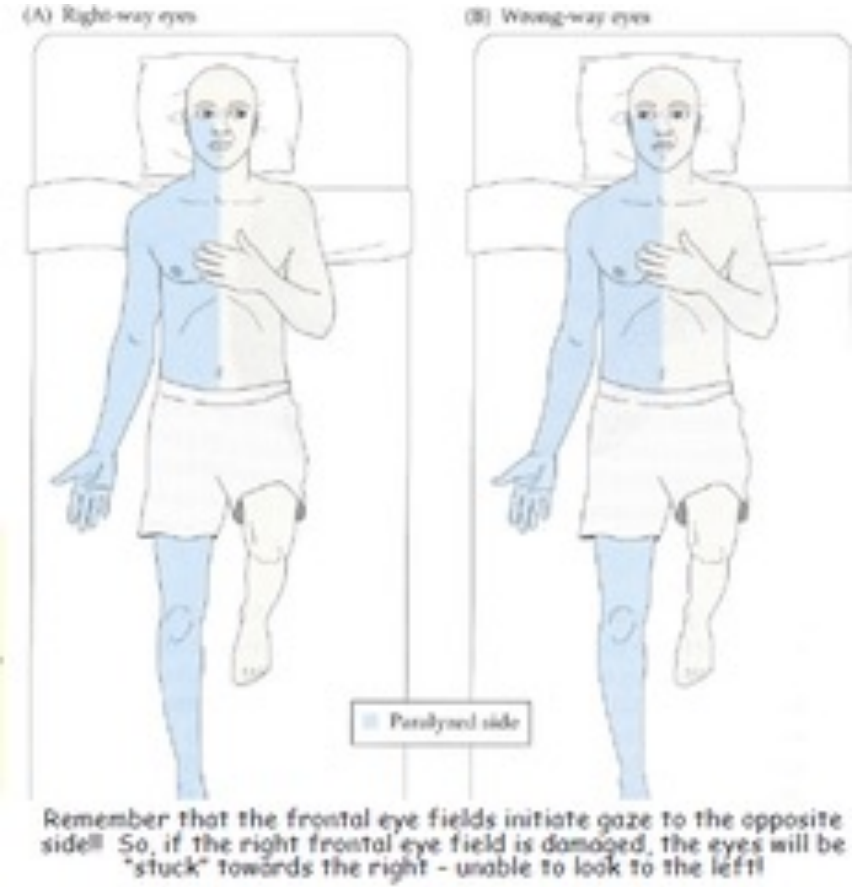
- Pupillary light reflex (CN 2,3)
  - Impairment → Dilation
    - Herniation
    - Brainstem Lesion
  - State size & reactivity
    - *L pupil 6 mm and non-reactive, R pupil 5 mm → 3 mm*
  - Sedatives can affect reactivity
  - Pinpoint pupils
    - Opiate overdose
    - Disruption of descending sympathetic outflow (pontine pupils)
- Funduscopic exam
  - Papilledema



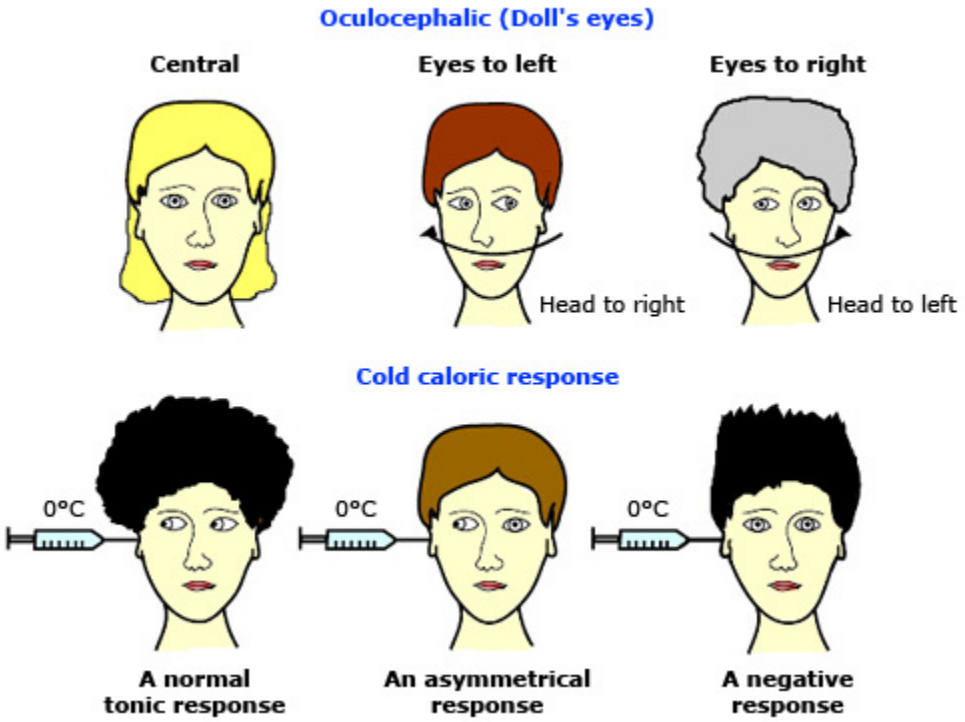


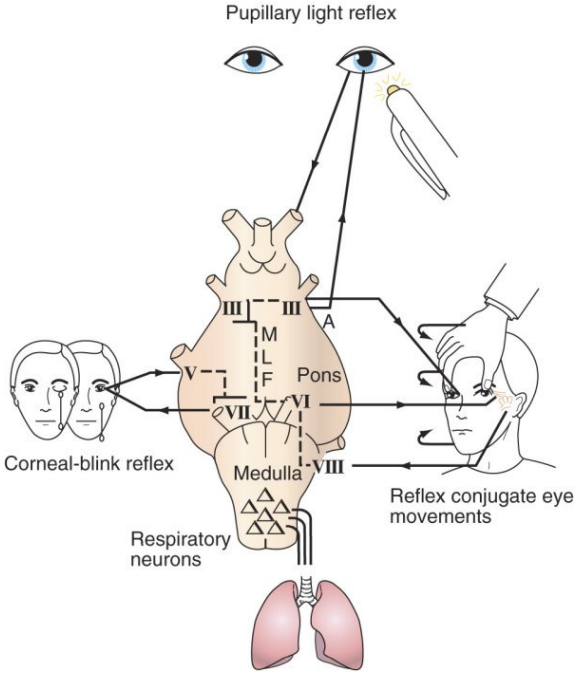
- Eye Movements (CN 3,4,6)
  - Eye position
    - Deviation
    - Dysconjugate
    - Nystagmus
  - Oculocephalic reflex
    - C-spine cleared?



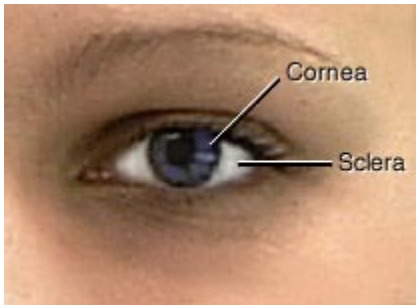


- Caloric testing of OCR
  - Stronger stimulus
  - Tympanic membrane intact?
  - Syringe with catheter + >50 cc ice water → deviation of both eyes toward stimulated ear

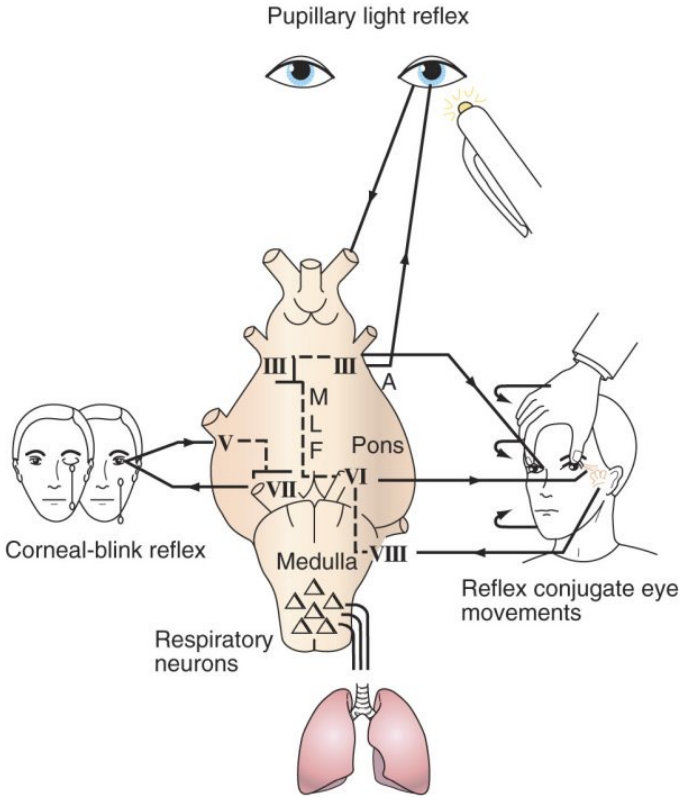




- Corneal reflex (CN 5,7)
  - Touch edge of cornea → blink

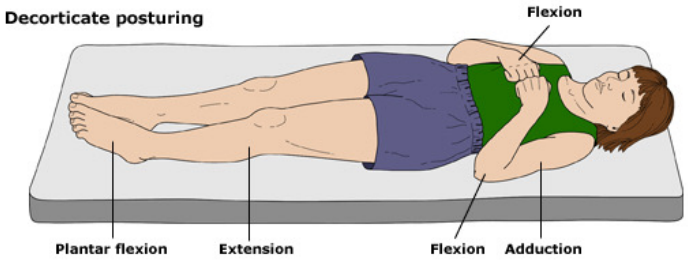


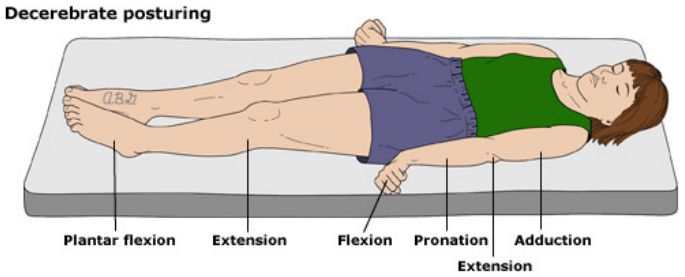
- Gag reflex (CN 9,10)
  - Touch posterior pharyngeal wall → elevation of soft palate + pharyngeal muscle contraction

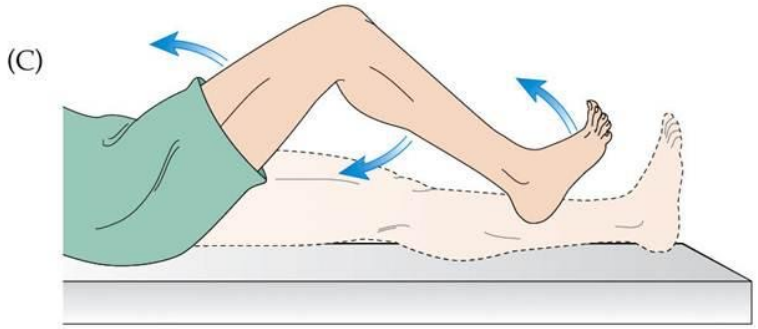


Sensorimotor Response

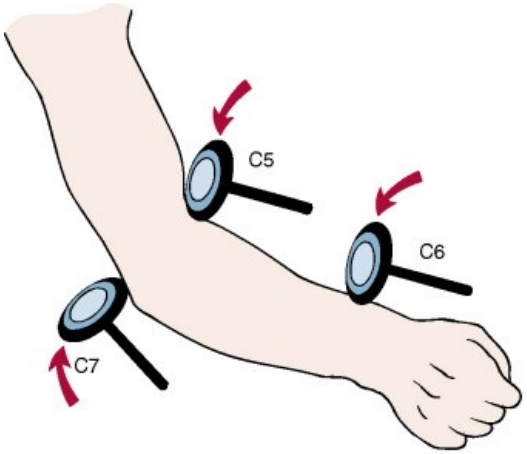
- Muscle tone
- No spontaneous movement → noxious stimulation
  - Purposeful (withdrawal away from stimulus)
  - Posturing
  - Reflexive
  - Abnormal movements

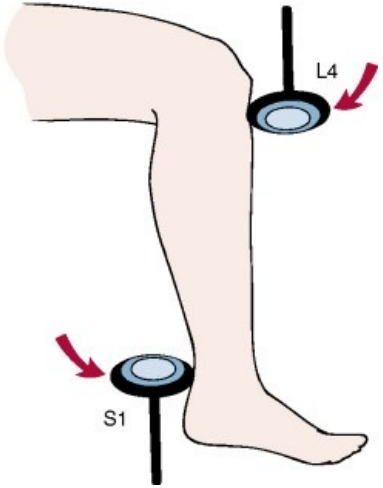


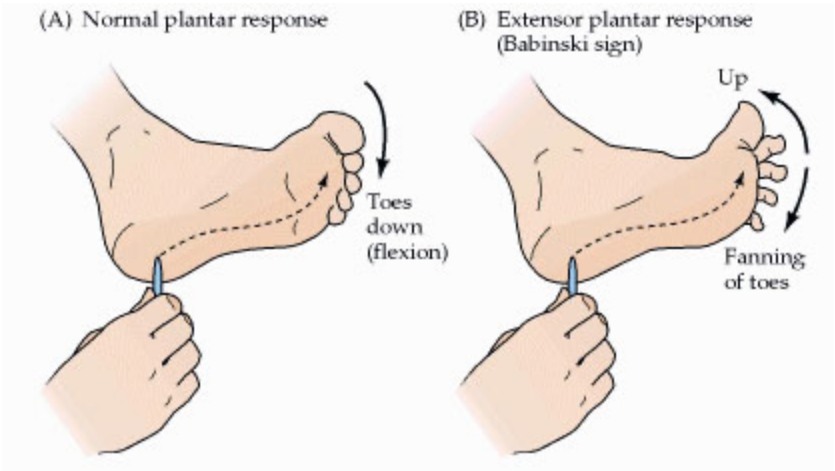


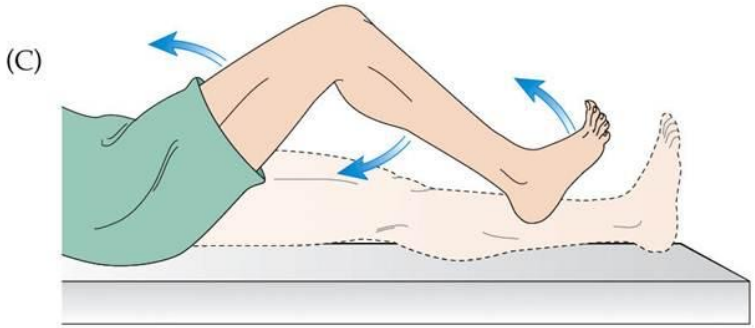


Reflexes





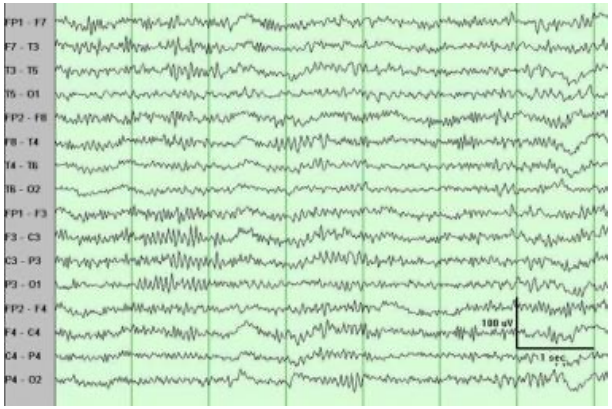




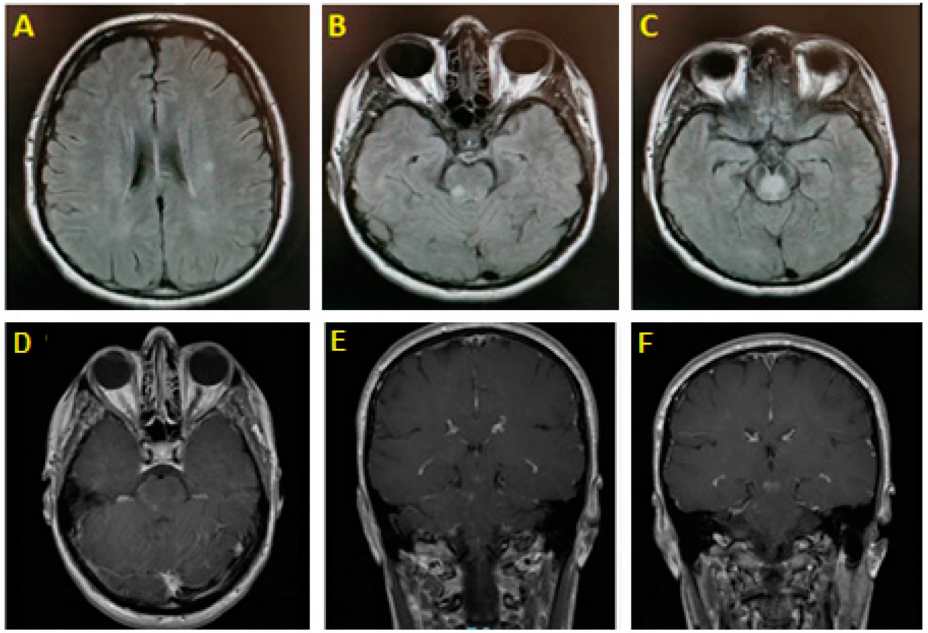
Diagnostic Approach

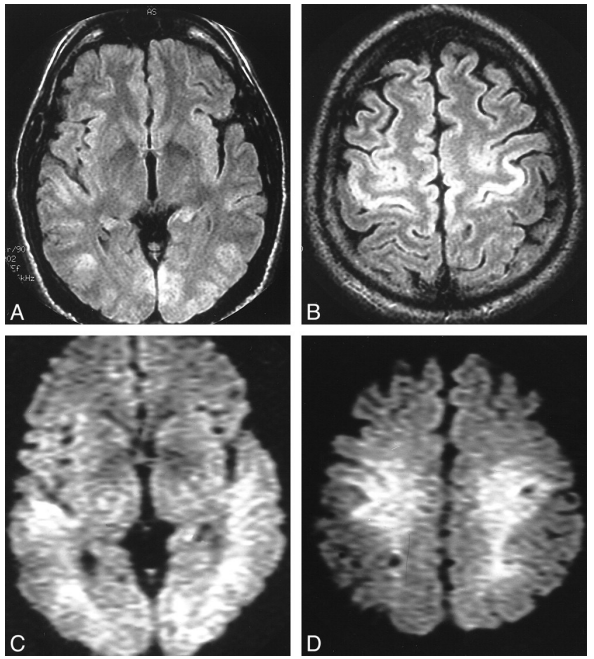
- ABCs + Glucose
- History/Exam
- HCT & Labs
  - focality, fever, papilledema → STAT HCT
  - CMP, CBC, Coags, Lactate
    - ABG, Ammonia, Cultures, Tox
  - Acute onset → CTA head
  - Fever → CT and then LP
  - Seizure(s) → EEG

* Life-threatening & treatable causes



- Initial evaluation unrevealing →
  - MRI brain
  - Prolonged EEG monitoring
  - Serum drug levels, TSH/FT4, poisoning





AJNR Am J Neuroradiol. 2001 Sep;22(8):1561-5.
J Clin Med. 2021 Jul 1;10(13):2970.

Management

- ABCs
  - Stabilize C-spine
  - GCS<8 → intubation
  - Treat hypotension (MAP<70mm Hg), fever, hypo-/hyperglycemia

* Empiric thiamine (before D50)

  - Overdose
    - Narcotic → naloxone
    - Benzo → flumazenil
  - Herniation → mannitol
  - Seizure → benzodiazepine + phenytoin/fosphenytoin
  - CNS infection → vancomycin/ceftriaxone + acyclovir
    - Blood cx + empiric treatment

Mimics of Coma

- Locked-In Syndrome
  - alert/aware, vertical eye movements & blink preserved
  - quadriplegic, lower cranial nerve palsies
    - horizontal gaze palsy
    - facial diplegia
    - palate/tongue weakness
  - ventral pontine lesion
    - ➢basilar artery thrombosis
    - ➢central pontine myelinolysis
    - ➢mass lesion

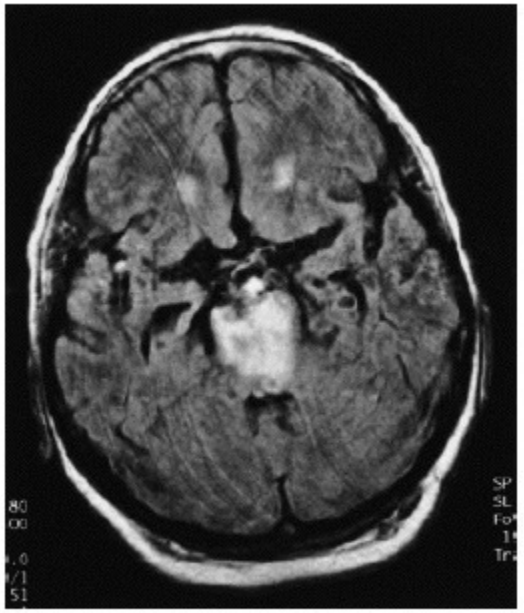
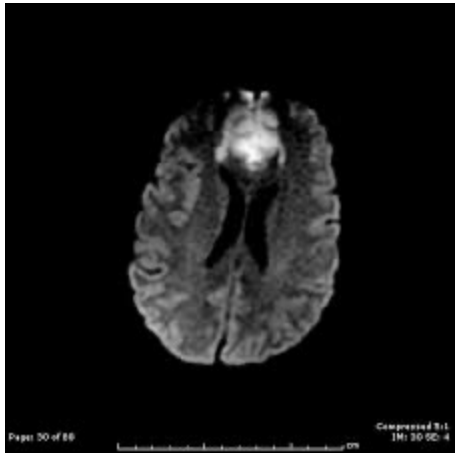


Fig. 3. T2-weighted axial MRI showing massive and bilateral pontine infarction.

Mimics of Coma

- Persistent Vegetative State
  - loss of awareness & cognitive function
  - vegetative fxn (cardiorespiratory drive) preserved
- Premotor/Prefrontal Pathology
  - akinetic mutism or abulia
  - impaired motor initiation/planning
- Catatonia, Psychogenic
  - EEG
  - cold calorics



Checklist for the Evaluation of Acute Coma

History

- Sudden onset? Witnessed onset?
- Previous level of function
- Comorbid conditions
- Medications and toxic exposures
- Previous episodes of altered consciousness?
- Location (out of hospital, hospital floor, intensive care unit)

Physical Examination

- Vital signs
- Brainstem reflexes
- Funduscopy
- Motor responses to pain
- Lateralizing or other focal findings?
- Meningeal signs?
- Adventitious movements?

Blood (and Urine) Tests

- Glucose, electrolytes, blood urea nitrogen/creatinine, complete blood cell count
- Consider pH, $PaCO_2$, liver enzymes, ammonia, ethanol, toxicologic screen (urine and sometimes serum), levels of prescribed drugs, thyroid-stimulating hormone (TSH), cortisol
- Infectious workup (when pertinent)
- Autoimmune encephalitis panel (when pertinent)

Brain Imaging?

- Brain parenchyma (CT versus MRI)
- Brain vessels (arteries, veins)

Lumbar Puncture?

- Glucose, protein, nucleated cells
- Infectious workup (when pertinent)
- Autoimmune encephalitis panel (when pertinent)

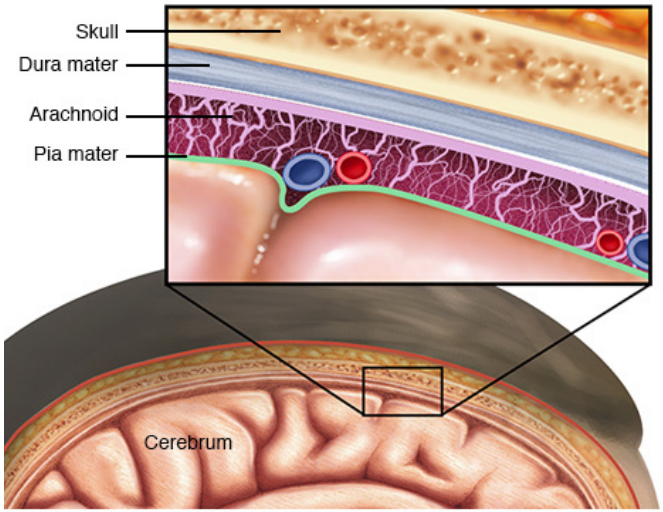
EEG?

- Spot versus continuous

Meningitis

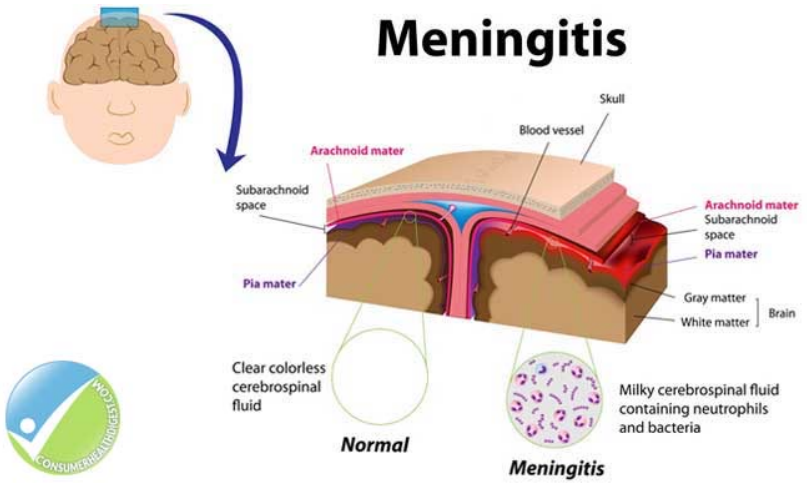
- Inflammation of meninges
  - Arachnoid, Pia (leptomeningitis)
  - Dura (pachymeningitis)

- **Infectious (LM)**
- Autoimmune (PM)
- Medications
- Neoplasm

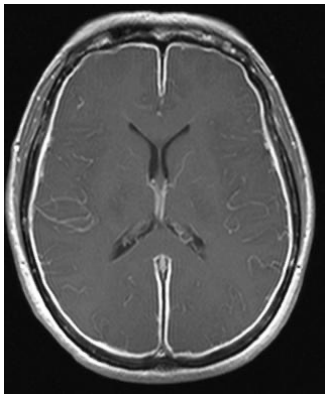


Clinical Features

- Fever
- Meningismus
  - Kernig/Brudzinski → specific, NOT sensitive
- Altered mental status
  - meningoencephalitis



* <50% have all 3 features



Etiology

Acute

- Bacterial
  - Community-acquired
    - Streptococcus pneumoniae
    - Neisseria meningitidis (purpuric rash)
    - Listeria monocytogenes
      - >50 years, cell-mediated immunity deficiency
  - Healthcare-associated / Trauma
    - Staphylococci
    - Aerobic GNR
- Viral
  - HSV
  - VZV
  - Enterovirus
  - Arboviruses, HIV

Subacute/Chronic

- TB
- Fungal
  - Cryptococcal, Coccidiodes, Histoplasma, Blastomyces, Candida
- Neoplastic
  - carcinomatosis
- Autoimmune
  - Sarcoidosis, SLE

- ➢ Syphilis, Lyme, Parasites
- ➢ Drug-induced (NSAIDs, IVIG)

Evaluation

- CBC, BMP, Coags
- Blood Cx
- LP
  - CT before LP:
    - ↓ LOC or focal deficit
    - ↑ ICP or new seizure
    - Immunocompromised
  - Delay → blood cx & empiric tx
  - Opening pressure, cell count, glucose, protein, gram stain, cultures

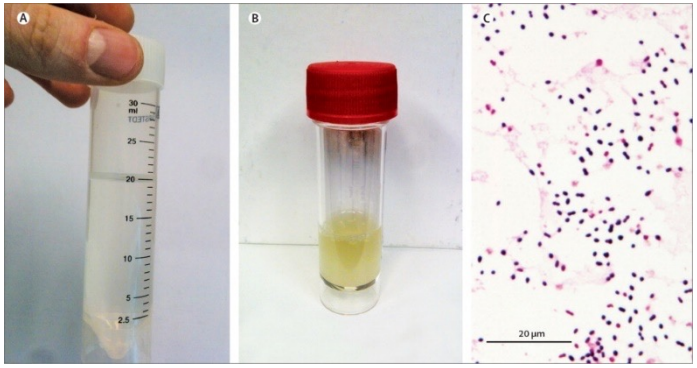


Table 2. Cerebrospinal Fluid Findings In Central Nervous System Infections[3]

Infection	White Blood Cell Count (cells/mL)	Glucose Level	Protein Level
Bacterial Meningitis	Elevated (100-5000) Polymorphonuclear leukocytes predominate*	Decreased	Elevated
Viral Meningitis	Elevated (10-500) Lymphocytes predominate	Normal	Elevated
Fungal Meningitis	Normal to elevated (0-500) Lymphocytes predominate	Normal to decreased	Elevated
Tuberculous Meningitis	Normal to elevated (0-1000) Lymphocytes predominate	Decreased	Elevated
Brain Abscess	Normal to elevated (0-500) Mixed differential	Normal	Elevated

Note: In 10% of cases, lymphocytes predominate - see the **Lumbar Puncture** section on page 8 for details.

Management

- Empiric treatment → vancomycin/ceftriaxone + acyclovir
- Bacterial
  - Acute community-acquired → Vanc/CTX
    - Amp: >50 years, immunocompromised
  - NSGY/trauma → Vanc + Cefepime/meropenem

* Dex → mortality benefit in S. Pneumoniae

Complications (bacterial)

- Seizures
- Infarction
  - infectious vasculitis
- CVST
- Cerebral Edema & ↑ ICP
- Abscess

- Chronic → hydrocephalus, hearing loss, epilepsy, cognitive impairment