# Neurology:

Edited by Robert D. Harbaugh, MD, Neurologist.

Contents: Neuro Exam: Weakness Disorders; Peripheral Neuropathy; Brachial Plexus; Movement Disorders; Parkinson’s.

Dz: Spells; Seizures; Strokes; Cephalgia (H-Ac) Comp; Cervical-Lumbar Pain; Pseudo-Neurologic Syndromes; Various Other Neuro: Diagrams; Preamble & Abbrev & Labs: 06 DEC 02.

Written by Carl G. Weber MD, board certified, Internal Medicine. Any feedback is appreciated: CGWEBER@POL.NET. This clinical file has been licensed for a single user only. If have a copy of this and did not personally purchase it, then it is pirated.

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## The Neurology Exam:


Basic Neuro Hx: “OPQRST” :

Onset (and evolution).

Provocation (exacerbating and relieving factors).

Quality. Radiation/site). Severity (best, worst, average, current on 1-10 scale),

Time (constant, intermittent, predictable).

Other: Prior tx’s, current meds, drugs/ETOH use, how pain interferes with life, why seek treatment now, patient’s ideas as to cause.

Neurology Pearls:

#1 Ask the basic questions: Is it neurologic? Where is it in the nervous system? What is the pathophysiology? What can we do about managing the problem?

#2 “History is everything”: take another history if uncertain (“the second visit rule”); interview observers before establishing a working diagnosis; use the patient’s own words in describing symptoms (diagnosis comes later). MSE can be incorporated into the Hx by asking questions about ADLs’, are they reading, writing, balancing check book.

#3 Use neurological localization tools in making a diagnosis. Most serious or threatening neurological disorders follow anatomic and physiologic principles of localization and function; however, human diversity exists and “outliers” are not uncommonly encountered. Embellishment is common, it doesn’t necessarily reflect malingering. Use objective test (reflexes) to confirm subjective abnormalities.

#4 Always think of the most threatening diagnoses, but do not feel compelled to pursue an exhaustive investigation unless clinical grounds support such... consider “following” the challenging patient with a slowing evolving disorder once reasonable diagnostic efforts have been exhausted (e.g. indolent neuropathy, dementia, subjective numbness, etc.)

#5 Customize the neurologic exam – the exam serves to 1) confirm or exclude suspected deficits by the history; 2) unearth subclinical signs (e.g. Babinski sign); 3) provide a baseline for future comparisons. Taylor the exam to the complaint. Use the pt’s own body as the control by comparing L-to-R.

#6 A few words about therapeutics: 1) there is no fixed dosing for any primary neurological disorder – thus, titration to optimal efficacy is always performed – “start low, go slow, but don’t stop”: 2) again, human diversity has led to a need for rational therapeutic trials for many neurological disorders: 3) always define your therapeutic goals with the patient – reassess if the goals are not met.

#7: The Neuro Differential:


Metabolic Degenerative/ Demyelinating.

Remember: Atypical presentations of common things are still common!

## The 2-Minute Neuro Exam:

For the young & healthy to r/o significant dz.

**Observation during interview:** arousal, speech, language, mood, behavior, vision, hearing, cognition, memory, thinking, personality, facies, grooming, tics, mannerisms, movements, postures, pain behaviors, signs of acute distress (pallor, edema, respirations).

**Step #1:** Stand with feet together, arms out in front, palms up, eyes closed; look for drift/ sway/ unsteadiness.

**Step #2:** “Close eyes tightly”; look for weakness/ asymmetry. “Touch your nose with each outstretched hand”. 

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<td>Basic Neuro Hx: “OPQRST”</td>
<td>ONSET (AND EVOLUTION), PROVOCATION (EXACERBATING AND RELIEVING FACTORS), QUALITY. RADIATION/SITE, SEVERITY (BEST, WORST, AVERAGE, CURRENT ON 1-10 SCALE), TIME (CONSTANT, INTERMITTENT, PREDICTABLE). OTHER: PRIOR TX’S, CURRENT MEDS, DRUGS/ETOH USE, HOW PAIN INTERFERES WITH LIFE, WHY SEEK TREATMENT NOW, PATIENT’S IDEAS AS TO CAUSE. NEUROLOGY PEARLS: #1 ASK THE BASIC QUESTIONS: IS IT NEUROLOGIC? WHERE IS IT IN THE NERVOUS SYSTEM? WHAT IS THE PATHOPHYSIOLOGY? WHAT CAN WE DO ABOUT MANAGING THE PROBLEM? #2 “HISTORY IS EVERYTHING”: TAKE ANOTHER HISTORY IF UNCERTAIN (“THE SECOND VISIT RULE”); INTERVIEW OBSERVERS BEFORE ESTABLISHING A WORKING DIAGNOSIS; USE THE PATIENT’S OWN WORDS IN DESCRIBING SYMPTOMS (DIAGNOSIS COMES LATER). MSE CAN BE INCORPORATED INTO THE HX BY ASKING QUESTIONS ABOUT ADL’S, ARE THEY READING, WRITING, BALANCING CHECK BOOK. #3 USE NEUROLOGICAL LOCALIZATION TOOLS IN MAKING A DIAGNOSIS. MOST SERIOUS OR THREATENING NEUROLOGICAL DISORDERS FOLLOW ANATOMIC AND PHYSIOLOGIC PRINCIPLES OF LOCALIZATION AND FUNCTION; HOWEVER, HUMAN DIVERSITY EXISTS AND “OUTLIERS” ARE NOT UNCOMMONLY ENCOUNTERED. EMBELLISHMENT IS COMMON, IT DOESN’T NECESSARILY REFLECT MALINGERING. USE OBJECTIVE TEST (REFLEXES) TO CONFIRM SUBJECTIVE ABNORMALITIES. #4 ALWAYS THINK OF THE MOST THREATENING DIAGNOSES, BUT DO NOT FEEL COMPELLED TO PURSUE AN EXHAUSTIVE INVESTIGATION UNLESS CLINICAL GROUNDS SUPPORT SUCH... CONSIDER “FOLLOWING” THE CHALLENGING PATIENT WITH A SLOWING EVOLVING DISORDER ONCE REASONABLE DIAGNOSTIC EFFORTS HAVE BEEN EXHAUSTED (E.G. INDOLENT NEUROPATHY, DEMENTIA, SUBJECTIVE NUMBNESS, ETC.) #5 CUSTOMIZE THE NEUROLOGIC EXAM – THE EXAM SERVES TO 1) CONFIRM OR EXCLUDE SUSPECTED DEFICITS BY THE HISTORY; 2) UNEARTH SUBCLINICAL SIGNS (E.G. BABINSKI SIGN); 3) PROVIDE A BASELINE FOR FUTURE COMPARISONS. TAYLOR THE EXAM TO THE COMPLAINT. USE THE PT’S OWN BODY AS THE CONTROL BY COMPARING L-TO-R. #6 A FEW WORDS ABOUT THERAPEUTICS: 1) THERE IS NO FIXED DOSING FOR ANY PRIMARY NEUROLOGICAL DISORDER – THUS, TITRATION TO OPTIMAL EFFICACY IS ALWAYS PERFORMED – “START LOW, GO SLOW, BUT DON’T STOP”: 2) AGAIN, HUMAN DIVERSITY HAS LED TO A NEED FOR RATIONAL THERAPEUTIC TRIALS FOR MANY NEUROLOGICAL DISORDERS: 3) ALWAYS DEFINE YOUR THERAPEUTIC GOALS WITH THE PATIENT – REASSESS IF THE GOALS ARE NOT MET. #7: THE NEURO DIFFERENTIAL: “VINDI ITCH MD”--&gt; VASCULAR, INFECTIONOUS, NEOPLASTIC, DRUGS, IMMUNE. IDIOPATHIC, TRAUMA/ TOXIC, CONGENITAL, HEREDITARY. METABOLIC DEGENERATIVE/ DEMYELINATING. REMEMBER: ATYPICAL PRESENTATIONS OF COMMON THINGS ARE STILL COMMON!</td>
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Step #3: Open eyes, follow my finger with your head held still: look at tracking and pupils.
Step #4: Sit pt on table: Check fundi, Check reflexes, look for Babinski sign.
Other: draw intersecting pentagons, check proximal muscle strength.

**Cranial Nerves:**

Most cases are examined by merely observing the patient. Pay special attention to the ocular fundus it is a window to the brain to directly assess the bodies vasculature. Check VA by reading the print on a 4X4 or alcohol prep at 15-18 inches. Compare visual fields by finger counts in each 4 quadrants of each eye. Use the whisper test to check hearing. Stick out tongue and say “Ah”, move neck from side to side against mild resistance, shrugged shoulders.

1 (Olfactory) = smell.
2 (Optic) = Acuity, fields, fundi. See Ophthalmology section.
3 (Oculomotor) = eye movement, pupils, eyelid opening.
4 (Trochlear) = Sup oblique m.
5 (Trigeminal) = muscles of mastication, tooth sensation, facial sensation, corneal reflex (sensory component).
6 (Abducens) = lateral rectus m for lateral gaze.
7 (Facial) = fascial expression, ant 2/3 of tongue taste, salivation, tearing, hyperacusis (stapedius).
8 (Acoustic) = hearing, equilibrium. Rub your fingers together on one side while moving the fingers noiselessly on the other. Ask the patient to tell you when and on which side they hear the rubbing. If abnormal, proceed with the Weber and Rinne tests. Test for lateralization (Weber) and compare air and bone conduction (Rinne), use a 512 Hz or 1024 Hz tuning fork. See ENT section.

9 (Glossopharyngeal) = motor of pharynx (Gag), taste to posterior 2/3 of tongue.
10 (Vagus) = motor to vocal cords, heart, GI. Sensory to bronchus, heart, GI, larynx, ear. visceral parasympathetic, larynx, taste. Listen to the patient's voice (hoarse or nasal), ask patient to swallow, ask patient to say "Ah". Watch the movements of the soft palate and the pharynx. Test gag reflex.
11 (Accessory) = trapezius and SCM m. Look for atrophy or asymmetry of the trapezius muscles, ask patient to shrug shoulders against resistance or “touch your ear with your shoulders”.
12 (Hypoglossal) = motor to tongue and neck strap muscles. Listen to the articulation of the patient's words, “stick out your tongue” and move tongue from side to side.

**Sensory Exam:**

**Links:** Basics: Upper-front Dermatomes & Cutaneous nerves: Lower-back Dermatomal Testing: Neuro Levels: Sensory Patterns:

Upper-front Dermatomes & nerves:

![Diagram](image_url)

Upper-back Dermatomes & Cutaneous nerves:
Basics: Least reliable part of the evaluation as it is unfortunately, always subjective and difficult to quantify. Use the sensory exam to clarify clinical hypotheses posed by the history and other elements of the exam. First have the pt outline the area of
loss. The patient's eyes should be closed during the actual testing. Compare symmetrical areas on the two sides of the body. Also compare distal and proximal areas of the extremities, recognizing better discrimination is found distally, hands more sensitive than feet. Articulate persons can usually discriminate areas/ regions of altered sensation, excepting those with non-dominant parietal lesions (e.g. anosognosia).

**Stocking-glove hypesthetic:** peripheral neuropathy.

**Mixed sensory/ opposite motor:** partial transection of spinal cord (Brown-Sequard lesion).

**Dermatomal Testing:** If vibration, position sense, and subjective light touch are normal in the fingers and toes you may assume the rest of this exam will be normal.

**Pain:** Break shaft of CTA. Some recommend saying “Does it feel the same” as touch multiple areas in rapid succession rather than have them cogitate over slight differences. “Sharp and dull pain discrimination”. Test the following areas:
- Shoulders (C4), forearms (C6 and T1), thumbs and little fingers (C6 and C8), front of both thighs (L2), calves (L4 and L5), little toes (S1), Map out the region of numbness. (nerve, root or stocking distribution).

**Temperature sensation:** Cold: use a tuning fork, compare both sides body in 6 places (face vs hand vs face), very reproducible.

**Warm:** heat under tap water. Compare UE and LE.

**Light Touch:** use a cotton wisp or your finger lightly brushed on pt’s skin, ask the patient to respond whenever a touch is felt, compare bilaterally. Ask the p to tell you if there is difference from side to side or other “strange” sensations.

**Vibration senses:** 128 Hz tuning fork, have pt tell you when it stops vibrating, compare your own response. If vibration sense is impaired proceed proximally. Like position sense, it evals dorsal columns and lemniscal system. Throw in a “test” with a non-vibrating tuning fork first to ensure that the patient is responding to the correct stimulus.

Test the pt’s DIP joint of index fingers and big toes, then as needed test wrists, elbows, malleoli, patella, anterior superior iliac spines, spinous processes, clavicles. Sensitive for peripheral neuropathy.

**Joint position sense (Proprioception):** hold distal digit at sides with your finger and thumb. Move up/ down. Hold the digit away from the other toes to avoid friction. First show the patient “up” and “down”, the have them close eyes and identify the direction you move the toe. Most normal patients can identify movements of a few degrees or less. If abnormalities are detected, proceed to more proximal joints in the same limb until a joint is found where position sense is intact. If impaired move proximally to ankle/ wrist/ elbow. Mechanoreceptors include Ruffini endings (joint capsule & ligaments), Pacinian corpuscles (quick adaption, in joint capsule), muscle spindle receptors (tendons) and Golgi tendon organs (tendons).

**Two Point Discrimination:** Use in situations where more quantitative data are needed, such as following the progression of a cortical lesion. Use an opened paper clip to touch the patient's finger pads in two places simultaneously. Alternate irregularly with one point touch. Ask the patient to identify “one” or “two.” Find the minimal distance at which the patient can discriminate.

**Graphesthesia:** perception of large figures (numbers) drawn on the skin. Pt closes eyes, write 4cm high numerals on the skin. Pt closes eyes, write 4cm high numerals on trunk/ pain/ dorsal of hand with blunt point. Ask the pt to identify the number.

**Stereognosis:** An alternative to graphesthesia. Place objects (coin, wood, stone, cloth, pencil, paper clip) in pt’s hand for identification. Looks for cortical dz.

**Paresthesias:** Central: CVA, TIA, tumor, trauma, brain abscess, encephalitis, SLE, B12 def, MS.

**Peripheral:** neuropathy.

**Neurological Levels:**

- **Spinal Level/ Muscle Action/ Sensory:**
  - C2: Moves Neck (C1-4), **Sensory Area**→ Occiput.
  - C3: Spontaneous Breathing→ Diaphragm.
  - C5: **Sensory Area**→ Thyroid Cartilage.
  - C6-8: Blink→ Frontal hairline.
  - **Sensory Area**→ Xiphisternum.
  - T1-2: **Sensory Area**→ Umbilicus.
  - T12-L1: **Sensory Area**→ Inguinal ligament.
  - L1: **Sensory Area**→ Gluteus maximus.
  - S1: **Sensory Area**→ Gluteus minimum.
  - L2: Thigh/ hip flexion→ Iliopsoas.
  - L3: Knee Extension→ Quadriceps.
  - L4: Great toe dorsiflexion→ E. hallucis longus. **Sensory Area**→ Lateral calf.
  - S1: Ankle plantar flexion→ Gastrocnemius. **Sensory Area**→ Lateral heal.
  - S2: Sphincter tone→ Perineum/ Anal Sphincter.
  - S4-5: Sensory Area→ Perianal area.

**Neurological Patterns:**

- **Incomplete Cord Injury:** Spinal Cord Injury.
Weber Syndrome: Hemiplegia with contralateral paralysis of oculomotor nerve secondary to a lesion in the cerebral peduncle.

Mid Brainstem Lesion: Ipsilateral facial loss of sensation with contralateral paralysis of body.

Thalamic Lesion: Contralateral sensory loss of face & body.

Brown-Sequard Syndrome: Unilateral hemisection of spinal cord causing ipsilateral motor and sensory (dorsal column) deficit with contralateral spinothalamic loss (pain & temp).

Unilateral Dorsal Column Lesion: Loss of ipsilateral proprioception and some touch.

Central Cord Lesion: Cape-like distribution loss of spinothalamic system.

Right Pons Lesion: Weakness of masseter m., facial anesthesia on right. Weakness of arm, leg and lower facial muscles.

Left Midbrain Lesion: Ptosis, dilated pupil with difficulty adducting eye on left. On right have lower facial paralysis and spastic paralysis of all both upper & lower extremities.

Anterior Spinal Column Syndrome: Presents with motor paralysis, pain and temperature loss, but proprioception is spared. Due to ventral lesion of the spinal cord (vascular insult, compression fx, tear drop fx, central disc herniation, hyperflexion & axial load injury).

Motor Exam:

Check: strength, tone, symmetry, and bulk in upper and lower extremities, proximal and distal muscles, and left and right sides of body.

Strength Grade: To test all extensors, put pt’s fingers, wrists and arm in extension and say “Resist me, don’t let me move it.” Always check foot dorsiflexion. Finger tap and toe tap tests for weakness and cerebellar dz.

0: No voluntary movement, flaccid.
1: Slight flicker movement/contraction, no joint movement.
2: From with assistance of gravity.
3: Some weakness, but enough power to resist gravity with FROM.
4: Slight weakness only.
4+: Slightly less than full.
5+: Full power = normal.

Pronator Drift: Have pt extend arms (best to stand) directly in front with palms up, eyes closed. One arm will slowly drop if weak. Good test if minimally cooperative pt. Instruct the patient to keep the arms still while you tap them briskly downward.
The patient will not be able to maintain extension and supination (and “drift into pronation) with upper motor neuron disease. From this position can monitor for tremor, then test UE strength then FTN.

**Muscle Tone:** ask the patient to relax, then flex and extend at the patient's fingers, wrist, elbow and knee. There is normally a small, continuous resistance to passive movement, observe for decreased (flaccid) or increased (rigid/spastic) tone or “catches” (Parkinson’s).

**Reflexes:**
The larger the hammer, the easier the elicitation of the reflex. Check when making small talk about the weather or Hx to distract them. You should feel the response even if you can’t see it.


**Clonus:** If the reflexes seem hyperactive, test for ankle clonus by supporting the knee in a partly flexed position. With the patient relaxed, quickly dorsiflex the foot. Observe for rhythmic oscillations.

**Common Reflexes tested:** CN 7: corneal blink; CN 9: gag.

**CS-6:** Biceps ("BJ", musculocutaneous nerve). The patient's arm should be partially flexed at the elbow with the palm down. Place your thumb or finger firmly on the biceps tendon. Strike your finger with the reflex hammer. C-5-6: Brachioradialis ("BR" jerk, radial n.) Have the patient rest the forearm on the abdomen or lap. Strike the radius about 1-2 inches above the wrist. Watch for flexion and supination of the forearm.

**C7-8:** Triceps ("TJ", radial n). Support the upper arm and let the patient's forearm hang free. Strike the triceps tendon above the elbow with the broad side of the hammer. If the patient is sitting or lying down, flex the patient's arm at the elbow and hold it close to the chest.

**T8-12:** Abdominal cutaneous. Use a blunt object such as a key or tongue depressor. Stroke the abd lightly on each side in an inward & downward direction above (T8-10) and below the umbilicus (T10-12). Note the contraction of the ab muscles and deviation of the umbilicus towards the stimulus. T1-2: ciliospinal. L1-2: cremasteric. L2-4: patellar (knee jerk = "KJ"). L4-5: medial hamstrings. S1-2: Achilles/ plantar (ankle jerk = "AJ", tibial n). Can check while dangling back over table/ chair, kneeling or supine. Often absent in the elderly.

**S2-4:** bulbocavernosus. S4-5: anal.

**Primitive Reflexes (Release signs):** Note: these occasionally may be seen in healthy elderly persons.

**Snout:** tap/ swept briskly and lightly across upper lip from side to center with a tongue depressor and get puckering/ sucking/ protrusion of the lips.

**Grasp:** gently touch palm of hand and pt's fingers slowly close, pt cannot release grip.

**Sucking Reflex:** same stimulus as snout reflex, causes sucking movement of lips, tongue and jaw.

**Palmomental Reflex:** tapping on palm causes mentalis muscle to twitch the lower lip and chin.

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**Pyramidal Tract diseases:**

**Hoffman sign:** Step #1: examiner supports the pt’s wrist (palm facing down) from below to stabilizes it loosely.

Step #2: take pt's middle finger in between your fingers, it is easiest to use your 2nd & 3rd digits to horizontally stabilize the pt's 3rd digit just proximal to their DIP. Use your thumb to bend their finger down (flex) at their DIP joint.

Step #3: the examiner quickly releases the bent (flexed) distal phalanx of index finger and looks for a flexion movement in the pt's thumb. If +, the usually indicated and UMN dz, particularly if asymmetric. Some consider it equivalent to the Babinski in the foot.

**Babinski (Extensor Plantar Response):** Probably the single most important physical "sign", never overlook. Stroke (smooth J stroke) the lateral aspect of the sole of each foot with the end of a reflex hammer or key. Start with relatively non-noxious stimulation and gradually increase the "stroke" (a few seconds in duration) until some response is observed. Note the movement of the toes, normally flexion (withdrawal). A positive Babinski is a stereotyped extensor plantar response: see dorsiflexion of the great toe, fanning of toes, pt may dorsiflex ankle, flex knee/ hip (flexor response). Indicates upper motor neuron dz (also unconscious with drug or ETOH intoxication or after seizure).

The normal response is for all the toes to flex (a "flexor plantar response").

**Muscle clonus:** Check: ankle/ patellar/ wrist, when forcefully hold flexion the muscle will contract longer than the typical 1-2 beats.

**Oppenheim’s Sign:** run finger along length (crest) of tibia : normally no reaction, if abnormal, get a plantar response (Babinski). Not as reliable as Babinski, used only to confirm a +Babinski.


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**Coordination (Cerebellar Tests) and Gait:**

Links: Ataxia: Gait Eval:

The cerebellum is the only part of the brain where the R side controls the rights as it “double crosses”. Lose smooth pursuit eye movements, get saccadic jerking.

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Romberg Sign: stand with ankles together and eyes closed for 5-10 sec. Looks at posterior columns/proprioception (sensory ataxia). If excessive swaying with eyes open and closed then cerebellar ataxia. May see truncal instability as sit in bed with eyes closed.

Rapid Alternating Movements:

Dysdiadochokinesia = inability to arrest motor impulse, then substitute another: Ataxia = incoordination. See gross overshooting, undershooting or confusion. **Ask the patient to strike one hand on the thigh, raise the hand, turn it over, and then strike it back down as fast as possible. **Ask the patient to tap the distal thumb with the tip of the index finger as fast as possible. **Ask the patient to tap your hand with the ball of each foot as fast as possible. **Ask the patient to move their arm and return to your finger with their eyes closed.

Rapid alternating pronation/supination: Rapidly rotate hands & forearm. Tests for cerebellar dz.

Heel to Shin: move heel up and down shin of opposite leg toward the big toe. (can be done in supine position if necessary) Tests cerebellum/posterior columns.

Finger to Nose (FTN): In rapid succession, have pt touch examiners finger and their nose 5X quickly. Move your finger about as the patient performs this task. +Cerebellar dz if tremor just before target. +Essential tremor if see hand tremor throughout the ROM. Hysteresis if wide oscillations and always just off target.

Dysmetria: inability to estimate distances in movements or inability to control the amount of force needed to affect movements.

Stewart Holmes Rebound (Check) Sign: Have pt flex their biceps against resistance, then let go. Will get a rebound with overshoot as pt tries to return it to same position. Can do after pronator drift.

Gait Testing: Walk across the room, turn and come back. Add stress gait with walking heel-to-toe in a straight line (tandem), walk on their toes in a straight line, walk on their heels in a straight line, hop in place on each foot, do a shallow knee bend, rise from a sitting position.

Cerebellar Disease:

Affects equilibrium, muscle tone, execution of movement. The patient usually has no atrophy, weakness, or fasciculations. They do have a broad-based gait with decreased muscle tone.

Common Findings: ‘HANDS Tremor’:

Hypotonia (loss of muscle tone), Asynergy (lack of coordination), Nystagmus (ocular oscillation), Dysarthria (speech abnormalities), Station and gait (imbalance, gait ataxia). Course intention Tremor.

Progressive ataxia: an accurate family history should be obtained and a pedigree constructed. In some families, the mode of inheritance will be evident; this can aid in the selection of appropriate genetic tests. In other families, direct examination of family members may be informative if the patient's history alone is inadequate. Nonhereditary causes of progressive ataxia, such as multiple sclerosis, strokes, alcoholic cerebellar degeneration, mass lesions, and meningeval lesions, have to be excluded, especially if the family history is not convincing. Imaging studies, particularly magnetic resonance imaging, are useful in this regard. In selected cases, especially recessively inherited childhood disorders, treatable diseases have to be ruled out, which can often be achieved with simple blood assays. Finally, a genotypic dx can be suggested on the basis of the specific phenotype observed with currently available mutation analyses, many of which are readily obtainable through commercial labs. More accurate genetic counseling is possible if an anticipated genotype is confirmed. In some instances, the genetic assay can be used to screen family members who are at risk.


Acute Cerebellar Ataxia: Etiology:

Viral: varicella, measles, rubella, mumps, EBV, HIV, CMV, rabies, HSV.

Post Vaccine: Hep B, smallpox, measles.

Bacteria: Mycoplasma, Typhoid, Coxelia, Strep, Leptospira, Borrelia, Legionella, Listeria, TB.

Other: Malaria, Cryptococcus,

Parainfection: ataxia, +dysarthria, +nystagmus. (Vs. GBS with dec reflexes +Romberg as the most common postinfectious ataxia).

Generalized Cerebellar Ataxia:

Acute-transient: ETOH, barbiturate, Phenyoitoin.

Acute-enduring: hyperthermia, Hg, toluene (glue sniffing).

Subacute (weeks): Brain tumor, alcoholic-nutritional, paraneoplastic.

Chronic (mo-ys): Friedreich Ataxia, metabolic dz.

Exam Considerations with Ataxia:

B12 Def: loss of vibration and position sense, up going toes, hyperreflexia, MS changes.


Cerebellar tumor: inability to tandem walk. Drunken gait, titubation of head and neck.

Parietal ataxia: pt forgets how to walk.

Hysterical ataxia: inconsistent, does movements that actually require extra coordination.

Lower Motor Neuron Dz: atrophy, weakness and fasciculations. Have decreased muscle tone with steppege-waddling gait.

Corticospinal Tract Dz: weakness and spasticity (inc tone). No atrophy or fasciculations. Have spastic-scissoring gait.

Extrapyramidal: Have a shuffling, festinating gait. No atrophy, weakness or fasciculations. Has increased muscle tone (rigid).

Hereditary Spinocerebellar Ataxias (SCA’s): Can be X-lined, AR or AD.

Friedreich ataxia (FRDA): is the most common type, it is recessively inherited. The onset of sx’s usually occurs in the first or second decade but may be delayed to the third decade or later.

S/s: progressive gait ataxia, gait/limb ataxia, dysarthria, absent muscle stretch receptors in the LE (dec DTR), sensory loss and other signs of corticospinal tract disease (up going toes). It has a relentless progression. Arrhythmia is common. Usually with onset before 25 years of age, loss of deep tendon reflexes, and proprioceptive loss in the limbs-all signs of major early pathology in the dorsal root ganglion cells and their peripheral sensory processes. Other signs include dysarthria, extensor plantar responses, and oculomotor abnormalities, including square-wave jerks. Muscle atrophy, weakness, and
dysphagia occur late in the disease. Tremor, vision loss, and hearing loss may occur in a few patients. About 30% to 50% of patients develop symptomatic heart disease, including hypertrophic cardiomyopathy. Diabetes occurs in 10% of patients, and skeletal deformities, such as scoliosis, are frequent. The mutation in FRS4 is an expansion of an intronic GAA trinucleotide repeat in a gene named X-25.

Ataxia-telangiectasia: typically manifests early in the first decade as increasing gait ataxia. Neurologic signs that evolve during the first decade include hypotonia, some degree of choreoathetosis, areflexia, and a characteristic oculomotor disorder that is associated with an impaired ability to generate saccades, which necessitates head thrusts to move the eyes. The typical telangiectasia appears in children about 5 years of age and can be found over the conjunctiva, eyelids, and cubital and popliteal fossae. These children have a high risk of malignancies, especially lymphomas. Measurement of altered radiation sensitivity and elevated alpha-fetoprotein levels in serum are useful to confirm the diagnosis.

Other SCA’s include Ataxia with isolated V-E deficiency (AVED, recessively inherited), early onset cerebellar ataxia with retained reflexes (EOCARR), posterior column ataxia with retinitis pigmentosa, infantile onset SCA, myoclonic ataxia syndrome and other rare syndromes.


**Weakness:**

Links: Approach to Weakness: Lab W/u; Anatomic Localization; Myopathy: Ddx-CIPD and other; Post Polio: Syringomyelia; Acute Paralysis: Myasthenia Gravis; Demyelinating Diseases: Guillain-Barré; Multiple Sclerosis: Muscular Dystrophy: ALS; Stiff Mar; Peripheral Neuropathy: Ataxia: Pseudo-Neurologic Syndromes: Myositis/ Myopathy: Mitochondrial Myopathy: Strokes:

Basic Definitions: Proximal = muscle (inflam/ toxic/ NMJ (MG)) Vs Distal = neuropathic (neuropathy or ALS). Monoparesis refers to weakness of a single limb. Hemiparesis is weakness of one side of the body. Paraparesis is weakness of both lower extremities. Quadriplegia is weakness of all four limbs. Monoplegia, hemiplegia, paraplegia, and quadriplegia are analogous terms that refer to complete or nearly complete paralysis of the involved limbs.

Approach to Patient: L MN: UMN: The first step is to determine if the weakness is true muscular weakness or from the perception of “weakness” due to other problems such as anemia, arthritis, CHF, neuropathy or deconditioning. Once weakness is confirmed via manual resistive testing consider an inflammatory Myositis/ Myopathy.

Distal weakness: decreased grip strength, weakness of wrist flexion or extension, decreased plantar flexion strength, and foot drop. These pt’s have difficulty on their heels or toes. Foot drop can be detected by opposing the pt’s attempt to dorsiflex the ankle. Distal symmetric weakness is characteristic of motor neuron disease or peripheral neuropathy.

Proximal weakness: involves the axial muscle groups, deltoids, and hip flexors. Pt has difficulty flexing or extending the neck against resistance. One way to detect the presence of neck flexor weakness is to observe the patient sit up from the supine position. In this setting, the head will lag behind as the patient sits up. Sitting up may be difficult or even impossible in patients with more severe proximal muscle weakness or at times may be the only objective evidence of weakness. Deltoid muscle strength can be assessed by pressing down on the patient's fully abducted arms with the elbows flexed (the examiner should not be able to overcome the pt's resistance if strength is normal). Pt's with proximal leg weakness may rise from sitting on the floor by “climbing up their legs with their hands” (Gower's sign), seen in Duchenne muscular dystrophy and in various myopathies.

Hx: Time course, FHx, Toxins (Myopathy: ETOH, prednisone, statin, colchicine, AZT. Vs. Neuropathy: ddl, vincristine, ETOH, dilantin).


Reflexes: absent/ decreased in neuropathy, nl in myopathy and NMJ problems. Increased in UMN dz’s (ALS, C-spine dz).

Strength: Grade: 0: No voluntary movement.

I: Slight movement.
II: From with assistance of gravity.
III: Some weakness, but enough power to resist gravity.
IV: Slight weakness only.
V: Full power. Feet often affected, usually generalized, hand usually from entrapment neuropathy. Feet: 99% small fiber, length dependent, symmetric, painful at rest, progressive.

PE: Weakness: is it proximal (myopathy) or distal (neuropathy), symmetric. Proximal and distal weakness (Chronic inflammatory demyelinating polyradiculoneuropathy = CIDP).

Sensory level: use pinprick start distal and move proximal, confirm in both feet, ?stocking/ glove.

Assess ventilation: FVC should be ≥5ml/kg and inspiratory force >15cm H2O.

Lab w/u: Check: BS (glucose), TSH, CBC, SED, U/A (myoglobinuria), Chem 18 (exclude liver, kidney, Mg, P, Ca,
systemic dz), HIV. **2nd Line:** CPK, A1c, RPR, B12, ANA, SPEP, UPEP, HCV/ HBV, RA, PPD, CXR, FOB, CPK & aldolase (if inc get EMG to dx dermatomyositis). **3rd Line:** If uncertain about dx or chronic Check: NCV’s & EMG (to confirm, estimate severity), consider LP, sural nerve Bx, muscle Bx, heavy metal analysis, cryoglobulins, complement assay, myelography, MRI with "cord protocol" for a quick scan of entire spinal cord. Of consider CT with myelogram.

**Electrodiagnostic Studies (EDS):** two components Electromyography (EMG) and Nerve Conduction Studies (NCS). Both are used to confirm neuropathy, give a physiologic determination of nerve function (axonial vs demyelinating). They can be painful, expensive, time consuming and only give info on large fibers.

**Nerve conduction studies (NCS):** can provide support for a diagnosis of neuropathy and are a relatively objective way to follow the course of the disease. May also allow a clinician to infer whether a dz is affecting primarily axons or their myelin sheaths—an important distinction in the differential diagnosis of polyneuropathy. The motor and sensory responses are distinguished by each other by recording either from a cutaneous branch of the nerve (sensory) or from an innervated muscle (motor). If the nerve conduction studies show decreased motor and sensory amplitudes but preserved conduction velocities, the underlying pathologic process is probably loss of or destruction of axons. By contrast, if amplitudes are relatively preserved and there is marked slowing of conduction velocity or conduction block, an abnormality of the myelin sheath is likely.

**Electromyography (EMG):** Needle electromyography is a complementary investigation that is usually performed at the same time as nerve conduction studies. In a patient with peripheral neuropathy, electromyography is helpful in detecting small degrees of axon loss that may go undetected by nerve conduction studies. EMG can also be helpful in pinpointing the precise location of the lesion in a mononeuropathy. The procedure entails recording electrical activity in muscle by use of a needle electrode inserted into the muscle. Muscles are examined at rest and during mild voluntary contraction. If the electrical activity produces an abnormal pattern, the electrophysiographer can determine whether a patient’s weakness is the result of a diseased muscle or a diseased motor nerve.

**EMG Patterns:** myasthenia gravis (dec decremental response to tetanic stimulation), Eaton Lambert (incremental response to repetitive stimulation), myotonia (dive-bomber EMG = high frequency action potential d/c’s), polymyositis (fibrillation = low amplitude action potentials due to denervation).

**Nerve Bx:** can provide a specific diagnosis (e.g., necrotizing vasculitis) but more often gives less specific information that can be useful in combination with the other clinical data. Apart from alteration in the number or size of axons, the most common abnormality found by nerve biopsy is inflammation, usually related to altered immune function. On occasion, a disease that affects both the CNS and the PNS (e.g., metachromatic leukodystrophy) can be conveniently diagnosed by nerve biopsy. The sural nerve is preferred in most instances because sural nerve biopsy results in a small area of sensory loss along the lateral side of the foot that is generally well tolerated. **Anatomic Localization:**

A central lesion is characterized by spasticity, whereas tone is normal or reduced with a peripheral lesion.

**Myopathy/ Polymyositis:** Inflammatory dz of skeletal muscles. F:M is 2:1. Subacute (weeks to months), symmetric. Spares forearms/ hand/ leg/ foot. If age >60yo, up to 25% may have a malignancy (bronchogenic Ca).

S/s: Symmetrical proximal <distal weakness, normal tone, no sensory loss, usually no pain (except HIV), may have mild dec reflexes, nl Babinski/ CN’s. Difficultly walking up stairs, combing hair, reaching for objects above their heads or rising from a low chair. May have an ascending proximal weakness. Improves with steroids. If associated skin involvement.

Ddx: Increased serum CPK & Aldolase.

**EMG findings** (spontaneous fibrillations potentials at rest that are bizarre high-frequency. Short-duration, small amplitude polyphasic motor unit potentials with muscle contraction.) If +EMG refer for consideration of a muscle Bx.

Ddx: mitochondrial myopathy, Hereditary myopathy (Duchenne, Becker’s, Limb-girdle, myotonic dystrophy, Endocrine (glucocorticoid excess, hyper/ hypoparathyroidism, acromegaly). Autoimmune, MD, myotonic, periodic paralysis (inc dec K). glycogen d/o, lipid (carnitine), toxic (glucocorticoids, penicillamine, statins, procamamide, ETOH, AZT). Inflammatory-- Dermatomyositis which is associated with CTD’s. Check: ESR (normal), inc CPK, Bx normal in 18%. Rx steroids. Link: Polymyositis / Dermatomyositis: Differs from muscular dystrophy in that there is no FHX/ older age/ weakness evolves more rapidly/ associated CTD/ inc muscle enzymes and EMG findings.

**Myelopathy:** Link: Syringomyelia:

Spinal cord dz.

3 specific sign: +sensory level/ bladder involvement/ up-going toes.

S/s: gait ataxia, spasticity and hyperreflexia. Weakness is variable (proximal & symmetric), inc tone, inc reflexes, back pain, normal CN’s. Proximal atrophy, possible fasciculations.

**Subacute Combined Degeneration:** due to B12 deficiency, segmental loss of myelin esp. in dorsal and lateral columns presenting as generalized myelopathy.

**Vacuolar Myelopathy:** AIDS pt’s (rare), must r/o other spinal cord problems (lymphoma).

Cervical Myelopathy: due to herniation or spurs compressing the cervical cord, nerve outlets, or nerve roots causes sensory changes in the typical dermatomal pattern. C5 - lateral arm, C6 - thumb and index finger, C7 - middle finger.

**Motor symptoms:** C5/C6/C7 - deltoid/ biceps/ triceps.

**Tendon reflexes:** C5/C6 – biceps, C7 – triceps, C8 – brachioradialis, T1 – biceps, T1 – wrist extensors. If a RA patient presents with post-op focal neuro deficit, suspect C1-2 spinal cord trauma due to intubation because of asymmetric C1-2 subluxation.

**Thoracic Myelopathy:** sensory levels are T4 at the nipple and T10 at the umbilicus myelopathy at thoracic level should prompt a workup for tumor.

**Lumbosacral Myelopathy:** the spinal cord itself is NOT affected by LS problems but the cauda equina and nerve roots can be damaged - esp. L4-S1.

**Dermatomes:** L5 - large toe, S1 - lateral side by small toe.

**Myotomes:** L5 - weakness of great toe and ankle dorsiflexion (standing on heel) presenting as foot drop, S1 - weakness of ankle plantar flexion (standing on toes).

Ddx: trauma, DJD, CVD, infection (cysticercosis, HSV, HIV, schistosomiasis), paraneoplastic, neoplastic, radiation, sarcoid, MS, ischemia, chemo, heroin, B12 or V-E def, thalassemia. Spondylytis myelopathy (spondylitis) is due to herniation or spurs compressing the cervical cord, nerve outlets or nerve roots causing dermatomal sensory changes.

N-M transmission d/q: Variable weakness that fluctuates, normal tone, no sensory level or pain. NI Babinski, bowel/bladder. +CN dysfunction.

Ddx: myasthenia gravis, botulism, Eaton-Lambert, tick-bite paralysis, drugs/ toxins (organophosphates).

**Motor Neuron D/z:** segmental weakness, inc dec tone, no sensory level/ pain/ bowel-bladder dysfunction. Inc dec reflexes,
up going toes, +CN dysfunction.

**Ddx:** Idiopathic, ALS, electrical/ radiation injury, spinal cord ischemia, trauma, HSV, HIV, polio, heavy metal intoxication, lymphoma, monoclonal gammopathy, syringomyelia, paraneoplastic.

**Link:** *Peripheral Neuropathy:* distal > proximal weakness (legs > arms, commonly symmetric), nl/dec tone, variable sensory loss (stocking-glove distribution of sensory loss), often painful (distal), dec reflexes, nl Babinski/ bowel-bladder. +CN.

**Distal atrophy/fasciculations.**

**Diffuse:** myositis, metabolic myopathy, paraneoplastic syndrome, degenerative NM d/o, toxin, myelopathy, transverse myelitis.

**Bulbar sign’s:** diplopia/ dysarthria/ dysphagia/ ptosis.

**Ddx of Extremity Weakness:**

**Cerebral Hemisphere (unilateral):** hemiparesis, contralateral, no pain, inc DTR, extensor plantar response, dec sensation, no atrophy or fasciculation.

**Spinal Cord:** legs if below T1, bi or unilateral, may have pain in spine, inc DTR, extensor plantar response, dec sensation, no atrophy/fasciculation.

**Plexus:** focal weakness in involved extremity, pain is common, dec DTR, flexor plantar response, dec sensation, +atrophy/ fasciculations.

**Nerve Root:** myotomal pattern of weakness, not symmetric, radiating pain, dec DTR, flexor plantar response, dec sensation, focal atrophy/fasciculations. *Peripheral Neuropathy*.

**Myelopathy:** See above.

**Wasting Syndrome of AIDS:** diffuse weakness, symmetric, no pain, normal DTR, flexor plantar response, normal sensation, diffuse atrophy, possible fasciculations.

**Botulism:** 50% with GI sx’s, then ptosis, dysphoria, facial weakness, total body weakness, dx with EMG, tx with antitoxin.

**Diphtheria:** inflammatory exudate on throat, trachea or wound infection, symmetric sensorimotor paralysis mimicking GBS.

**Tx:** antitoxin.

**Tetanus:** laryngospasm, h/o infected wound in 75%, then difficulty opening mouth.

**Tx:** high dose benzo, respiratory support.

**Tick Paralysis:** tick toxin, 1wk after initial attachment (usually head or neck) get fatigue, irritability, ataxia, rapidly progressive muscle pain, asymmetric sciatic fasciculation, 50% with paresthesias. Absent DTR’s, normal CSF.

**Tx:** remove tick, respiratory support.

**Hypophosphatemia:** nonspecific distal paresthesias, often in alcoholics. P<0.7mg/dL.

**Hypo- or Hyperkalemia:** ascending or symmetric with diminished or absent DTR’s. Often with predisposing illness or med.

**May be familial.** Check- ECG.

**Hypermagnesemia:** H/o RF or severe N/V. Hypotension, respiratory insufficiency, heart block, dec DTR’s. Check: ECG, creatinine. Give Ca gluconate.

**Organophosphates/ carbamates:** GI sx’s agitation, miosis, paralysis, sweating, bradycardia, pulmonary edema, CNS depression. Treatment: Atropine 2mg IV q3min. 2-PAM 1g IV over 2min if organophosphates.

**CNS: chronic demyelination**

**Peripheral Neuropathy (CIDP):** An acquired idiopathic disorder affecting all ages. Proximal as well as distal weakness separates this entity from many chronic distal axonopathies. Patients exhibit generalized hyporeflexia or areflexia and variable sensory deficits. Whereas dz severity reaches its nadir within 4 wks in GBS, CIDP is differentiated by continuing or recurrent progression beyond 8 wks. In some cases, sensory sx’s may predominate or autonomic manifestations may be prominent. The course of CIDP may be chronic progressive or relapsing and remitting. Approximately 10% of patients carry associated systemic illnesses in addition to CIDP. These conditions include malignancies (Hodgkin’s disease, melanoma, and various carcinomas), connective tissue diseases, hepatitis, HIV infection, inflammatory bowel disease, glomerulonephritis, thyrotoxicosis, and diabetes. CIDP may also occur in the setting of a monoclonal gammopathy of undetermined significance (MGUS), with its 25% attendant risk of hematologic malignancy at long-term follow-up.

**Base on clinical presentation: Cerebral Hemispheres (unilateral), spinal cord, peripheral nerves.**

**Tx:** IVIG @ 0.5 g/kg/d for 4 days, a clinical response is commonly seen within 1-3 wks, improvement may be maintained with a single dose of 0.4 to 0.5 g/kg every 3 to 4 weeks, the approximate half-life of the immunoglobulin. If patients fails give prednisone @ 1.0 to 1.5 mg/kg/d as a single, morning dose X2mo, the reduce the dose to an alternate-day. If fails this try plasma exchange.

**Multifocal Motor Neuropathy:** Characterized by asymmetric weakness, fasciculations, and atrophy affecting the arms more than the legs and is caused by multifocal conduction block of motor axons. Although superficially resembling ALS, the lack of upper motor neuron findings on examination and the presence of abnormal nerve conduction studies on electrophysiologic testing readily distinguish the two conditions. Focal areas of partial conduction block demonstrated by nerve conductions study are the sine qua non of diagnosis. Increased titers of IgM anti-GM1 antibodies are usually, but not always detected and do not influence the decision to treat. Patients should be treated with IVIG as corticosteroids and plasma exchange are not effective. Cyclophosphamide may be beneficial.

**Peripheral Nerve Vasculitis:** may be one of the manifestations of a systemic necrotizing vasculitis accompanying polyarteritis nodosa, microscopic polyangiitis, Wegener’s granulomatosis, Chung-Strauss syndrome, collagen vascular disease (lupus erythematosus, rheumatoid arthritis, Sjögren’s syndrome), infection (hepatitis B or C, HIV), malignancy, or drug hypersensitivity. A neuropathy in the setting of multiorgan involvement raises a strong suspicion of vasculitis. However, in one third of cases, a vasculitic neuropathy occurs in isolation without accompanying dz and is referred to as isolated peripheral nerve vasculitis or nonsystemic necrotizing vasculitis. Vasculitic neuropathy has an ischemic pathogenesis evolving from inflammation and necrosis in the vessel walls of the vasa nervorum, with subsequent occlusion of vascular lumina. The features of vasculitic neuropathy may reflect multiple individual nerve involvement (multiple mononeuropathies), overlapping mononeuropathies (which obscure the involvement of single nerves), or a confluent, distal, symmetrical stocking-glove polyneuropathy. Classically associated with burning, dysesthetic, neuropathic pain, peripheral nervous system vasculitis does not cause pain in 20% to 30% of cases. Electrodiagnostic studies may help delineate the pattern of multiple mononeuropathies, and laboratory studies screen for non-neurologic organ involvement and underlying etiologies. The dx requires bx demonstration of transmural inflammatory cell infiltration and fibrinoid necrosis of blood vessels.

**Paraproteinemic neuropathies:** occur in association with monoclonal gammapathies in several disorders, including multiple myeloma, amyloidosis, Waldenström’s macroglobulinemia, cryoglobulinemia, and MGUS. All adult patients with undiagnosed chronic neuropathy should be screened by serum and urine immunofixation electrophoresis for the presence of an abnormal monoclonal protein (IgG, IgM, or IgA). If a paraprotein exists, further evaluation should include a skeletal survey,
bone marrow biopsy with aspiration, and a nerve biopsy where appropriate.

**Non physiologic Causes of Weakness:**

- **Psychogenic/ Conversion d/o:** h/o anxiety, stress, or depression. An unconscious transformation of psychic conflict.
- **Malingering:** Feigning illness of disability to derive secondary gain.
- **Chronic Fatigue Syndrome:** Multiple sx’s including persistent fatigue affecting daily activity by 50%. Mild fever, sore throat, sleep disturbances.
- **Anxiety D/o:** chronic neurotic d/o with unrealistic anxiety, often with acute attacks. Trembling, hand sweating, somatic cardiorespiratory complaints temporarily prevent rational thinking.
- **Fibromyalgia:** Nonarticular rheumatic d/o with pain and tenderness in the muscles. Symptoms exacerbated by emotional, environmental stress and overuse. Often have insomnia, irritable bowel syndrome.

**Postpolio Syndrome (PPS):** new, late manifestations occurring years after acute polio syndrome. It may be difficult to diagnose, with exclusion of other conditions essential. Polio is an RNA virus, 2% of individuals experience CNS invasion, if up to 50% of the neurons partially or completely damaged the pt would still have an apparent recovery. 2/3 of survivors were left with residual weakness, scoliosis, shortened limbs, dysarthria, dysphagia, bladder difficulties or respiratory insufficiency.

**Risks:** severe acute poliomyelitis paralysis, older age onset of polio, the amount of recovery and physical activity in the intervening years. (1) greater severity of the poliomyelitis and the resulting paralysis. Patients may have: required hospitalization, had all 4 limbs paralyzed, required a ventilator. (2) age at the time of onset of the poliomyelitis, having polio at an age >= 7 years, adolescents and adults tend to have more severe disease than infants and small children, which may partially explain the age-related risk. (3) amount of recovery: the greater the recovery the more likely PPS will occur (this probably implies having had more severe disease). (4) excessive exercise or overuse. (5) a period of immobilization after illness, injury or surgery.

**S/s:** Generalized fatigue is the most common manifestation. Cold intolerance common. Occurs after years of stability in survivors of paralytic polio.

**Two clusters:** 1. progressive atrophy. 2. Combo of pain, perception of weakness and fatigue.

**Criteria for the Dx:** A dx of exclusion. 1) A prior episode of paralytic poliomyelitis with residual motor neuron loss. 2) A period of neurologic recovery, followed by an interval of neurologic and functional stability. The interval of stability is usually >= 15 years. Or >= 5 years. A gradual or abrupt onset. More one or more of the following: new weakness or abnormal muscle fatique (decreased endurance), muscle atrophy, generalized fatigue. 4) Exclusion of other conditions that could explain the findings in (3) Where: The previous poliomyelitis with residual motor neuron loss may be confirmed by a typical patient history, a neurologic examination, or an electrodiagnostic examination. The interval stability may range from 8 to 71 years.

**Tx:** A multidisciplinary approach with neurologist, ortho, pulmonologist, psych, physical/ occupational/ speech therapy. Lower extremity orthosis, non fatiguing strengthening exercises, physical activity pacing. May need noninvasive positive-pressure ventilation at night or even a tracheostomy and permanent ventilation. Need special swallowing techniques if get dysphagia. (Characteristics and management of Postpolio Syndrome. JAMA. 2000; 284: 412-414)

**Other weakness causes:** hypothyroid, muscular dystrophy, steroid myopathy, hyperparathyroidism, adrenal insufficiency, early rheumatoid arthritis, hyperinsulinemia.

**Syringomyelia:** Link: Myelopathy.

A progressive myelopathy dz of the spine characterized by fluid-filled cavities in the spinal cord that may extend into the brainstem, may be due to obstruction of the outlet of the 4th ventricle.

**Etiology:** Can be idiopathic, developmental or acquired. May have a h/o of birth injury. 2/3 of cases are assoc. with Arnold-Chiari malformation (there is a downward shift of the cerebellum and medulla through the foramen magnum into the cervical spine area).

**S/s:** insidious onset, usually begins age 30-40yo. Shoulders (“cape-like distribution”) and upper limbs where pt has relatively normal sense of light touch and vibration but no sense of pain or temperature when the anterior horn is affected. Intrinsic hand atrophy, weakness, sensory loss common. May notice getting burns on hands if a smoker as lose pain and temperature sensation with preservation of tactile sense. Sharp testing not painful, but can tell that it is sharp. May get spasticity and hyperreflexinss in LE. Scoliosis is a common finding as is nystagmus and Horner’s syndrome. May get Charcot joint in the shoulder or elbow. May lose DTR in UE.

**Dx:** MRI.

**Tx:** Neurosurgery for operative repair, often laminectomy of C1-2 to stop progression. Variable course.

**Ddx:** ALS, MS, spinal cord tumor, tabes dorsalis, MD.

**Chiari Malformations:** congenital hindbrain dysgeneses resulting in the brainstem protruding into the spinal canal resulting in various degrees of spinal cord impingement. Usually diagnosed in infancy or childhood. Chiari II has displaced tonsils with caudal dislocation of the vermis, 4th ventricle or medulla. Presents with CN abnormality (60%), limb weakness (50%), sensory abnormality (50%), H-A (50%), neck pain, ataxia and atrophy/ hyporeflexia of upper extremity (35%).

**Acute Paralysis Ddx:**

**Tick-bite:** ascending symmetric flaccid paralysis (see above).

**Transverse Myelitis:** rapidly progressive weakness, ataxia, optic neuritis, multiple neurologic deficits, bowel / bladder problems. CSF shows pleocytosis, inc protein levels.

**Poliomyelitis:** fever, respiratory or GI sx’s. Flaccid, asymmetric paralysis, max deficit 3-5d after onset.

**Guillain-Barré:** symmetric, ascending flaccid paralysis. See below.

**Secondary Polyneuropathy:** low grade fever with variable involvement of ataxia, flaccid paralysis, CN lesions, generalized weakness. May be infectious or inflammatory, intoxication, or autoimmune. CSF shows inc protein, few mono’s, Check: NCV.

**Other:** trauma, spinal cord mets, cauda equina.

**Hypokalemic Periodic Paralysis:** attacks of weakness occur during periods of hypokalemia. About 2/3 of patients have a Filex of the dz, remainder likely due to spontaneous mutations. Onset of sx’s usually before age 20, but as early as age 3-4, always begin before age 30.

**S/s:** severe weakness of the limbs occurs spontaneously, paralysis occurs without pain or changes in level of consciousness. The limbs are primarily affected (facial and respiratory muscles usually spared), pt’s may become temporarily quadriplegic. Attacks typically last for 3-4 hours, but may persist up to 24 hours, worse in males than females. Attacks usually follow exercise (at rest), or during sleep. Serum K+ level usually low, may be low normal, during an attack, reducing K+ levels will precipitate an attack. Weakness improves with gentle exercise. Common to have eyelid myotonia is often present even between attacks. A d/o of voltage-gated calcium (Ca2+) channel gene, CACNL1A3, chromosome 1q, the physiologic basis remains unclear.
ATM

2 weeks. 30-60% get MS. May be the initial symptom in 50% of MS pt's. Presents with vision disturbances such as a central R-G color defect, Marcus-Gunn pupil (Afferent pupilary defect), papillitis (hem and swell) of optic nerve, then atrophy (pallor) in

1. Optic Neuritis (ON):

Monophasic Immune Mediated CNS

Recurrent Immune-mediated CNS:

neuropathy, paraproteinemic demyelinating neuropathy.

Cause of chronic demyelinating neuropathy include CMT, Refsum’s dz, metachromatic leukodystrophy, CIPD, multifocal motor neuropathy, paraproteinemic demyelinating neuropathy.

Recurrent Immune-mediated CNS:Multiple Sclerosis:

Monosymptomatic Immune Mediated CNS:

1. Optic Neuritis (ON): presents with monocular, retrobulbar pain that in 2 days progresses to central scotoma, dec VA, R-G color pupil defect (Afferent pupillary defect), papillitis (hem and swell) of optic nerve, then atrophy (pallor) in 2 weeks. 30-60% get MS. May be the initial symptom in 50% of MS pt’s. Presents with vision disturbances such as a central scotoma and retrobulbar pain with movement in one eye. Funduscopic exam is usually normal, may see papillitis or pallor from a previous attack. There is often failure of adduction on lateral gaze but preservation of adduction with convergence.

Myasthenia Gravis (MG):

An autoimmune dz where Ab’s destroy ACh receptor at NM junction. Thymus abnormalities in 10-25%.

Presentation:

Flu-like sx’s. Gave atropine at bedside in case of cholinergic crisis.

Factors predicting a favorable outcome to thymectomy:


In cholinergic and brittle states.

Thyrotoxic Periodic Paralysis: acquired, sporadic disease associated with underlying thyrotoxicosis and resolves with tx of thyrotoxicosis. Always associated with hypokalemia. About 95% of cases occur in men, more common in Asians. Suspect dx pt who develops periodic paralysis after age 30yo as typical signs and symptoms of thyrotoxicosis are often completely lacking. Dx: Low TSH with increased radioiodine uptake by thyroid.

Thyroid dysfunction, beta-adrenergic blockers can be of some benefit prior to definitive therapy.

Andersen’s Syndrome: potassium-sensitive periodic paralysis. Pt has frequent ectopic ventricular premature beats, bigeminal or bidirectional tachycardias common, have short stature, hypertelorism, low set hair, mandibular hypoplasia, clinodactyly. Usually presents as arrhythmia detected on exam. Raising serum K+ precipitates weakness, but normalizes ECG, lowering serum K+ improves strength, but worsens ECG abnormalities. Occasional patients can develop weakness with hypokalemia.

Demyelinating Disease:

Causes of chronic demyelinating neuropathy include CMT, Refsum’s dz, metachromatic leukodystrophy, CIPD, multifocal motor neuropathy, paraproteinemic demyelinating neuropathy.

Links:

ON-ATM: ADEM; Leukodystrophy; Metabolic/Infectious: Leukoencephalopathy; Guillain-Barre: Multiple Sclerosis; CIPD:

Ddx: Graves dz, Cholinergic Crisis: overdose of anticholinergic meds. Weakness & SLUDGE (salivation, lacrimation, urination, defecation, GI upset, emesis), botulism, Lambert-Eaton syndrome, hyperthyroid, drugs, intracranial lesion, progressive external ophthalmoplegia.

Ddx: anterior ischemic optic neuropathy (painless, age >50yo), Leber hereditary optic neuropathy, nutritional/ toxic neuropathy.

Tx is 3 days IV methyl pred 250mg q6 then PO pred 1mg/kg X11d.

2. Acute Transverse Myelitis (ATM): Often follows a vaccination or a viral illness. May be due to echovirus, varicella, zoster, flu, EBV, CMV, mycoplasma, parasite, MS or SLE. Similar presentation as MS, often presents with thoracic back pain, then paraparesis, loss of sensation with a sensory level on the trunk, urinary/fecal retention, 1/3 recover fully, some get MS. Motor weakness varies, some with max deficit at 2d, others at 2mo. Neuro findings are typical of a functional cord transgression at one segment (loss of sensory and motor). MRI shows extensive involvement and swollen cord. CSF show pleocytosis of up to 10,000 cells (lymph & PMN), but can be normal, but 75% have inc protein as high as 500mg/dL. Viral serology helpful, but antivirals may not. Tx with steroids is controversial. DVT prophylaxis.

3. Acute Disseminated Encephalomyelitis (ADEM): usually follows vaccination or viral illness. Acute onset on meningeal signs, H-A, sz, altered mental status, hemiplegia, paraplegia, sensory or vision loss. Usually progresses within days. See widespread presentation with multiple WM lesions in brain and spinal cord. CSF shows lymphocytes.

Tx with high-dose methylprednisolone: 1g IV qd, plasma exchange if not improving, most fully recover in 2-4 wks. Ddx: CNS vasculitis, neurosarcoid, SLE, intravascular lymphoma, acute viral encephalitis, HSV, PML.

Inherited CNS:

1. Adrenoleukodystrophy: AR and X-linked types. Get accumulation of very long chain fatty acids (VLCSA’s). In child will have cognitive deficits and rapid neurological deterioration with death in 2-5 yrs. An adult form presents around age 28yo with spinal cord dysfunction. Dietary treatment with unsaturated fatty acids does lower the level of VLCFA’s, but does not significantly alter the progression.

2. Metachromatic leukodystrophy: AR, demyelination of both central and peripheral axons due to the accumulation of metachromatically staining sulfatides. Usually has onset by early childhood. Dx by measuring low Arylsulfatase activity in peripheral blood leukocytes, urine or skin fibroblasts. Mean survival time is 12 yrs.

Metabolic CNS:

1. V-B12 Deficiency: Subacute combined degeneration of the spinal cord from demyelination of both central and peripheral axons. Presents with paresthesias, sensory loss that starts in the feet and progresses proximally. Later get weakness.

2. Central Pontine Myelinolysis: due to rapid correction of a hypernatremia. Sx’s begin ~3 days after the correction with altered mental status, dysarthria and spastic quadriplegia. Due to symmetrical demyelinated lesion in the pons. Recovery is variable.

Infectious CNS:

1. Progressive Multifocal Leukoencephalopathy (PML): a disease of brain white matter. Rarely seen outside of severe immunodeficiency. Presents with progressive motor deterioration, loss of vision, incontinence and eventually dementia. (see ID chapter)

2. Subacute Sclerosing Panencephalitis: a rare late complication of the measles virus infection. Seen ~7 years after an infection. Have progressive cognitive impairment, then motor dysfunction with myoclonus. Due to a reactivation of the measles virus in the brain, no known cure.

Leukoencephalopathy:

A structural alteration in the cerebral white matter. May be due to exposure to a wide variety of agents. Can occur in any age and in any setting. Stop med, give supportive care.

Etiology: Trauma, hydrocephalus, demyelinating dz, genetic. Toxins: antineoplastic agents, immunosuppressive agents (cyclosporin, tacrolimus), drugs of abuse, environmental toxins (CO, arsenic CH4). Infection: HIV, CMV, VZV, SPP.

Metabolic: cobalamin or folate def, high altitude cerebral edema, HTN encephalopathy, hypoxia, eclampsia. Vascular: Binswanger’s, cerebral amyloid.

S/s: spectrum from confusion, inattention forgetfulness, personality change to akinetic mutism, coma, stupor. H-A is prominent, sz, tremors, hallucinations, paranoia and mood swings common. MRI with patchy intramyelinic edema to brain necrosis. (Toxic leukoencephalopathy. NEJM 2001;345:6)

Peripheral Nervous System (PNS):

Guillain-Barré Syndrome (GBS):

= Acute Inflammatory Demyelinating Polyneuropathy (AIDP) The leading cause of flaccid paralysis. Self limiting autoimmune d/o. Antecedent pathogen: 60% viral (CMV), Campylobacter jejuni is frequent, also 10% follow a surgical procedure, vaccines. 1/3 need respiratory support.

S/s: Rapidly progressive, ascending symmetric limb weakness (upper and lower). Loss of DTR’s and autonomic dysfunction. Early sx’s may be preceded by sensory sx’s and back pain.

Supportive sx’s: progression over 3-28d, relative asymmetry, mild sensory s/s, CN involvement, recovery beginning 2-4wks after progression ceases, no fever at onset, autonomic dysfunction, inc CSF protein with <10 lymphs. Albumino-cytologic dissociation = inc protein but normal WBC count, seen in Guillain Barré.

Doubt dx if: sharp sensory levels, severe bladder/bowel dysfunction, >50 lymphs in CSF, or PMN's in CSF.

W/u: Initial examination must include respiratory function with forced vital capacity (FVC) and negative inspiratory force, arterial blood gas determination, an electrocardiogram (ECG), chest radiographs, serum electrolytes, and a complete blood count. Tx: supportive. Plasma exchange (plasmapheresis) effective if used within 2wks of sx onset, remove 200–250 mL/kg. IV IgG @ 0.4mg/kg X5d is easier and less risk than plasma exchange. No benefit combing IVIG and plasmapheresis as both effective. Atelectasis and mucous plugging may be minimized with careful pulmonary toilet and incentive spirometry. Transfer to the intensive care unit is mandated if the FVC falls below 20 mL/kg, if the negative inspiratory force (NIF) is less than 20 cm H2O, or if oropharyngeal weakness threatens airway control. Intubation should be performed when the FVC falls below 15 mL/kg or the patient can no longer protect the airway. Tracheostomy should be performed to prevent tracheal stenosis if the patient remains ventilator dependent in excess of 14 days.

Variants: Variants with weakness as the predominant manifestation include acute inflammatory demyelinating polyradiculoneuropathy (AIDP), acute motor sensory axonal neuropathy (AMSAN) and acute motor axonal neuropathy (AMAN). Pt’s with AMAN and AMSAN become maximally weak within 5 to 6 days. The time to maximal functional recovery is 3 months in 70% and 6 months in 82%. Patients with AMSAN frequently experience extended recovery periods (12–18 months) and retain residual severe neurologic deficits.

Miller-Fisher variant: a descending paralysis, often with ophthalmoplegia.

R/o polio (has >50WBC) via LP, GBS has few WBC, inc protein. CSF see oligoclonal bands, “albumino-cytologic dissociation = inc protein with ni cell. Mechanical ventilation if VC <20ml/kg, MEP <30 cm H2O, MEP <40 or rapid progression.
Complications: thromboembolism, cardiac dysfunction, ventilatory failure, oropharyngeal weakness. 75% at max dysfunction in 2-4 weeks, 94% @ 4 weeks, 70% with full recovery in 1yr, 80% in 2yr. 7% mortality. 2% relapse.

Ddx: acute transverse myelitis, diptheria, botulism, carcinomatous meningitis, periodic paralysis (inc/dec K), hypermagnesemia, hypophosphatemia, tick paralysis, heavy metal intoxication, organophosphate poisoning, acute porphyria, polio, myasthenia gravis, AIDS-related progressive polyradiculopathy, critical illness polyneuropathy, Zerri (44T).


Multiple Sclerosis (MS):

Links: Sx/Dx Course: Tx Ddx:

Chronic T-cell autoinmune inflammatory demyelinating dz of CNS that can be clinically recurrent or progressive. There is an increase in prevalence as one moves from equator with early life and genetic components (HLA DRB1), 0.1% risk in the general population, 3.5% risk if sibling or parent with MS, 5% for dizygotic twin and 31% risk if monozygotic twin with MS. Presents ages 10-50 with peak occurrence at age 30. More common in whites than blacks, rare in Asians. Environmental exposure before age 15 yo such as EBV (JAMA 2001;286:3083)?

Sx/S: May produce impairment of sensations in any anatomic distribution and in any combination of modalities. Positive: optic neuritis, transverse myelitis, ataxia, vertigo, sensory deficit, dysesthesias and hyperesthesia, are common. Negative: weakness, pain, pyramidal, facial, vocal cord paralysis.

**Tx:**

- **Primary Progressive (PP):**
  - 7-8 yrs are onset.
  - Progressive course, leading to significant disability in multiple neurologic systems or death in a relatively short time after dz.
  - 15 years after the disease onset. 15% of pts will never experience a relapse.
  - 4 courses unifocal neuro manifestations, atypical response to tx, lack sensory/bladder findings or nl MRI.
  - Unlikely MS if:
    - Lesions/demyelinated plaques seen on Gadolinium enhanced MRI seen as oval, well-demarcated hypocellular area.
    - Evoked potential (w/u: looks forward their gaze is normal, but when they look to one side the affected eye cannot fully adduct.
    - Clinical (two attacks and two separate lesions), with MRI and LP as backup. CSF with oligoclonal bands on electrophoresis, lymphocytic pleocytosis (<25 lympha), 1nc protein/lgG/ myelin basic protein. EEG shows a slowed/ delayed evoked potential (visual: strobe light, auditory). There are periventricular, brain stem, cerebellar or spinal cord white matter lesions.
  - Malignant plaques on Gadolinium enhanced MRI seen as oval, well-demarcated hypointense area.

  - Paroxysmal motor sx's include paroxysmal dystonia, transient weakness, facial myokymia and hiccups. Very common to have limb weakness & spasticity (abn inc muscle tone). May have ON, paraparesis, diplopia, ataxia, dysarthria, vertigo, urinary difficulties, upper motor neuron signs (hyperreflexia, Babinski), dec position/vib sense, all worse when pt is warm (fever, exercises, hot bath). Often patients may initially be considered hypertensive or hysterical. Visual loss or oculomotor dysfunction (40% at presentation, 100% during course), weakness (43% at presentation, 88% during course), sensory deficits (41% presentation, 87% during course), incoordination (23% & 82%), bladder/bowel/sensory dysf (10%, 63%), cognitive impairment (4%, 39%).
  - No inc risk of sz's compared to regular pop.

  - Lhermitte's sign:
    - Paresthesias that radiate down the spine and into the extremities upon flexion of the neck due to cervical spine lesions. The lower extremities tend to be more severely affected, such as loss of vibration sense, there is a 50% chance of walking in 15yrs. New deficits tend to develop over the course of days to hours, then remain stable for 2-20 days before gradually improving. The deficits become more permanent with repeated exacerbations.

  - Confusion/epilepsy:
    - Acute cerebral lesions occasionally manifest as a confusional state associated with progressive focal paralysis. These findings can be mistakenly attributed to a tumor.

  - Coordination: gait imbalance, difficulty in performing coordinated actions with the arms, and slurred speech may occur as a result of impairment of cerebellar pathways. PE typically reveals dysmetria, decomposition of complex movements, and hypotonia, most often observed in the upper extremities. An intention tremor may be noted in the limbs and in the head.

    - Walking is impaired by truncal ataxia. Ocular findings of nystagmus, ocular dysmetria, and failure of fixation suppression (square wave jerks) suggest cerebellar or cerebellar-vestibular connection dysfunction. Speech can be scanning or explosive in character. In severe cases there is complete astasia (inability to stand), inability to use the arms due to a violent intention tremor or facial dyskinesia, or dysphonia.

    - Visual loss or ocular motor dysfunction (40% at presentation, 100% during course), weakness (43% at presentation, 88% during course), sensory deficits (41% presentation, 87% during course), incoordination (23% & 82%), bladder/bowel/sensory dysf (10%, 63%), cognitive impairment (4%, 39%).

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- Acute/chronic demyelinating dz: w/u: ANA, B12, TSH, ESIR, CBC, MRI.
- Dx: clinical (two attacks and two separate lesions), with MRI and LP as backup. CSF with oligoclonal bands on electrophoresis, lymphocytic pleocytosis (<25 lympha), inc protein/lgG/ myelin basic protein. EEG shows a slowed/ delayed evoked potential (visual: strobe light, auditory). There are periventricular, brain stem, cerebellar or spinal cord white matter lesions. 4 courses:
  - all eventually get worse.
  - Benign: with transient sensory sx's, pt remains fully functional in all neurologic systems 15 yrs before the disease onset. 15% of pt's will never experience a relapse. Malignant MS refers to dz with a rapid progressive course, leading to significant disability in multiple neurologic systems or death in a relatively short time after dz onset.


  - Acute transverse myelitis, diphtheria, botulism, carcinomatous meningitis, periodic paralysis (inc/dec K), hypermagnesemia, hypophosphatemia, tick paralysis, heavy metal intoxication, organophosphate poisoning, acute porphyria, polio, myasthenia gravis, AIDS-related progressive polyradiculopathy, critical illness polyneuropathy, Zerri (44T).

recovery, early cerebellar/ motor problems. 40% of all pt’s after 15yrs require assistance with walking and almost all suffer impairment of bowel & bladder control.

**Immunomodulator therapy:** early use may prevent the progression. No current evidence to support overwhelming superiority of any one agent. All cost ~$1K/yr. All cause flu-like sx’s of F/C, H-A, and muscle aches that begin 3-4h after each shot and last 3-8h. The SE’s tend to lessen after the first few months. Can start with lower doses initially, take prophylactic NSAID or low dose prednisone (10mg TID) or take dexamethasone at night and “sleep through” the systemic response. Also have injection site reactions ranging from local erythema to necrosis. Reduce the dose if LFT’s >5x normal.

**Interferon-β (IFN-β1a) (Avonex):** 30µg IM qwk. It inhibits the release of TNF and lymphotxin and IFN-g from mono’s to decrease expression of MHC proteins, also increases T-suppressor cell function. Has demonstrated efficacy in slowing the cognitive progression in relapsing MS, but may lead to immunogenotoxicity (Arch Int Med 2002;162:2161-8)

**Interferon-β (Betaseron) (INF b1b):** 0.25mg (8 mil units) SQ qod. The only room-temperature drug available.

3. **Copaxone (Glatiramer):** 20mg SQ, has mildest SE’s. **All prevent progression** (neuroprotective). - data suggests treated groups have >30% less disability over modest timeframes than untreated group (efficacy may increase with longer duration of use – i.e. treated group disability may be substantially less over many years of Rx).

4. **Rebif (Beta interferon-1a):** 22 or 44 mcg (in 0.5ml) three times a week by SC injection slows progression of disability and reduces the frequency and severity of disease attacks in RRMS. Use of Rebif also significantly reduces the number of active brain lesions. Comes in ready-to-use, pre-filled syringes.

**Novantrone (Mitoxantrone):** anticancer drug, only more advanced or chronic MS to reduce the neurological disability and/or freq. of relapses. SE: blue sclera/ stoo/ urine for 2 days. N/V, H-A, leukopenia, alopecia, amenorrhea, heart failure.

**Other:** For symptomatic therapy one needs to prioritize the patient’s chief concerns, only monotherapy (start only one med at a time) starting slow titrating slowly, aim to improve function rather than isolated S/s, switch or add another therapy only after maximum tolerated dose is reached. Link: Muscle Relaxer: IV IgG 0.15-0.2 g/kg IV qmo for 2yrs. Reduces relapse rate.

**Plasma exchange:** seven exchanges QOD. Enhances recovery in acute relapse, or spasticity use Zanaflex (Tizanidine) 2 or 4 mg 2-3x/day, or Baclofen (Lioresal) 15-100mg/day, stretching. Diazepam, Dantrolene, Clonidine, Cyproheptadine.

For Ataxia: INH 600-1200mg. Clonazepam 2-8mg (low efficacy). Gabapentin 100-600mg TID, Primidone, Ondansetron.

**Dysesthesia:** CBZ or Phenytoin or TCA or other AED (e.g. Neurontin).

**Paroxysmal Pain:** CBZ, Phenytoin, Misoprostol, Gabapentin, Elavil.

**Fatigue:** a characteristic finding in MS, usually described as physical exhaustion that is unrelated to the amount of activity performed. Many patients complain of feeling exhausted on waking, even when they have slept soundly. It can also occur during the day, but may be partially or completely relieved by rest. It is often seen in association with an acute attack and may precede the focal neurological features of the attack and persist long after the attack has subsided. There is a poor correlation between fatigue and the overall severity of disorder or with the presence of any particular sx or sign. Amantadine 100mg BID-TID, avoid late day doses as get insomnia. Pemoline 37.5-112.5 mg qd. Methylphenidate 10-20mg BID-TID. SSRIs or Provigil (= Modafinil, an anti-narcoleptic): 100-200mg qAM.

**Other:** depression (SSRI, TCA), vertigo (Medicline, Scopolamine, Diazepam), detrusor hyperactivity (Oxybutynin, Tolterodine, Hyoscyamine), Flaccid bladder = detrusor areflexia (Bethanechol or intermittent self-catherization). Detrusor-sphincter dyssynergia (Terazosin or intermittent self-catherization). Avoid caffeine. If PVR >100-150ml consider qHS Desmopressin nasal spray, suppository. Avoid alcohol, caffeine, sleep deprivation, Stress (Sildenafil).

**Principle of Energy Conservation:** work at moderate pace, schedule short rest periods, organize tasks to avoid unnecessary steps, maintain good posture, avoid lifting/ carrying, delegate stress/ fatiguing work, ensure good temperature.

**Differential Diagnosis MS:**

Acute disseminated encephalomyelitis (ADEM, Follows infections or vaccination in children, fever, H-A, and meningitis), Lyme disease (+Ab’s to Borrelia sp.), HIV-associated myelopathy, HTLV-I myelopathy (HTLV-I antibodies present in serum/CSF), Neuropathophylaxis, Progressive multifocal leukoencephalopathy (Immunosuppressed patients, Bx of lesions demonstrates virus by electron microscopy), SLE (+ANA, anti dsDNA), Polyarteritis nodosa (PAN), Sjögren’s syndrome (anti-Ro and anti-LA antibodies, low lip biopsy helpful), Behçet’s disease, Sarcoidosis, Paraneoplastic syndromes, Subacute combined degeneration of cord (Peripheral neuropathy, B12 levels), Subacute myelopticoneuropathy (Japanese; adverse reaction to chlor hydroxyquinoline), Adrenomyeloneuropathy (Adrenal dysfunction, neuropathy, plasma very long fatty acids increased), Spinocerebellar ataxia (familial, pesc, spasticity, decreased reflexes, normal CSF IgG and no bands), Hereditary spastic paraparesis/ primary lateral sclerosis (nCSF, MRI, and visual evoked potentials). **Stroke**(multiple infarcts from emboli, vascularity, hypercoagulable state), paraneoplastic, Progr Multif LE, sarcoid, AVM, SLE, extradural cord lesion, cranial-cervical junction abnormality, psychophysiological disorder, Vit-E def, Vit B12 def, central pontine myelinolysis, primary CNS lymphoma.

Miscellaneous: arteriovenous malformations, arachnoid cysts, Arnold-Chiari malformations, and cervical spondylosis all may lead to diagnostic dilemmas on occasions. These conditions may coexist differentiation based on history, clinical follow-up, and MRI features.


**Muscular Dystrophies:**

A heterogeneous group of congenital muscle dz’s characterized by severe muscle weakness, atrophy, elevation of serum muscle enzyme levels, and destructive cytoarchitectural changes of muscle fibers. The traditional classification of muscular dystrophies into Duchenne, Becker, limb-girdle, and congenital has changed because several genetic defects in muscle proteins responsible for some of these dz’s have been identified and because the absence or deficiency of specific muscle proteins has been demonstrated as the cause of these dz’s.

**Myotonic dystrophy:** the most common adult muscular dystrophy. It has an incidence of one per 8,000 population and a prevalence of about five per 100,000 population. The myopathy has a unique distribution: (1) ptosis of the eyelids, without extracocular muscle involvement; (2) atrophy of the masseters and the temporal muscles, which results in a unique, narrow face structure; (3) sternocleidomastoid muscle atrophy and relatively preserved posterior neck and shoulder girdle muscle (a clinical sign that differentiates myotonic dystrophy from facioscapulohumeral muscular dystrophy [FSHD]); (4) distal muscle group atrophy, with slight proximal involvement in the earlier stages of disease; and (5) involvement of the palatal and pharyngeal muscles, which may produce dysarthria and dysphagia. Myotonia, defined as the slowing of relaxation of a normal muscle contraction, is an important clinical sign. To elicit myotonia during examination, a patient makes a firm hand grip and...
then lets it go rapidly. An inability to immediately release the grip is evident. Percussion of the thenar eminence or the extensor digitorum also shows the characteristic slow relaxation of myotonia. Systemic features include cardiac conduction defects, mild mental dysfunction (often with silly or inappropriate behavior and expressions), testicular atrophy, frontal baldness, caraacts, gastrointestinal tract involvement (with delayed motility and emptying), hypersomnia, and a diminished response to hypoglycemia, which leads to poor concentration and apathy. Therapy is symptomatic. Emotional support and education regarding the precautions necessary to avoid falls and injuries are essential. Careful monitoring of the cardiac status, especially during the administration of anesthesia, is important. Drugs such as quinine, procainamide, mexiletine, phenytoin, and beta blockers may help relieve the myotonia but not the weakness. Mexiletine appears to be the most effective therapy.

**Facioscapulohumeral:** Autosomal dominant, congenital form and adult form. Normal life span, facial and UE. The third most common form of muscular dystrophy. It usually begins during the second decade of life. Patients present with facial muscle weakness (especially of the orbicular muscle of the eye); the extracocular, masseter and pharyngeal muscles are spared. Early weakness of the scapular muscles produces prominent scapular winging and gives the shoulders a forward, sloped appearance. Weakness in the anterior tibial muscles, which leads to footdrop, is always present. The disease progresses slowly, and there are long periods of stability. Progression occurs in a descending manner: involvement of the shoulder girdle muscles is followed by involvement of the biceps, triceps, and pelvic girdle muscles.

**Dystrophinopathies:** caused by a deficiency of dystrophin, a 427 kilodalton rod-shaped cytoskeletal protein. Dystrophin constitutes 5% of all sarcolemmal cytoskeletal proteins and serves to anchor F-actin (the filamentous form of actin) to the plasma membrane (sarcolemma) of muscle. Dystrophin appears to reinforce and stabilize the plasma membrane during the stress of muscle contraction by maintaining a mechanical link between the cytoskeleton and the extracellular matrix. Deficiency or absence of dystrophin is associated with various dystrophinopathies, the prototype of which is Duchenne muscular dystrophy (DMD).

**Duchenne’s:** Seen in early childhood. X-linked recessive, progresses over 10-20yrs, calf hypertrophy, contractures, abnormal ECG, inc CPK.

**Becker muscular dystrophy (BMD):** Seen in mid-childhood/adolescence, X-linked, progresses over 20-40yrs, calf hypertrophy, symmetrical, pelvic/femoral distribution, contractures, 45% with abnormal ECG, inc CPK. Becker muscular dystrophy BMD and DMD are allelic disorders, but BMD generally starts later and progresses more slowly. About 65% of patients with BMD have in-frame deletions in the dystrophin gene, but the produced protein is often truncated and only semi-functional. Cases may be recognized as early as 3 years of age or as late as 70 years of age; the mean age at onset is 12 years. The spectrum of phenotypic expression of BMD is wide. Mild forms manifest only as muscle cramps, exercise intolerance, hypotonia, asymptomatic elevation of serum CK levels, mild muscle weakness, or quadriiceps myopathy. Calf pain on exercise is often a presenting symptom, and calf enlargement is frequent. Most patients lose ambulation by the age of 40 (range, 10 to 70 years of age). The age of death also varies, from 23 to 89 years (mean age, 42 years). Patients present with proximal muscle weakness and serum CK levels as high as 20 times normal. The muscle biopsy findings are similar to those in DMD patients but are not as severe. In patients younger than 8 years, the presentation of BMD is usually indistinguishable from that of DMD. Cardiac manifestations are common; their severity is unrelated to the myopathy, and the cardiomyopathy may be severe.

**Muskular Dystrophy Caused by the Absence of Telethonin:** telethonin is a sarcomeric protein localized to the Z disk of skeletal muscle. Absence of telethonin causes limb-girdle muscular dystrophy (LGMD) referred to as LGMD 2G. It is a rare autosomal recessive disorder. Disease onset occurs at 2 to 15 years of age, often with distal muscle involvement. Disease progression is variable. Muscle biopsy may show vacuoles within the muscle fibers. The CK levels are increased 10- to 30-fold. Mutations in the telethonin gene cause disruption of the sarcomeric structure. 12 The absence of telethonic localization, as determined immunocytochemically, confirms the diagnosis. There is no specific treatment for this disorder.

**Sarcoglycanopathies:** the sarcoglycan complex consists of four transmembrane proteins, the 50 kd alpha-sarcoglycan, the 43 kd beta-sarcoglycan, the 35 kd gamma-sarcoglycan, and the 95 kd epsilon-sarcoglycan. The transmembrane components of the sarcoglycan complex are specific to skeletal and cardiac muscle, and their integrity is critical for normal muscle physiology. Defects in these proteins cause the autosomal LGMDs known as the sarcoglycanopathies. Males and females present with mild to severe proximal muscle weakness (especially in the legs), an elevation of the CK level to about 3,000 units, dystrophic changes in the muscle, and often calf hypertrophy. The age at onset is variable.

**Cavendish-3 Deficiency:** a 21 to 24 kd internal membrane protein, may play a role in the regulation of muscle glycolysis. In a report of eight patients from two families, mutations in the caveolin-3 gene were identified as causing an autosomal dominant LGMD, designated LGMD 1C; disease onset occurred at 5 years of age, with muscle cramps after exercise, muscle hypertrophy, and moderate muscle weakness. There is no specific treatment for this disorder.

**Defects of Alpha-Integrin:** integrins are heterodimers that integrate the extracellular matrix with cytoskeletal proteins.

**Myotonic Dystrophy:** mutations in the alpha-integrin gene have been found in rare patients with delayed motor and psychomotor milestones on neurologic examination and development. In these patients, alpha-integrin was found to be defective in the sarcolemma.

**Dysferlinopathy:** mutations in the dysferlin gene cause two types of myopathy; the Miyoshi distal myopathy, characterized by very high CK levels and early involvement of the gastrocnemius muscle, and LGMD 2B, characterized predominantly by proximal muscle weakness.

**Other Causes of MD:** mutations in the cytosolic proteins, intermediate filaments, nuclear membrane protein called emerin and defects in extracellular matrix proteins.

**Amyotrophic Lateral Sclerosis (ALS):**

Lou Gehrig's dz. Mean onset age 5-7y/o, but any age affected. Idiopathic, progressive degeneration of anterior horn cells/UMN/ LMN in lateral column of spinal cord: muscle weakness/ wasting/ fasciculations. Familial in 5%, most sporadic. (Postgrad Med 1999:4)

**Criteria:** LMN & UMN signs in 3-4 regions with evidence of progression. Probable if 2 regions with evidence of progression. Most p’s die in 5yrs (70%). 15% live for 10+ yrs.

**Clinical:** asymmetrical muscular weakness. C/o of tripping, stumbling or awkwardness when running or walking. May have difficulty buttoning clothes, picking up small objects or turning keys. Bulbar ALS leads to speech problems and exaggerated emotional responses. Cramping, twitching, ill-defined weakness and fatigue. Tongue fasciculations with progressive limb weakness affecting distal more than proximal muscles, particularly of the hand. Bowel and bladder function unaffected.

**W/u:** LP, B12, SPEG, UPEP, heavy metal studies, anti ganglioside Ab, MRI to exclude other etiologies.

**Tx:** Refer to multidisciplinary ALS care center. (WWW.mdausa.org oralsa.org) Riluzole (Rilutek): decreases glutamine
release. 10mg qd. Tx spasticity and sleep disturbances with symptomatic meds such as Baclofen, Diazepam, Dantrolene, anticonvulsants, TCA’s.

**Stiff Man’s Syndrome = Stiff Person Syndrome (SPS):**

A heterogeneous d/o associated with involuntary muscle stiffness or spasms. May be idiopathic, paraneoplastic or an autoimmune disorder depending on the pt. Leads to functional impairment of spinal neurons due to ab’s directed against the enzyme glutamic acid decarboxylase (GAD) in others. This enzyme is essential for the conversion of glutamic acid to GABA, an inhibitory neurotransmitter. There also is a paraneoplastic form of SPS. Studies show continuous excessive firing of the motor unit, suggesting that the disorder is due to disinhibition of the descending pathways to the Renshaw cells or gamma motor system.

**Risks:** more common in women, associated with other autoimmune disorders (DM, thyroiditis, MG, pernicious anemia, and vitiligo).

**S/s:** often presents with painful muscle cramps, severe lordosis secondary to chronic spasm of the paraspinal muscles. Cranial involvement in 25%. Stress or exertional activity may provoke painful spasms that may last for hours. Because of hypertonicity, the gait may resemble that of a “tin soldier.” Insidious onset during the fourth or fifth decade. Intermittent muscle rigidity/stiffness and spasms, usually symmetric, most often in the back but may involve muscles in the abdomen, extremities, head and neck. A stereotypic motor pattern during attacks may occur. Lack of neurological signs. Episodes may be spontaneous or they may be precipitated by sudden or loud noises, sudden movements, anxiety, strong emotions, and/or sudden jarring. The spasms may be painful. Late changes include gait abnormalities, a restricted range of motion and slowness of movement. Some pt’s experience an aura-like feeling prior to spasmodic attacks. Some pt’s show a phobia to crossing open spaces unaired.

**Ddx:** dystonia and orthostatic tremor (tight cramping muscles and pain, especially when standing). Tetanus (local muscle spasm at the site of inoculation, then to bulbar and generalized spasms), progressive encephalomyelitis with rigidity (begins with pain and sensory changes), and Isaac’s syndrome (familial, peripheral neuropathy, sx’s more in the appendicular muscles than in the axial).

**W/u:** EMG: continuous motor unit activity is essential to confirm the diagnosis of SPS. The presence of reduced motor activity after benzo administration. EMG studies may be nonspecific but often show continuous motor unit activity in the affected muscles. Diagnostically, spinal fluid analysis may reveal inc immunoglobulin or oligoclonal bands, and the presence of GAD ab’s. 65% with + serum anti-Gad-65 Ab = glutamic acid decarboxylase. Autoantibodies, which may be present in both serum and CSF include anti-GAD ab’s, ab’s to islet cells, antithyroid antibodies, antilipidic ab’s, anti-GABA-ergic neurons, ab’s to amphetamin (a protein in synaptic vesicles, found in the paraneoplastic syndrome) and ab’s to 125/130 kd protein (found in the paraneoplastic syndrome).

**Tx:** controlling rigidity, Diazepam @ 20-300 mg/day is the most effective med for this purpose. Baclofen, clonazepam, valproic acid, and clonidine may all help. The role of tx for autonomic conditions, such as phasemapheriesis, corticosteroids, or azathioprine, has yet to be defined. Intrathecal baclofen and botulinum toxin may also be beneficial. Caution must be used in mixing narcotic medications with benzo’s, especially if the patient’s spasms induce respiratory acidosis because of the rigidity of the diaphragmatic muscles. IVIG can give remarkable improvement in some individuals in case reports (NEJM 2001;345:1870). **Interventions that can reduce or stop an attack:** Both rigidity and spasms stop during sleep or anesthesia. Myoneural or peripheral nerve blockade may stop attacks. Intravenous or oral diazepam may result in a significant improvement in symptoms, which may be a diagnostic finding. Corticosteroids with or without plasmaphoresis may result in significant clinical improvement.


**Peripheral Neuropathies:**


Diffuse lesions of peripheral nerves causing weakness, pain, sensory disturbances, reflex changes.

**Hyperalgesia =** excessive sensitivity to pain.

**Allodynia =** a painful response to a stimulus that would normally be non-noxious.

**Diagnosis:** Considering:

**Vibratory sense:** ankle Vs knee. If pin is more affected then small fiber (DM, amyloid, idiopathic), if both affected then mixed, if vibratory more, then inherited/ cervical spine (dorsal columns) or demyelinating.

**Refluxes:** absent, symmetric. If absent reflux with preserved strength indicated demyelinating/ inherited or acquired.

**Normal neuro exam:** myopathy, Check: systemic sx’s (fever, r/o infection: viral (polio, rabies, coxackie, flu, rubella, HIV, EBV), bacterial, parasites).

**Bilateral Diffuse:** Proximal: MG, polio, alcoholic myositis, acute periodic paralysis. Distal Weakness: botulism, diphertheria, tetanus, heavy metals, tick paralysis, Guillain-Barré Syndrome (GBS), metabolic d/o.

**Asymmetric/ focal:** mononeuropathy (compression, trauma, HSV, Bells, sarcoid), mononeuropathy multiplex (MS, vasculitis, transverse myelitis).

**Non physiologic:** psychogenic, conversion d/o, malinger, chronic fatigue syndrome, fibromyalgia, anxiety d/o.

**Rapid Onset:** ischemic neuropathy, PAN, RA, DM, nerve compression (hernorrhage, swelling), penetrating wound, thermal injury, iatrogenic.

**Patterns:**

Acute severe generalized peripheral neuropathy: seen with vasculitis, GBS, DM, drugs (nitrofurantoin, vincristine, cisplatin, revers transcriptase inhibitors), porphria, diphertheria, paraneoplastic, critical illness and acute idiopathic sensory neuropathy.

**Multiple Mononeuropathy:** d/o of 2 or more nerves. Most commonly is due to a systemic abnormality such as vasculitis, can be seen in sarcoid, lymphoma, carcinoma, amyloid, leprosy, cryoglobulinemia, Lyme, HIV, neoplasms invading nerve root, neurofibromatosis or due to multiple compression pathies (metabolic or toxic neuropathy or hereditary).

**#1:** Symmetrical distal sensory loss & weakness: Stocking-glove neuropathy. They are the most common form, seen in 5% by age 55yo. Seen in DM after 10-25yrs, often with autonomic involvement. Common with alcoholism and consuming >100ml ethanol daily >3yrs as directly neurotic along with poor Vit-B intake. Also seen with uremia and metabolic disorders such as liver dz, hypothyroidism, BLE, rheumatoid, sarcoid, SJogren’s, mega dose B6, B12 def, hereditary neuropathy (CMT), and HIV.

**Sx:** "+" pain, pins-and-needle, burning or cold, "-" hypesthesia, esthesia, anesthesia can quantitate the sensory loss with
successively rigid flexible monofilament. Often assoc. with wt loss at time of Dx, worse at night. Improves in 6-24 mo depending on glycemic control, monitor for secondary depression. Motor→ dec strength of intrinsic foot muscles→ hammer/claw toe, bunion deformities, prominent metatarsal heads, muscle atrophy.

Ddx: metabolic (uremia, folic acid/ B12 def, hypothyroid), toxic (ETOH, heavy metals, industrial hydrocarbons, drugs), inflammatory (sarcoid, leprosy, PAN, SLE), other (disproteinemia, paraproteinemia, paraneoplastic syndrome, leukemia, amyloidosis).

#2: Symmetrical Sensory Loss with both distal & proximal weakness: Usually due to acquired demyelinating process such as acute inflammatory demyelinating polyneuropathy such as Guillain-Barré (GBS) or chronic inflammatory demyelinating polyneuropathy (CIDP). Also seen with paraproteins (IgG, IgA or IgM) such as monoclonal gamopathy of undetermined significance (MGUS).

#3 Asymmetric Sensory Loss & Weakness: seen with mononeuritis multiplex, vasculitis (PAN, Churg-Strauss, SLE, Sjögren’s, Wegener’s, Giant cell), cryoglobulinemias, infections (Lyme, Leprosy) and multiple pressure palsies (multiple nerve entrapments seen in RA, hypothyroidism, acromegaly, amyloid, sarcoid).

#4: Asymetric sensory loss w/o weakness: seen with compression neuropathy (carpal tunnel), injury to the dorsal root ganglia, paraneoplastic (anti-HU Ab’s).

#5: Asymmetric Weakness w/o sensory loss: rare, mostly with motor neuron dx such as ALS or multifocal motor neuropathy (MMN, has distal > proximal, begins in upper extremity, high titers of anti-GM1 & anti ganglioside, Tx with IVIG, Cycloxyan and plasmapheresis). R/o lead poisoning if have asymmetric wnst drop.

Approach to Neuropathy: Questions:

#1: Time course: acute (<1mo), chronic (>1mo).

#2: Distribution: symmetric, proximal (demyelinating) or polyneuropathy.

Mononeuropathy: d/o of a single nerve, often from entrapment or trauma. Or Mononeuritis multiplex (see above).

#3 What Nerve Fiber Type Involved: Pure motor: GBS, DM, critical illness polyneuropathy, porphyria, chronic inflammatory demyelinating polyneuropathy (CIDP), lead intoxication (often have sensory findings), Charcot-Marie-Tooth (CMT, a hereditary motor and sensory neuropathy), Ab to GM1 gangliosides, multifocal motor neuropathy. Consult neurology.

Acute polyneuropathy: GB synd, spinal cord compression.

Rare: acute intoxications (arsenic, thallium), porphyria, MG, botulism, Fabry’s dz, vasculitis.

Sensorimotor: consider DM, ETOH, meds, B12, hypothyroid, uremia, HIV, vasculitis, hypothyroid. Lyme, paraproteinemia, cryoglobulinemia, paraneoplastic, drugs, toxins, CIDP, CMT, other hereditary, metachromatic leukodystrophy, Refsum’s dz, lipoprotein def, adrenomyeloneuropathy.

Sensory only: consider early sensorimotor, DM, uremia, ETOH abuse, dec V-B1,6,12, niacin, HIV, hereditary polyneuropathy, drugs (vinca alkaloids, cisplatin, Phenytoin), toxins (inc B6), Sjögren’s, paraneoplastic, cryoglobulinemia, amyloid, leprosy, anti-sulfated Ab’s. Acquired pure sensory neuropathies are rare, usually due to pyridoxine therapy or paraneoplastic syndromes.

Prominent Proprioceptive Loss: Vit-E def, HIV, B6 intoxication, Sjögren’s, paraneoplastic (anti-HU), Cisplatinum, idiopathic sensory neuropathy.

Prominent Ataxia: B12 def, tabes dorsalis, Friedreich’s ataxia, megadose of pyridoxine, Cis-Platinum, monoclonal gamopathy, paraneoplastic, inflammatory, hereditary, polyneuropathy.

Vasculitis: asymmetric (as is CIDP), tx with prednisone, Cytoxan.

Autonomic/ Small fiber Neuropathy: Have die pinprick & temperature sensation, often with neuropathic pain. C/o of erectile dysfunction, incontinence, orthostatic hypotension and GI dysmotility.

R/o DM, ETOH, AIDS, amyloid, paraneoplastic, hereditary d/o, vircristine toxicity, acute porphyria, HIV, GBS, paraproteinemia.

Idiopathic small fiber neuropathy: elderly, common, have slowly progressive burning feet, stocking sensory loss, nl NCV (NCS) (as tests mostly large fibers, gives velocity and amplitude. Helps distinguish axonal neuropathy (DM, ARF) from demyelinating (disimmune: GBS, CIDP, or genetic); Impaired thermal perception (C fibers)/ cold perception (A-Alpha). Death due to arrhythmia, aspiration pneumonia, renal failure, silent AMI→ cough, N/V, dyspnea, tiredness, ECG changes.

S/s: CV→ Orthostatic hypotension with nocturnal HTN (vagal denervation, lose the normal beat-beat variability in HR)-resting tachy, fixed HR, painless ischemia, sudden death, heat intolerance (prone to dehydration).

Cutaneous→ inc/dec sudomotor (sweating) causes dry scaly skin and fissuring along with contracture and hammer toe it lead to ulcers. Pedal edema. Papillary→ tonic/ constricted pupil, sluggish light reflex, night blindness, Argyle Robertson pupil, + methacholine test. Gl→ constipation (dec gastrocolic reflex), diarrhea at night (r/o neoplasia, impaired motility or inc secretory), gastroparesis (see GI section), esophageal dysfunction, fecal incontinence (abnormal sphincter/ sensation). GU→ impotence, retrograde ejaculation, UTI’s, bladder-urgency (yet dec freq. is often the initial sx of neurogenic bladder).

Metabolic→ dec awareness of hypoglycemia, inc hypoglycemia (interference with counter regulation)

Tx: For gastroparesis use Reglan (metoclopramide) 10mg QID 10 min qAC and hs, or Emyc 200-mg PO 30 min qAC, liberal fluid intake. MRI to ensure adequate ventilation. If

SPEP, serum ACE, ANA, ANCA, CXR, anti-Ro and anti-La Ab’s.

Lab W/u of weakness: Focal: in rapid onset consult neurology, r/o DM & vasculitis, Check: ECG. Subacute onset, check EMG/ NCS, if common sight of compression, consider conservative Vs surgical correction.

Multifocal Pattern: EMG/NCS, if axonal consider DM/ vasculitis, neurology: for nerve Bx. If demyelinating consult neurology.

Symmetric Pattern: EMG/NCS, if demyelinating neurology. Check: FVC if acute onset to ensure adequate ventilation. If axonal (asymmetric features proximal/ CN’s/ arms-legs, acute onset) then neurology consult.

Step #3: Bence-Jones proteins in urine, CSF (cells, protein, oligoclonal bands of immunoglobulins), HIV, antigliadin Ab, antineuronal Ab’s (Hu & Yo), antmyelin associated glycoprotein Ab’s. Tests for Sjögren’s, search for ca (skeletal survey, pelvic U/S, CT of chest & abd, mammography, PET scan. Peripheral nerve myelin protein 22 gene duplication (CMT-type 1) or deletion (seen in hereditary neuropathy with liability to pressure palsies), PO gene mutation (another cause of CMT).

Exceptions: the more severe the neuropathy, the more likely a cause will be discerned – many mild neuropathies, especially in older persons, remain idiopathic with current diagnostic technology. A neuropathy work-up is still important because neuropathy may-be a sign of a more serious illness (diabetes, paraneoplastic, etc.), or there may exist a treatable entity
present (B12 def).

**Lower Motor Unit (LMN, NMJ, muscle):** individual muscles or groups, den nerve reflexes, den tone, fasciculations, +Wasting, weakness, atrophy (disuse and neurogenic).  
**Face:** Ipsilateral forehead and lower face weakness with impaired eye closure.  
**Tongue:** deviates to side of lesion as unopposed action of opposite genioglossus muscle.  
**Upper Motor Neuron (UMN) sign:** Affects muscle groups only, spasticity (inc tone), inc reflex, up going toes.  
**Autoimmune:** DM, amyloid, porphyria, paraneoplastic, lymphoma, thallium, arsenic, mercury, Thalidomide def, vincristine, GBS, alcoholic, HIV.  
**Pure Sensory:** paraneoplastic, meds, carcinomatous, lymphomatous, Sjogren’s, paraproteinemia, nonsystemic vasculitic, idiopathic, styrene induced, primary biliary cirrhosis, Crohn’s, Vit-E def, chronic gluten enteropathy, Friedreich’s ataxia.

UMN impaction can occur with the common acute stroke syndromes, space occupying lesions of the CNS, and lesions of the spinal cord (trauma, infection, tumor, vascular anomalies, hypertrophic degenerative skeletal changes, and the less common demyelinating diseases and congenital leukodystrophies).  

**Other cranial neuropathies** include medicamentosus peripheral neuropathy, diabetic sensorimotor neuropathy, and toxic neuropathies.  

**Other causes:** 
- **Other causes:** B12 def, Vit-E def, folate def, Thalidomide def, hypothryoid, uremia, entrapment, CTD (RA, SLE, PAN Sjogren’s...), syphilis (tabes dorsalis), diphtheria, leprosy, Lyme, Targets dz, acromegaly, paraproteinemia, neoplastic.

**Neurotoxins:** arsenic (GI distress, hyperkeratosis, hyperpigmentation, Mees lines), Lead (GI distress, microcytic anemia, basophilic stippling), Mercury (GI, tremor, ataxia, gingivostomatitis, neuropsychiatric), Thallium (GI, delirium, sz, coma, alopecia, Mees lines), Carbon disulfide (encephalopathy, Parkinson’s, nystagmus), acrylamide, Alcly chloride, ethylene oxide, hex carbons, methyl bromide, trichloroethylene, polychlorinated biphenyls (PCB’s), organophosphates, Voc (PNU).

**Drug causes of Polyneuropathy:**
- **Primarily Sensory:** Chloramphenicol, Colistin, Ethionamide, Nalidixic acid, Sulphiaime, Phenelzine, Methysergide, Hydralazine, Cytaarabine, Procambarine, Vincristine, Cisplatin, PCN, inc B6, DD, DD, Stavudine, Zalcitabine, Thalidomide, nitrous oxide.
- **Primary Motor:** Amphotericin B, Dapsone, Sulfonylamides, Amritiplyine, Imipramine, Gold, Cimétidine, Antitoxan toxin.

**Chronic Renal failure:**polyneuropathy develops in up to 60% of patients with chronic renal failure.  

**Risk of uremic neuropathy** is related to the duration and severity of renal failure. Slowing of motor conduction velocity is seen when the creatinine clearance falls below 10% of normal, although conduction slowing is only roughly correlated with symptoms. Uremic neuropathy is sensorimotor in nature, with distal predominance of symptoms and signs. Once established, uremic neuropathy tends to worsen slowly, the main troublesome symptoms being unpleasant dysesthesia in the feet.  

**Polyneuropathies Caused by Infectious Dz’s:**
- Leprosy: probably the most common cause of polyneuropathy in the world. Sensory loss is the cardinal symptom of leprosy.  
- HIV infection: Several PNS disorders occur, the main symptom is continuous burning discomfort, mostly in the feet, where some degree of sensory loss is apparent. Motor involvement is usually minor, although the patients are often debilitated by concomitant infections and weight loss. The cause is sometimes identifiable-for example, vitamin B12 deficiency or treatment with a retroviral agent known to be neurotoxic (DDC or zalcitabine) but the cause in some patients remains unclear.  
- **Lyme disease:** It is unclear whether the neurologic manifestations are caused directly by spirochetal invasion of nerve tissue or by the immune response to the host’s organism. The main early neurologic features are cranial neuropathies, spinal radiculopathies, or both. Headache and neck stiffness may accompany the peripheral nerve symptoms, reflecting meningeval inflammation. Facial neuropathy is the most common cranial neuropathy, and a misdiagnosis of Bell palsy is often made. However, unlike in idiopathic Bell palsy, bilateral facial neuropathy is common in Lyme disease. Other cranial neuropathies occur less often. Spinal nerve root involvement typically begins with pain in a radicular distribution, followed by weakness in 1 to 4 weeks. The weakness is often asymmetrical and patchy, resembling multiple mononeuropathies, In late-stage Lyme disease, patients may experience either a mild distal polyneuropathy or radicular pain with sensory signs.
Varicella-zoster virus: The initial symptom is dermatomal pain, followed in 3 to 7 days by the vesicular eruption. Sensory loss is difficult to demonstrate until the skin lesions begin to heal. Motor weakness is reported in as many as 30% of patients but may not be noticed by a patient distracted by pain. The cutaneous lesions persist for 7 to 10 days and then resolve, often leaving depigmented areas and scarring. Motor weakness can be expected to improve spontaneously in most patients. Pain also improves slowly, except in patients who experience postherpetic neuralgia (PHN). PHN is usually defined as pain persisting more than 4 to 8 weeks after healing of the skin lesions.

Charcot-Marie-Tooth Syndrome (CMT):
A hereditary neuropathy with peroneal atrophy, high arches (pes cavus), claw/hammer toe deformity, scoliosis, Charcot joints. Causes 90% of inherited peripheral polyneuropathy. 70% of pt’s have duplications of the gene for the 22kDa peripheral nerve myelin proteins on Chromo 17 leading to overexpression of the protein. Sensitives ranges from the classic pes cavus with inverted champagne bottle legs to scarcely detectable clawing of the toes. Follows a symmetrical pattern with distal motor & sensory deficits. There are many forms (~10 types), can be autosomal dominant (AD), AR and X-linked. Type 1, the most common is demyelinating (slows nerve conduction velocity) and is AD. Type 2 is axonal (conduction velocity is only slightly slowed), Type 3 (rare, Dejerine-Sottas dz, demyelinating), Type 4 (rare, Refsum’s dz), hereditary neuropathy with liability to pressure palsies (HNPP). If FHx is unclear, examine relatives and order NCS. Sx’s usually begin during the 2nd decade. No specific therapies.

Diabetic Neuropathy:
Due to protein glycation and polyol pathway. Variable manifestations. Incidence in Type 1, inc prevalence in Type 2 DM. Diffuse lesions of autonomic nervous system (ANS), both afferent and efferent, only 30% are symtomatic. Risk: HTN, inc LDL, dec HDL, female, age and duration of DM.

1. Distal symmetric sensorimotor polyneuropathy (75%) loss of ankle reflexes and distal vibration
2. Autonomic:

Tx of Neuropathy: Most forms have no specific tx. Optimal glucose control if diabetic. Prevent problems with appropriate footwear, moisturizing creams, water temp monitoring before bath, avoiding positions that compress such as leg crossing and leaning, nocturnal wrist splints for CTS, topical capsaicin (Zostrix)-warn that dysesthesia may worsen first 2-3 days. Antioxidants=> V-E 400 IU/d, V-C 500mg/d. Supportive with ROM exercises & splinting to prevent contractures, ankle-foot orthoses, ambulatory aids, DVT prophylaxis as needed.

Pain Control: 1st Line: Gabapentin start @900mg/d, increase to max of 3,600mg/d over 4wks. Or Tramadol (Ultram).
2nd Line: TCA,
3rd Line: CMZ, phenytoin, capsaicin, mexiletine.
4th Line: long-acting narcotics.

Sharp/lancinating pain: use CMZ (Tegretol) start @ 200mg BID, then TID (monitor CBC/LFT) or phenytoin (Dilantin) that inc membrane stability, reducing synaptic transmission.

Burning, steady pain: antidepressants amitriptyline (Elavil) @10-25 mg qHS titrating slowly to 150-200, this potentates 5HT in descending anti-pain pathways (or Nortriptiline = Pamelor 25mg qHS titrate to 150mg). Can use phenoxybenzamine (Dibenzyline) to decrease sympathetic potentiation of nociceptive fibers. Bupropion SR 150-300mg qd.

Unremitting Foot pain: 150mg Mexiletine BID-TID (antiarrhythmic at ½ dose) X 3mo than taper, if pain returns restart at lowest effective dose. 50% improvement.

Other: Thiocytic Acid (Alpha Lipoic Acid): herbal antioxidant 600-1200mg/d. Found in potatoes, liver, broccoli and skeletal muscle. May help increase blood flow to nerve. Pregagalin: 300mg TID PO, shown to be safe and effective in small studies, a structural analog of GABA.


**Brachial Plexus Neuropathy:**

**Sensory loss of ½ of finger:** digital neuropathy (paresthetica). Often due to carrying heavy plastic grocery bags, bowling, playing a stringed musical instrument or prolonged use of tools or scissors. R/o compression by a cyst or neuroma. Weakness is never present. Tx conservatively with avoidance of compressive activity. Add protective padding. Brachial plexus formed by ventral (dorsal to paraspinal m’s) rami C5-T1.

The Plexus:

Erb's Palsy (Duchenne): upper brachial plexus injury (C5-6): paralysis. Birth injury, MVA. Arm hands at side internally rotated & extended at elbow in “bellhops tip position”.

Klumpke's Palsy: Lower plexus injury (C8-T1), from traction on an abducted arm in falls, Pancoast’s tumor. Claw deformity weakness/ wasting of hand muscles. May have Horner's syndrome if T1 lesion.

Suprascapular Nerve (C5-6): supraspinatus, infraspinatus. May get entrapped under the transverse scapular ligament, causing muscle atrophy and deep shoulder pain. R/o rotator cuff injury, frozen shoulder, arthritis, cervical radiculopathy, upper brachial plexus injury.

Musculocutaneous Nerve (C5-6): arm flexors, coracobrachialis, biceps, brachialis, and lateral cutaneous nerve (sensory to radial forearm).

Subscapular N (C5-7): teres minor, subscapularis.

Thoracodorsal N (C6-8): latissimus dorsi.

Long Thoracic N (C5-7): serratus anterior. Damage: winging of scapula. Have pt lean forward against a wall with arms outstretched, will see scapula separate from posterior chest wall when it is contracting.

Multiple brachial plexus lesions:

Etiology: tumor (Pancoast’s, lower trunk), idiopathic brachial plexitis, viral, DM, vasculitis, trauma, inherited (AD), radiation.

Lab: CXR, Chem 7, ANA, ESR.

Idiopathic Brachial Plexus Neuritis:

M:F 2.4:1, most cases age 20-60yo, prior URI in 25%, bilateral in 30%, recent vaccination. His is relatively common, and it can mimic acute shoulder or cervical disease. Cervical disease has neck pain as well as simultaneous muscle weakness.

Sx: acute onset of intense shoulder/ arm/ rarely hand pain (often burning), then 70% with weakness in 2 wks with gradual recovery of strength in 3-4 months. Clearly has >2 nerves involved. Good prognosis, 60% normal in 1yr, 90% in 3yrs. If not improving in 4wks, Check: MRI of plexus, see inc T2 signal intensity in affected muscles with some atrophy if late.

Tx: analgesics, then PT X 3-8wks. Corticosteroids have no proven benefit. Get cervical MRI if not improving.

Radial Nerve (C5-8):

Links: Posterior Interosseous Syndrome: Radial Tunnel:

Triceps, brachioradialis, supinator. In forearm as posterior interosseous nerve; Extensor indicus, ECU, EDL, EPB, EPL, APL. 3 areas of common injury:

1. Axillary compression: from crutches misuse, poor arm position in drunken sleep, will have weakness of triceps & distal muscles.

2. Upper Arm Compression: from drunk sleep with arm draped over a chair, aka Saturday Night Palsy, or from callus of humerus fx, general anesthesia; Wrist drop (weakness of wrist extensors), normal triceps, r/o lead poisoning.

3. Forearm Compression: Posterior Interosseous Neuropathy (PIN): from lipoma, ganglion, fibroma, rheumatoid changes entraps it. Finger drop (weak thumb/ finger extensors), no sensory change, no wrist drop. If not improved in 4-8wks, need surgery.

Post interosseous syndrome:

Compression of radial nerve as it courses through the supinator m. 
S/s: lateral elbow pain that radiates into distal forearm, more diffuse pain than epicondylitis, aggravated by supination-pronation. Exam often with a +Tinel’s as tap 8cm distal to lateral epicondyle. Max TTP distal to condyle. Weakness of wrist extensors/ extension of digits 2-4 at MCP joint.
Tx: similar to lateral epicondylitis rest, modify activity.

Radial (Supinator) Tunnel Syndrome:

Tunnel is at the elbow, and has the radial nerve and its two main branches (posterior interosseous and superficial radial). Compression at fibrous bands anterior to radial head, branches of recurrent radial artery, ECRB and supinator muscle.
Associated with repetitive manual activities that involve forearm rotation.

**S/s:** Dull ache/ pain in dorsal proximal forearm and TTP in extensor-supinator mass at lateral aspect of elbow (distal to epicondyle) radiating to forearm. Inc pain with resisted extension of middle finger and resisted supination. Relief on injection of lidocaine into radial tunnel. Very similar sx’s to tennis elbow, both may coexist in same pt. Tennis elbow has sharp pain at the ecmined wrist, worse with activities. May have paresthesias in distribution of superficial radial nerve. Usually no muscle weakness.

**Dx:** Motor & sensory findings usually absent. Point tenderness over radial nerve in proximal forearm. Injection of an anesthetic agent into lateral epicondyle to r/o tennis elbow.

**Tx:** Cessation of activities that provoke sx’s (repetitive movements, forceful gripping). Heat, ice, stretch the extensor muscles. Next try splinting elbow in flexion with elbow supination and wrist extension to relax the involved musculotendinous units (wrist cock-up splint). Usually takes months for improvement. Comprehensive physical therapy program.

### Axillary Nerve (C5-6):

Teres minor, deltoid. Injury seen when sleep in prone position with arms abducted above head, compression from a thoracic harness, quadrilateral space entrapment (terte minor muscle & triceps)

### Median Nerve (C5-T1):

All forearm pronator, flexors (except FCU, FDP of 3&4), “LOAF” muscles in hand: Lumbricals 1&2, Opponens pollicis brevis, Abductor pollicis brevis, Flexor pollicis brevis.

#### Carpal Tunnel Syndrome (CTS):

**Links:** S/s: Steroid Injection

F-M: 3:1, often in 5th-7th decade. 50% bilateral, usually worse in the dominant hand. 14% of pop has sx’s of it, only 1/5 (3%) have pt CTS based on exam and electrophysiologic testing.

**Etiology:** Idiopathic, Trauma: repetitive movements of hand/ wrist (carpenter), repeated forceful grasping/ pinching, awkward hand positions, direct pressure, vibrating tools. Ill-fitting watch, hand cuffs, gloves.

**Associated systemic dz’s:** If bilateral sx’s. RA, DM, hypothyroid, acromegaly, amyloid, gout, ETOH, states of fluid retention (pregnancy-20%, menopause), mechanical conditions, obesity, A-V shunts, psoriasis, sick nerve with predisposed (cervical HNP, TOS, proximal median neuropathy), OCP use, lack of exercise, smoking.

**S/s:** Nocturnal awakening arm pain and/or paresthesia, esp. distally (60% sens, 50% spec). Sx’s requiring “shaking” of limb, correlates highly with presence of CTS = Flick Sign: “What do you actually do with your hands when your sx’s are at their worst”: pt demonstrates a flicking motion as if shaking down a thermometer. Often complain of weakness, clumsiness, pain, numbness, tingling, (paresthesias/ hyperesthesia) median innervated fingers (1st 3 digits, occasionally 4th - 5th included). Pt should have no sensory loss proximal to the wrist (vs C6 goes up to the shoulder). Often have proximal pain radiation to forearm and arm common. Check: Thumb Adduction Test: isolate abductor pollicis longus (APL) which is only innervated by the median nerve. Pt’s hand palm-up on table as they raise their thumb perpendicular to the palm, the examiner applies downward pressure at distal thumb, look for weakness. “Pincher strength”.

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**Phalen Sign:** hyperflex wrist to 90 deg and hold the “back of your hands together” X 30-60s to reproduce sx’s (paresthesias of median n). Time the interval until onset of tingling/numbness (71% sens, 80% spec).

**Tinel Sign:** lightly percussion at wrist (tap nerve over tunnel, 44% sens, 84% spec). Ask “does this reproduce your symptoms? Or produce radiating paresthesias” The pressure provocation test (examiner’s thumbs press over the carpal tunnel for 30s or the tourniquet test (BP cuff on arm is inflated above SBP for 60s) are variants.

**Dec Two-point discrimination:** Normal person can tell 4mm apart, mild if 6mm, moderate if can only sense 8mm, a late finding (33% sens, 100% spec, can use a paperclip).

**Median n. compression test (Pressure provocation test):** Compress the tunnel manually for 60 sec to reproduce sx’s.

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**Axillary Nerve (C5-6):**

**S/s:** Absent Tinel Sign, >30s to Phalen sign, no atrophy. Modify the way they use hand during activity: change positions, dec frequency of movements, rest periodically, use ergonomically designed tools, rotate work activities, rehab weak muscles. Spontaneous improvement in 30%, more common in younger, unlikely if bilateral or +Phalen sign (Neurology 2001;56:1459).

**Full-time splint** better than “night” and/or “activity” splint, keep in position of function (neutral) X 6wk, give >80% of pt’s improvement within days. Can get splint at any drug store, just to prevent extreme ROM, should be comfortable (can take bar out of it). May need an occupational therapist to suggest ergonomic changes at work site.

**RTC 6wks:** If still bothersome: Give a steroid injection as well proven. Inject where ulnar border of ring finger crosses wrist crease, @90-45 deg aim @ thumb lasts 4+ mo, tell pt that their hand will get numb from the Xylocaine. Stop injection and pull back if get paresthesias. Check: Labs to r/o secondary cause.
Steroid injection Technique:

- Diagnostic & therapeutic (77% improve in 1mo, resolves in 50%, and 66% respond for up to 15mo). Use 1¼” 25-27g with 8ml of 1% Lido (10mg) + 2ml K40 (or 40mg Methylprednisolone). Avoid intraneural injection. Wrist is held in slight flexion with towel underneath. Insert needle just radial to pisiform bone (at or point ~2-4cm proximal to the proximal wrist crease & ulnar border of ring finger) at 20-45 deg, advance 2cm. Until push through the transverse carpal lig. Meds should flow easy, if irritate the nerve, pull back 1-2mm. Restrict wrist motion X 3d. Start flexor stretching at 4 weeks. Can repeat in 4-6wks (max 3/yr). Sx’s often return in one year.

- Short Term PO steroids: Prednisone 20mg qd X14, then 10mg qd X14d if refuses injection. Corticosteroid cream with iontophoresis may provide an alternative.

Education:
- Avoid aggravating activities, use padded gloves, ergonomics, no repetitive use. Stretching exercises for the flexor tendons if improving.
- RTC 4 wks: if still bothersome Check: EMG/ NCS (confirm dx, presurgical eval), + repeat injection or surgical decompression (cut transverse carpal ligament: 75-90% cured/improved).
- Pregnancy: wait as long as possible for surgery as sx’s often abate after parturition. Splint, hold off on NSAIDs.
- Traumatic: early surgical consult.

- Consider (no proven benefit):
  - Pyridoxine (B6): 50-200 mg/day - use pyridoxal 5'-phosphate if there is no response within 6 weeks. Riboflavin: 10 mg/day. Contrast hydrotherapy. Immerse for 3 minutes in hot water followed by a 30 second immersion in cold water, three to five times/day. Perform daily stretching (Yoga). NSAIDs, diuretics, acupuncture & B6 are of no proven benefit and are probably no better than placebo.

Ddx:
- C6 cervical radiculopathy (radiating neck pain, Spurling’s sign, biceps weakness, diminished biceps jerk, additional sensory loss also on lateral arm), TOS, pronator teres syndrome, de Quervain’s, brachial plexopathy, syringomyelia.

**Ref:** (Carpal tunnel syndrome. NEJM 2002;346:23) (BJM 1999;319:884-6) (Neurology 1998;51) (JAMA 1999;282:2)

Pronator Teres Syndrome:
- Proximal compression of median nerve at the elbow at Ligament of Struthers, biceps aponeurosis, pronator teres muscle, FDS muscle. Insidious onset of pain in anterior proximal forearm, paresthesias in volar forearm and radial 3-½ digits.
- Tx: Conservative, steroid injection, splint forearm in pronation with mild wrist flexion.

Anterior Interosseous Syndrome:
- Compression form tendon bands, accessory m’s, anomalous vascular. Presents with forearm pain and vague/ achy weakness of fine touch (tip to tip).
- Tx: observe 6-12wks, if no spontaneous improvement: surgical decompression.

Ulnar Neuropathy [C8-T1]:
- Nerve can be compressed at 5 major sites. Most commonly at either the epicondylar groove or as it passes between the carpi flexor ulnaris (FCU) muscle (the true cubital tunnel). Nerve supplies 2 muscles in forearm: FCU & FDP, all hand muscles except LOAF (median n).
- Etiology: acute trauma, chronic trauma, congenital (anomalous muscles/ ossicles), neoplastic (ganglion, lipoma, neuroma, neuromiema, intraneural cyst), vascular (false aneurysm, thrombosis), metabolic (gout), degenerative (arthritis, bursitis, hematoma)
- Injury can occur: Above elbow: injury to median cord of brachial plexus. At elbow: the most vulnerable point of injury (“Funny Bone”). Tardy ulnar palsy can occur 12+ years after an injury. Entrapment in forearm: See Cubital Tunnel Syndrome.
- Entrapment in Hand/wrist: Guyon’s Canal (Ulnar Tunnel). Compression between pisiform/transverse carpal lig hook of hamate/ palmar fascia. Divided into 3 types from proximal to distal ends of the tunnel.
- S/s: mild numbness & paresthesias in the ring finger and little fingers; severe pain of the medial aspect of the elbow with dysthesia radiating into hand, sometimes proximal to shoulder and neck. May have difficulty opening bottles/ jars, or state that their hands fatigue easily with repetitive activities.
- Wartenberg’s sign: abduction of 5th digit due to weak 3rd palmar interosseous m. (an early sign).
- Froment’s Thumb sign: grasping sheet of paper between thumb and index finger results in extension of proximal thumb (to substitute FPL for weak adductor pollicis).
- Wasting of interossei: at thumb web space 1st.
- Claw deformity: occurs on attempted extension of fingers 3-5.
- Exam: start at neck, axial compression of spine, TOS tests
Athetosis
Asterixis
Most from basal ganglia (caudate/ putamen/ globus pallidus) problem.
Huntington's Disease
Links:
Ext carpi ulnaris
Ext digiti minimi
Ext. indicis proprius
Ext pollicis longus
Ext carpi radialis longus
Extensor pollicis brevis
Abductor pollicis longus
Flexor carpi ulnaris
Flexor Dig. Superficialis
Flexor Dig. Profundus
Lumbrical:
Interossei:
Radial Nerve
Muscles r/o T1 root lesion (bronchogenic carcinoma) or ulnar nerve lesion.
Median Nerve
1999;12:597-602)
and sensory loss), central cord tumors.
Ddx:
Step #3:
Surgical decompression.
Ddx: C 8 radiculopathy – neck injury, Spurling’s sign, weakness in forearm muscles, additional sensory loss on medial forearm.

Cubital Tunnel Syndrome (CUTS):
The 2nd most common peripheral neuropathy after carpal tunnel.
Where: (5 anatomical areas) Arcade of Struthers medial intermuscular septum, medial epicondyle, cubital tunnel, fascia
overlying the flexor carpi ulnaris.
Sx: paresthesia, sensory loss, anesthiesia in ulnar distribution of the hand. Weakness and clumsiness writing, medial elbow pain.
Nocturnal pain frequently awakens pt.
Dx: medial elbow pain exacerbated by flexion, dec 2pt and vibratory sensation in ulnar distribution of hand. Muscle wasting,
clawing of ring and little fingers. Wartenberg’s sign. Have weak key pinch (resisted grasping of paper between thumb and
index (1st) fingers as they are kept parallel), -Froment's sign (recruitment of FPL and FDP seen as flexion of PIP and DIP
joints as key pinch, forming ‘OK sign’), inability to cross index and middle fingers. Occasionally need electrodiagnostic testing
to localize site of compression.
Tx: nonoperative is successful in 90% so long as 2pt discrimination is normal. Refer if atrophy or persistent/ progressive sx's
after 90days of nonoperative tx.  Education on modification of activities, avoiding repetitive elbow flexion, night splinting in
extension.

Hand Weakness/ Atrophy:
Ddx: cervical spondylosis (sensory disturbances common), ALS (no sensory changes), syringomyelia (burning dysthesias
and sensory loss), central cord tumors.
1999;12:597-602)

### Nerves & Muscles of the Hand:

**Median Nerve (M):** lay hand of dorsal surface, hold radial border of thenar eminence and resist pt's palmar abduction of the
thumb.

**Ulnar Nerve (U):** abduct fingers or pinch paper between thumbs and fingers. If any unilateral wasting of the small hand
muscles r/o T1 root lesion (brachogenic carcinoma) or ulnar nerve lesion.

**Radial Nerve (R):** extend fingers and wrist against resistance.

**Interossei:** (U) -- spread hand (dorsal), hold paper between fingers (ventral)

**Lumbrical:** (M,U) -- extend wrist and DIP/PIP as fingertips held.

**Flexor Dig. Profundus (FDP):** (U) -- flex DIP while MCP and PIP extend.

**Flexor Dig. Superficialis (FDS):** (M) -- flex PIP all other digits are extended, have thumb and index finger pinch.

**Flexor carpi radialis (FCR):** (M,U) -- flex and radial deviate the wrist.

**Flexor carpi ulnaris (FRU):** (U) -- flex and ulnar deviate the wrist.

**Extensor pollicis longus (EPL):** (R) -- ext and abd thumb.

**Extensor pollicis brevis (EPB):** (R) -- ext and abd thumb.

**Ext carpi radialis brevis (ECRB):** (R) -- make fist while extending wrist.

**Ext carpi radialis longus (ECRL):** (R) -- make fist while extending wrist.

**Ext pollicis longus (EPL):** (R) -- lift thumb off flat surface while palm flat.

**Ext. Digitorum communis (EDC):** (R) -- extension of fingers at MCP joint.

**Ext. indicis proprius (EIP):** (R) -- ext index finger at MCP as others in fist.

**Ext digitii minimi (EDM):** (R) -- ext of 5th digit while making a fist.

**Ext carpi ulnaris (ECU):** (R) -- ext and ulnar deviation of wrist.

### Movement Disorders:

**Links:**  Spasticity: Dystonia: Chorea: Athetosis: Myoclonus: Asterixis: Akathisia: Paroxysmal Tic: Tourette's Syndrome:
Parkinson's Disease: Huntington's Disease: Cerebral Palsy: Ataxia:

Most from basal ganglia (caudate/ putamen/ globus pallidus) problem.
Common Agents Causing Movement D/o: Amoxapine, amphetamines, antihistamines, black widow spider bite, butyrophenones, Carbamazepine, CO, Chloroquine, ethylene glycol, fluoride, ketamine, Levodopa, lead, Li, metaldehyde, methylyphenidate, metoclopramide, MAOIs, nicotine, organophosphates, Meperidine, PCP, phenothiazines, Phenyltoin, strychnine, toluene, TCA's.

Akinetic: rigid (parkinsonian).

Hyperkinetic Disorders:

Spasticity: Links: Spasms:

Hypertonia: several forms of increased resistance to passive manipulation are distinguished.

Rigidity: in contrast to spasticity, is characterized by increased resistance throughout the movement. Lead-pipe rigidity applies to resistance that is uniform throughout the movement. Cogwheel rigidity is characterized by rhythmic interruption of the resistance, producing a ratchet-like effect. Rigidity is usually accentuated by distracting the patient.

Paratonia: increased resistance that becomes less prominent when the patient is distracted; without such distraction, the patient seems unable to relax the muscle. This is particularly common in patients who are anxious or demented. Paratonia is also called gegenhalten. When it is prominent, other abnormalities of tone are difficult to assess.

Spasticity: depends upon the limb position and on how quickly the limb is moved, classically resulting in a "clasp-knife phenomenon" when the limb is moved rapidly. The limb moves freely for a short distance, but then there is a "catch" and you must use progressively more force to move the limb until at a certain point there is a sudden release and you can move the limb freely again. Spasticity is generally greatest in the flexors of the upper extremity and the extensors of the lower extremity. Spasticity is a velocity-dependent response which may be shown by skeletal muscle during passive stretching. It is a finding which may be seen in central nervous system disorders. The scale of Ashworth was modified by Bohannon and Smith (Phys Ther 1987; 67: 296-207) to make it more discrete for grading mild disorders.

Physical Findings --> Grade

No inc in muscle tone. --> 0.

Slight inc in muscle tone, manifested by either a catch and release or a minimal resistance at the end of the range of motion when the affected body part is moved in flexion or extension. --> 1.

Slight inc in muscle tone, with catch followed by minimal resistance, with the resistance affecting less than half of the range of motion. --> 1+.

More marked inc in muscle tone over most of the range of motion; the affected body part can still be easily moved. --> 2.

Considerable inc in muscle tone, making passive movement difficult --> 3.

Affected body part rigid in flexion or extension --> 4.

Ddx: MS, HTLV (Tropical Spastic paraparesis), ALS, Transverse Myelitis, Stiff Man, tabes dorsalis, cerebral palsy.

W/u: anti-GAD, HTLV, FTA-ABS, MRI of head & spine.

Tx: Antispasmodics such as Baclofen, may need an intrathecal pump. Benzo's.

Autoimmune Acquired Neuromyopathy (Isaac Disease): characterized by myokymia, which is a rippling muscle twitching that occurs during rest; impaired muscle relaxation and stiffness at rest; painful cramps; and increased sweating. It is caused by hyperactivity of the peripheral motor nerve endings, and it is correctly called neuromyotonia because the continuous muscle fiber activity is abolished by curare but not by proximal nerve block. Neuromyotonia occurs sporadically, but familial cases have occurred that have often been associated with neuropathy. Associations with myasthenia gravis and thymoma have also been noted. An antibody against o-dendrotoxin-sensitive K+ channels may be responsible for the disease.

Treatment is symptomatic (phenytoin, carbamazepine, and mexiletine are used), but in resistant cases, intravenous immunoglobulin or plasmapheresis may be necessary.

1. Tremor: (rhythmic oscillations) Result from alternating contractions of opposing muscle groups (Parkinson) or from simultaneous contractions of agonists and antagonists (Physiologic tremor).

Ddx: endocrinopathy, drug intox / withdraw, Li, anti-psychothics, valproic acid, steroids, TCA, beta-agonist. Link: Tremors;

2. Dystonia: sustained muscle contraction/ spasm causing stereotyped twisting/ turning or abnormal postures. May have rhythmic interruptions (dystonic tremor). May be primary (idiopathic) or secondary.

Due to an idiosyncratic drug reaction---> Anti-psychothics agents (high potency, anti dopaminergic properties), Compazine, which is more common in young males and manics. May be hereditary (AD, AR or X-linked) or part of a syndrome (Wilson's, Huntington's, Parkinson's, psychogenic). May due be to mass lesion, head/ spinal cord trauma, perinatal injury, encephalitis, CVA or demyeelinating d (MS).

Classification: Focal dystonia -->

Cervical Torticolis: sustained muscle contractions, causes twisting of posture. Neck tipped to one side and usually rotated. The pt's head will tend to drift to one side when they close their eyes. Pt is often unaware until it is brought to their attention, not until later in the course to they maintain an abnormal posture that leads to pain and concern with appearance. 75% respond to "sensory tricks" such as lightly touching the face which leads to temporary improvement. Usually progressed over Sys, then stabilizes.

Facial grimacing (oromandibular), and opisthotonos (entire body, with head, back and belly up), oculogyric (eyes fixed upwards and to the side), laryngospm (rhythmical oscillations) Result from alternating contractions of opposing muscle groups (Parkinson). They may have rhythmic interruptions (dystonic tremor). May be primary (idiopathic) or secondary.

Other Focal: Blepharospasm (involuntary spasm of the orbicularis oris, resulting in eye closure, often bilat). Limb dystonia (writers cramp);

Spasmodic dysphonia (laryngeal), oromandibular, craniofacial or isolated limb dystonia (writer's cramp, musicians cramp, chewing.

Other types: segmental dystonia, hemidystonia (involves one side of the body), multifocal dystonia (cranial, brachial, crural), generalized (leg, head and arm), paroxysmal, tardive and psychogenic.

Tx of Acute Dystonia: Diphenhydramine (Benadryl) 50 mg IM or IV, or Benztpine 1-2 mg IM or IV; improvement within 15 to 30 min. These doses can be repeated in 30 min. Even if the agent is discontinued, oral treatment with either agent for the next 3 to 2 days, as ax can recur. OtherTx's --> Dopaminergic (Levodopa, Bromocriptine), Anticholinergics such as Artane (Trihexyphenidyl): 6-90mg divided qd, ant dopaminergics (Halidol), Benzo such as Valium (Diazepam): 4-40mg divided qd or Clonazepam (Klonopin): 1-8mg qd divided. GABA agonists Lioresal (Baclofen): 10-80mg qd divided, Antidepressants (Amitriptyline), Anticonvulsants (Carbamazepine). If chronic can add an anticholinergic, antihistamine, lower the dose, change to a low-potency dopaminergic.

Tx of chronic torticollis: Botox injection @ 100-300 units ($450/ 100 units), lasts 3-4mo.
Torticollis Cocktail: Trichopherinidyl (Artane) 0.5 mg PO BID + Clonazepam 0.5mg PO BID + Baclofen 5mg PO BID, each titrated to max effective dose with minimal SE.

Other: Tetrazenazine, Ethopropazine, Diazepam, Lorazepam, Carbamazepine, Cyclobenzaprine. Often congenital due to contracted SCM, need passive stretching and positioning of child to face the opposite way. If older child, may need surgical release. If associated with Kleine-Feil Syndrome: fusion of +2 vertebrae, Sprengel's deformity (elevation of the scapula), cardiac anomaly, major renal anomaly (30%) and scoliosis.

Ddx: tardive dyskinesia (from anti-psychotic, Reglan), L-dopa, tic, Wilson’s dz, hyperthyroidism, Sandifer syndrome (GERD, dystonia, torticollis), ophthalmologic (sup oblique muscle), illicit drugs, cervical cord' root injury, hemivertebrae, basal ganglia lesion, infection, congenital.

3. Chorea: rapid (not shock-like), sustained, flowing, often distal (each movement is distinct), non-rhythmic, non-stereotyped, irregular, purposeless, jerking movement, spreads randomly to different body parts. Usually due to a physiologic abnormality of the basal ganglia.

Milk maid sign: as squeeze your fingers, they can’t keep a solid grip.

Causes: SLE, hyper/hypoglycemia, polythemia vera, hyperthyroid, chorea gravidarum (rare, starts in 1st trim with bilateral involuntary mov’t, usually resolved with termination of pregnancy), CVD, stroke of lacunar, after strop infection (rheumatic fever), thyrototoxicosis, Wilson’s dz, subcortical infarcts, antiphospholipid syndrome, inc DA from meds (Phenytoin, L-dopa, anti-psychotic, Reglan, estrogen, opiates, stimulants).

If degenerative: Huntington’s (see below), cerebellar degeneration.

W/u: CT/ MRI, lytes, CBC, TSH, CBC, copper studies, peripheral smear (look for acanthocytes). ASO titer, antiphospholipid Ab’s, Huntington’s CAG nucleotide repeat test.

Tx: underlying d/o. Clonazepam 1-6mg/d. Risperdal 0.5mg/d, Prolixin, neuroleptics.

4. Athetosis: continuous, slow, writhing, non-stereotyped, asynchronous mov’t, often combined with chorea, which travel randomly among body parts. Seen in limbs, trunk, head, face or tongue. When brief they are called choreoathetosis. When sustained called athetotic dystonia.

5. Myoclonus: involuntary, sudden, brief, lightening-like/ shock-like muscle jerk. Lack rhythmicity. Single or successive sudden jerks, may throw the pt to the floor. Due to contractions or inhibitions. Usually arises from the sensorimotor cortex or brain stem. Seen in normals as sleep jerking.

Causes: Demerol, TCA, phenytoin, L-dopa, uremia, hypomagnesemia, CJD, liver failure, most any drugs/meds at toxic doses (narcotics, anticonvulsants, anesthetics, antibiotics, cardiac/ HTN meds, antihistamines, psychiatric, OTC meds, contrast media). (Mayo Clin 1996;71)

Classification Myoclonus:

Physiologic: hypnic sleep jerks, anxiety/ exercise induced, hiccups, benign infantile (during feeding).

Essential: hereditary, sporadic.

Epileptic: sz dominates.

Symptomatic myoclonus: progressive or static encephalopathy dominates. Storage dz, ataxic syndromes, basal ganglia degeneration, dementia’s, viral, metabolic derangement, focal nerve damage, malabsorption.

W/u: CT/ MRI, EEG, lytes, glucose, LFT, BUN/ Cr, drug/ toxin screen.

Vs. Myotonia a continued contraction after voluntary or reflex arc has ceased.

Tx: Clonazepam 1-6mg/d. If not effective can try Valproic acid, Primidone, Phenobarbital, Phenytoin, benzo, SSRI or anticholinergic agents.

6. Asterixis: sudden lost of posture of the outstretched dorsiflexed upper limbs producing the characteristic “flap”. A nonspecific neurological sign due to a dysfunction in the descending reticular activating system. Seen in most all types of metabolic encephalopathy. Two ways to test:

1. Have pt squeeze two of the examiner hands for 30-60 sec, feel intermittent relaxations.

2. Have pt sustain their wrist in dorsiflexion fro 30 sec, see a “flapping tremor" due to transient interruptions in the electrical current.

Asterixis Ddx: hepatic encephalopathy, CHF, COPD, uremia, hypoglycemia, hypoxia, tranquilizer/ sedative OD, dec K/ Mg, CVA, Cheyne-Stokes respiration, recovery from anesthesia, Bromide intoxication, glutethimide intoxication, CO2 narcosis.

7. Akathisia: an inner feeling of motor restlessness or the need to move. A common side effect of antipsychotic meds, also seen in delirium, encephalopathy, dementia and Parkinson’s. May include leg crossing/ uncrossing, pacing, scalp caressing, squirming in the chair, picking at things.

8. Paroxysmal Movement Disorders: a heterogeneous group of disorders characterized by a sudden onset of an abnormal movement out of a background of normal motor activity. The movement may be choreic, dystonic, ballistic or any combination. Divided into 4 basic categories: Paroxysmal Dyskinesias (often precipitated by stress, startle, prolonged exercise, ETOH, caffeine or fatigue. AD inheritance, age of onset 6mo-30yo, most ~12yo), Episodic Ataxias (have dysarthria, ataxia, weakness, vertigo, precipitants same as above, may be responsive to Acetazolamide.), Paroxysmal Hypnogenic Dyskinesias (often from sz’s during sleep) and Hyperekplexia (risk of injury from sudden falling with attacks, hereditary or sporadic).

9. Hemiballismus: random, sustained, violent, flinging, large amplitude, proximal, one side of body.

Cause: stroke, structural lesion of subthalamic nucleus, cocaine.

10. Tics: A sudden, rapid, purposeless, repetitive (patterned), focal, non-rhythmic, stereotyped movement/ vocalization that briefly and intermittently bursts forth on the background of normal activity. May resemble a myoclonic jerk, but more complex. The most common movement d/o, not psychological, but neurochemically driven. May be simple, complex, primary (idiopathic) or secondary. Often preceded by buildup of inner tension and may be temporarily suppressed. Worse with stress, fatigue, high complex. Involuntary rhythmic movement of individual muscle groups. 6-20% all children before age 10yo have a single transient lasting 2-12 weeks (up to 1 yr). Motor tics more common and last longer. Usually simple eye blinking, facial grimacing, Inc anxiety/ stress/ fatigue, less noticeable during sleep, briefly suppressible with concentration; “build-up” is often discharged at home in flurries lasting 1-2 hours. Transient (<1yr), Chronic: genetic (AD), single tic.

Motor Tics:

Simple: blink, arm flics, posturing, stick tongue out, kicking, flex fingers, shoulder jerking.

Dystonic tic: blepharospasm, ocular deviations, bruxism, mouth opening, torticollis, shoulder rotation.

Tonic tics: muscle tensing (abd, limb).

Complex: flapping arms, facial grimacing, adjusting/picking at clothing (habit spasms), jumping, shaking feet, pinching, poking, kissing self/others, spitting, obscene gesture (copropraxia).

Phonic Tics: Simple: meaningless/animal sounds, grunting, sniffing, throat clearing, barking, yelling, coughing, hiccuping, belching.
Complex: utterances such as repeating parts of words/phrases (echolalia if sounds of others, paillalia if repeat ones own sounds), prosodic changes, talking to oneself, assuming different intonations, use of obscene words (coprolalia). 

Tx of Tics: avoid if possible, observe if mild. If chronic or Tourette’s with comorbidity: each conditions should be assessed and treated, multidisciplinary team approach. If chronic/Tourette’s with no comorbidity: use nonpharmacologic (behavioral modification for skill deficiencies/socialeducation) or drug therapy (methyphenidate, clonidine). In drug therapy, special caution with antipsychotics as seen in many developmental disabilities. In children, use low doses. Anticholinergics can exacerbate the cognitive impairments and worsen the chorea.

(100% penetrance). Only 20% at risk ever request testing. If h/o depression, refer to a mental health before testing as 4-fold increase in risk. 

Dx:
dyskinesia (stereotypical, repetitive movements). 

Ddx:
familial and sporadic forms. 

Progressive cognitive decline:

Disinhibited:

Apathetic:

Personality changes:

Psychoses:

Depression:

Neuropsychiatric features:

Tx:

α1-antagonist: Clonidine @ 0.05 BID to 0.1mg D. Guanafacine (Tenex) @ 0.5-1.5mg BID is less sedative, or Klonopin. 

Neuroleptics/ anti-psychotics: Risperdal, Halodol @ 0.5-4mg qHS. 

Pimozide @ 1-8mg qHS. SSRI’s for OCD’s. If ADHD use clonidine, TCA’s (desipramine, nortriptyline). 

(Am Fam Phys 1999, 59:8) If have also ADHD (child) use Desipramine (Norpramin): 1mg/kg initial dose, cl ECG. Well tolerated and effective, titrate weekly up to 3.5mg/kg/d (Arch Gen Psych 2002:59:469).

Ddx Tics: early Huntington’s, myoclonus, stereotypes (habit), tic strength reflex.

Myokymia (twitching of the eyelid): very common, not serious.

Hemifacial spasm: involuntary twitching of side of face. A motor analogue to trigeminal neuralgia. 80% have a tortuous dilated basilar artery which irritates the cerebral face Rx with surgery or carotid angioplasty.

Blepharospasm: bilateral eye closure which may be accompanied by Meigs Syndrome which is grimacing, smacking lips, twisting of the neck the patient has NO history of taking antipsychotics. Tx with injections of botulinum toxin, last 3mo, try anti-psych mics, L-dopa, carbidemipine. 

D/c any amphetamine/ caffeine use. Pt’s with idiopathic blepharospasm, either isolated or associated with oromandibular dystonia, are more likely to develop parkinsonian sx’s.

Tourette’s Syndrome: Link: Tx:

Onset 2-18yo (ave 6-7 yo), 10yo worst/peak time for sx’s. 1/1,000 prevalence. Only rarely begins during adulthood. Chronic vocal and motor tics, often involve multiple muscle groups, waxes and wanes. Genetic predisposition with environmental influences. Phonic tics usually begin 1-2 yrs after motor tics. The full syndrome typically develops within months to 5yrs of simple motor tic (seen in 10% of school-aged children) onset. May have dystonic tics.

Good prognosis: 70% resolve by age 18, 20% improved, only 7% unchanged/worse. Simple or complex, many have co-morbid behavioral d/o’s. ADHD in 50%. OCD in 33%. Learning disability in 25%. Sleep d/o. 

Behavior problems in 70% (quick temper, mood swings, overreaction, exhibitionism, negativism).

Echolalia: repeating others words spoken to the pt.

Copropraxia: imitating others actions.

Palilalia: repeating one’s own words/statements.

Coprolalia: hoarding groin, obscene gestures out of content, touching others sexually, placing head on another’s breast, picking at buttocks.

Coprolalia: repeat phrases or monosyllables (“Sh” or “Fu”, often obscene, may be mental (silent), seen in ~40%.

S/s:

Both involuntary muscular movements (motor tics) and uncontrollable noises (vocal tics) present, although not necessarily at the same time. Tics tend to occur several times a day but may be intermittent. A tic-free period should not last > 3 months. Sx’s to vary over time, and may show exacerbation by anxiety or stress, disappear during sleep. Lasts > 12 months and is usually a lifelong condition. Obsessive compulsive behavior and/or attention deficit hyperactivity disorder may be present. Impairment in social, occupational or other areas of functioning. Other causes (stimulants, infection, metabolic conditions, etc.) excluded.

Involuntary muscular movements include: fast eye blinking, head jerking, facial grimacing, shrugging, knee jerks, grooming behaviors, jumping

Uncontrollable noises may include: grunting, snoring sounds, sniffing, throat clearing, barking, “odd” sounds, echolalia, coprolalia or profanity.

Ddx: AKA “Tourettism” caused by drugs (stimulants, Levodopa, antiepileptics, neuroleptics (Haldol), CJD, toxins (CO), Huntington’s, head trauma, stroke, schizophrenia.

W/u: DSM IV criteria. R/o secondary causes (head injury, stroke, encephalitis, CO poisoning, syphilis, hypoglycemia, CJD, genetic d/o, schizophrenia, mental retardation, stimulus drugs, antipsychotics, antiepileptics, Levodopa, antihistamines, anticlonicholinergics. Check: TSH, throat Cx, ASO/anti-DNAse B litter (if rapid onset).

Tx: Most need meds for 1-3yrs if mod-severe sx’s that interfere with peer relationships, social interactions or job performance. Avoid stimulants, see Tics. If have ADHD use TCA’s such as desipramine. Clonazepam 0.25mg BID-1mg TID (SE: sedation, weight gain, worsening ADHD). Clonidine, Guanafacine (Tenex), Benzo, Risperdone, Ciazopen, Pergolide, cannabinoids, Nicotine gum/pathes, Botux injections. Terbenazine (not yet approved in the USA). Avoid Haldol. www.tsa-usa.org (Tourette’s syndrome. NEJM 2001;345:16). Sertraline use contraindicated with Tourette’s syndrome drug pimozide (Orap) as leads to an increased concentration of Orap of about 40%.

Huntington’s Disease:

AD, Chromo 4. Common in mid-western USA. Due to pathologic triple repeats of CAG-CAG-CAG.

Clinical: insidious onset of chorea and dementia in late 30’s, mean duration of sx’s is 15yrs. Early manifestations: clumsy, restlesslessness, poor judgment, impulsive, lose interest in former things: delusions, uncooperative, locus of chorea jumps randomly, milkmaid grip of hand, grimacing X10yrs.

Neuropsychiatric features:

Depression: in 30-40%, 6% die by suicide, often early during the course of illness, may precede overt movement abnormalities (responsive to conventional antidepressant tx);

Psychoses: seen in 10-30%, usually with delusions & hallucinations. May appear before overt movement abnormalities, responsive to conventional antipsychotic tx.

Personality changes: 2 overlapping syndromes. 

Apathetic: slowness, disinterest in usual activities, hygienic neglect, social avoidance. 

Disinhibited: Irritability, angry outbursts, occasionally, violent behavior.

Progressive cognitive decline: almost universal, with onset often preceding overt movement abnormalities. As the dementia advances, patients may reach the point at which they are nearly mute, akineti, globally disinterested, unable to recognize family members and friends, and incapable of managing their activities of daily living.

Ddx: Sydenham’s chorea (presents in child/teen, acute onset, no dementia, spont remission in 3-12 weeks), drugs, tardive dyskinesia (stereotypical, repetitive mov’t, fly-catcher tongue).

Dx: A “CAG” repeat number >39 is diagnostic. Genetic counseling is strongly recommended, all carriers will develop the dz (100% penetrance). Only 20% at risk ever request testing. If h/o depression, refer to a mental health before testing as 4-fold inc suicide risk.

Tx: symptomatic, no medical tx known to delay onset. Antipsychotics, through their anti dopaminergic effect, may reduce the chorea. Anticholinergics can exacerbate the cognitive impairments and worsen the chorea.
Tremors:

Links: Hx Exam: Classification: Benign Essential (Physiologic): Movement Disorders: Parkinson’s:

An involuntary, rhythmic oscillation or reciprocally innervated, antagonistic muscle groups. All humans have physiologic tremors detectable by EP studies. Up to 98% of elderly have a tremor on testing, 30% worsen with activity.

Pharmacologic tremor: theophylline, metoproterenol, terbutaline, epinephrine, amphetamine, anticonvulsants (valproic acid), Li, neuroleptics, TCA, steroids, Levodopa, amiodarone, PCP, ETOH, metoclopramide, Reserpine, Valproate, Cyclosporine, Caffeine, bronchodilators.

Heavy metals: arsenic, bismuth, lead, mercury, methyl bromide.

Pathologic tremors: essential (o.4-6% prevalence), trauma, infections, drugs, peripheral neuropathy, exercise, tumors, vascular lesion, demyelinating dz, Parkinson’s, Wilson’s dz, adult onset idiopathic dystonia (resting and action, “wing beating” as starts in the shoulder then travels down the arm), psychological causes.

Hx: duration, age onset, site, symmetry, course (static vs progressive), effect on ADL’s, alleviating and exacerbating. Any speech disturbances, change in handwriting, visual impairment, falls, weakness, gait, balance. ETOH, tobacco, meds and caffeine use. FHx of tremors, Parkinson’s, Wilson’s, MS, cerebellar dz.

PE: look for stigmata of ETOH use, hyperthyroidism and Parkinson’s. Distribution, frequency and amplitude of the tremor, dystagmus, dysarthria, extrapyramidal system (dystonia, dyskinesia, rigidity, posture, gait, facial expression, eye blink, bradykinesia).

Frequency of oscillations per second:

Slow: 3-5 Hz.
Intermediate: 5-8 Hz.
Rapid: 9-12 Hz.

Rest: Action: Goal directed: Location: Freq. (Hz):

Physiologic tremor: 1+ 4+ 2+ distal 7-12

Parkinson: 4+ 2+ 2+ distal & head 4-6. Relieved by action, worse with walking/stress.


Cerebellar: 1+ 4+ 4+ prox & distal 2-5. Relieved by rest, worse with action.

Classified as:

Resting (Parkinsonian) Tremor: 4-6 Hz. Best observed when pt is distracted. When attempting to maintain the position of a body part (Parkinson’s). Caused by Parkinson’s (Aggravated by walking or stress, relieved by action, associated with rigidity, bradykinesia and gait disturbance), multiple systems atrophy, progressive supranuclear palsy, drug induced, rubral. Also seen with alcohol withdrawal, neurophilis, physiologic, secondary and essential tremor (see below).

Tx: Sinemet, anticholinergics, antiparkinson, deep brain stimulation, pallidotomy, thalamotomy. Parkinsonian tremor often persists despite adequate control of other sx’s. Can add anticholinergic such as Trihexyphenidyl (Artane): 4-10mg/d or Benzotropine (Cogentin): 1-4mg/d.

Postural Tremor: 5-9 Hz. When pt tries to maintain a limb posture against gravity. Caused by physiologic, ETOH/drug withdrawal, metabolic disturbance, drug induced, psychogenic.

Tx: beta-blockers, Primidone, Acetazolamide, Clonazepam, Botulinum toxin, Gabapentin, deep brain stimulation, thalamotomy.

Action (Senile) Tremor: 3-10 Hz. During movement. Due to cerebellar lesions, rubral tremor, psychogenic, Parkinsonism, drugs, physiologic and essential tremor. Can be in voice.

Divided into: 1) Kinetic: occurs during voluntary movement of a body part. 2) Isometric: occurs when voluntary muscle contraction is opposed by a stationary force.

3) Postural: occurs when a body part is voluntarily held motionless against gravity such as when pointing to an object or protruding the tongue. Essential tremor in the postural form may be mistakenly characterized as resting tremor.

Tx: Usually none needed. Wrist w’s if severe. INH 600-1,200mg/d with Pyridoxine.

Cerebellar (Intention) Tremor: 2.5-4 Hz. Kinetic (goal directed, ‘action’), worse as extremity approaches its target, relief with rest. May have titubation (head bobbing) when pt is upright but not on supination. Seen in MS, cerebellar dz. Associated with dysarthria, dystagmus, ataxia.

Secondary Tremor: drug withdrawal, brain abscess/ tumor, MS, peripheral neuropathy, pheo, psychogenic d/o, thyrotoxicosis.

Psychogenic Tremor: complex, can occur at rest, during postural or kinetic movement. Abrupt onset, static course, spontaneous remission.

Benign Essential (Physiologic) Tremor:

‘Essentially’ we do not know the cause. Increased prevalence with age, but not normal aging. 8-12 Hz. Variable onset, more common after 50yo, marked reduction with ETOH, +FHx in 50%. Bimodal peak onset in the 2nd and 6th decades. S/s: mild, symmetric postural tremor (max tremor at maintenance of posture) that is accentuated by voluntary movements (worse with action) and on reaching the target (terminal tremor). It is only rarely seen at rest. It usually begins on one side, but eventually becomes bilateral. It occasionally may spread to the lower limbs. May have tremulous handwriting, may affect the voice, tongue, legs (have tandem gait difficulties) and head. Head tremor (titubation) may be horizontal (“no-no”), vertical (“yes-yes”) or rarely rotatory.

**20X more common than Parkinson’s tremor. May occasionally get cogwheel rigidity, but voluntary suppression of the tremor is always possible. As Parkinson’s is max at rest, slower, unilateral, micrographic handwriting, no alleviation with small amounts of ETOH.) Occurs during sleep and voluntary suppression is not possible. If it is asymmetric and occurs at rest from onset, then most likely Parkinson’s.**

Key – no signs of extrapyramidal syndrome, as it is a monosymptomatic illness with no Parkinson's, cerebellar dysfunction or other neurologic abnormalities except tandem a gait abnormality (seen in nearly ½ of the pt’s).

Enhancing factors: emotions (anxiety, stress, excitement), fatigue, hypoglycemia/ hunger, sleep deprivation, thyrotoxicosis, exercise, temperature extremes, phe.

Meds: caffeine, Fluoxetine, Haldol, Li, Ritalin, Reglan, theophylline, Valproic acid, pseudoephedrine, phenytoin, baclofen, dantrolene, Botox, rhizotomy. If aspirat ion risk can check a videofluoroscopy, consult for diet and positioning during/ after meals.

Tremor rating: 0= none, +1= barely perceivable or intermittent, +2= mod amplitude (1-2 cm), usually present and clearly oscillatory, +3= amp > 2cm, violent, jerky, difficulty with tasks or inability to hold pen to paper. Can be diminished with ETOH intake, concentration, relaxation or increased load on the affected limb.

Dx: Clinical criteria.

Definite (all 4): 1) 2+ postural tremor of moderate amplitude of at least 1 arm. 2) 2+ kinetic tremor of at least 3 tasks (pour water/ use spoon to drink water, finger to nose, drawing a spiral). 3) If present in the dominant hand it must interfere with 1 Acts. 4) Have no other causes (meds, Parkinson’s, ETOH, dystonia, hyperhydrosis).

Tx: Expect a 50% improvement with meds.

Primidone (Mysoline): [50, 200mg scored tabs, 250mg/5ml elixir] Start at 25-62.5 mg qHS ant titrate to 250mg TID as very effective but sedating.

Second line agents: Propranolol (Inderal) - start low (30mg), go slow (max 320mg) - may need to combine agents – consider “as needed” treatment with short-acting benzodiazepine in selected patients. Gabapentin, clonazepam (Klonopin), Diazepam, Nimodipine, Nicardpine, Methazolamide, Topiramate, Remeron, Botox (for head and voice tremors), Xanax, thalamotomy, deep brain stimulation (DBS) of the thalamus. ETOH is effective, but short acting.


Cerebral Palsy:

CP is an umbrella term for a group of non-progressive, but often changing group of disorder of movement and posture. Has an increasing prevalence due to more low-birth wt infants surviving. Pyramidal and extrapyramidal sx’s common. Overall, 90%; learn co until age 20, up to 95% with diplegia and 75% with quadriplegia survive to age 30.

Etiology: Prenatal insult: vascular (perinatal hypoxic-ischemic encephalopathy), intracranial infection, genetic, traumatic or a primary neurologic: abnormal behavior, difficulty feeding (oro motor abn), 1/3 epilepsy, 2/3 mild MR. Presents with delayed development, spasticity starts by age 15mo, followed by athetoid and ataxic movements, sz’s in 30%, often by age 2yo. Puberty may be delayed, prolonged or precocious. Look for secondary cause if no preceding perinatal insult, +FHx of “CP”, developmental regression (loss of abilities), isolated abnormalities (see Ddx below)


Spastic: di/hemi/quadriplegia.

Dyskinetic: athetoid, dystonia.

Step #1: Basic Hx: Most have oral communication difficulties. Should be able to give a yes or no. Some use letter/ picture boards or talking computers as augmentation devices. Caregiver can assist with interpreting gestures and unintelligible speech. 60% have speech problems, often from dysarthria.

Step #2: Important to assess their level of comprehension as to actively participating in healthcare decisions.

Step #3: Social Hx, where living, daily living skills (ADL’s), school/ leisure activities, ambulatory status (20% of adults can walk), need assistance, 40% nonambulatory).

Step #4: ROS: visual defects (cataracts, optic atrophy, retinitis) in 30%. 20% of adults have hearing deficits. Assess aspiration risks which are higher with quadriparetic and gastrostomy tubes (do you cough during or immediately after a meal). Vomiting/ GERD/ constipation sx’s common. Feeding often takes over 1hr, thus poor caloric intake is common. Bladder size may range from small and irritable to enlarged and hypotonic. Any new onset “distress” while urinating should be evaluated for infection.

Step #5: Musculoskeletal: pt’s often have asymmetric abnormalities such as hip disease, flat feet, varus/ valgus/ equinus feet. Scoliosis in 45%. Osteopenia common if nonambulatory. Any neurologic change such as balance or increased frequency of seizures should be evaluated by a neurologist.

PE: retention/ asymmetry of primitive reflexes, hypoxia, hyperreflexia.

Tx: learn communication at CP center, PT for mobility (cast, tendon lengthening), independence in ADL’s, normalize appearance.

Spasticity: baclofen, dantrolene, Botox, rhizotomy. If aspiration risk can check a videofluoroscopy, consult for diet and teaching about airway protection and positioning during/ after meals. Treat GI sx’s with fluids, fiber, laxatives, reflux meds.

Ddx: hydrocephalus, subdural hematoma, amino acid d/o, hyperpexia, dopa-responsive d/o. If significant oromotor dysfunction consider Worster-Drought Syndrome (operative syndrome), a pseudobulbar palsy due to abnormality in the opercular cortex (dysgenesis).

Weakness d/o such as MD, mitochondrial cytopathy, infantile neuroaxonal dystrophy.

Dystonia or involuntary movement due to Lesch-Nyan, Rett syndrome, juvenile neuronal ceroid lipofuscinosis, pyruvate dehydrogenase def, other mitochondrial d/o’s.

Predominant diplegia/tetraplegia due to arginase def, adrenoleukodystrophy, hereditary progressive spastic paraplegia, hydroxocobalamin synthetase def.

Significant ataxia due to Angelman syndrome, ataxia telangiectasia, mitochondrial cytopathy, Niemann-Pick, posterior fossa tumor, X-linked spinocerebellar ataxia.


**Parkinson’s Disease (PD):**

Links: 4R’s & Dx: TX Basics: Meds: PD Problems: Atypical Parkinson’s:

Chronic variably progressive, unremitting neurodegenerative d/o caused by an idiopathic dec in dopaminergic cells in the substantia nigra which usually has an inhibitory affect on cholinergic cells of basal ganglia: dec thalamic excitation of the
motor cortex. Need 80% loss until sx’s. 25% get dementia and/or depression. Age is the most consistent risk factor, most present after 50yo (ave age at onset in 58yo, affects ~1% of pop age >50). ~5% of cases can present before age 40yo, can occur in mid 20’s. ~10% of cases are hereditary. M:F 3:2, all races. Have 2-5X inc mortality: reduction in life expectancy. 

**Levy bodies:** eosinophilic inclusions (alpha-synuclein-containing) in neurons accumulate in vulnerable areas of the brain.

Four major characteristics --> 4 R’s: 
1. Resting tremor, pill rolling, 4-5 Hz (cycles/sec) (75%).
2. Rigidity and flexed posture, insidious onset, initially affecting one limb.
3. Retarded movement (brady/akinesia).
4. Loss of postural reflexes (instability).

**TRAP:** tremor, rigidity, akinesia (slow onset of movement), postural instability.

First sx: is usually a resting tremor in distal extremities, may be present when arms are raised (postural tremor), may be absent. Usually starts on one side of the body and progresses to the other side in 2-3 yrs. It may either disappear with the onset of finger-to-nose testing or may remain constant throughout the ROM.

**Other:** Abnormal posturing, depression and subtle motor problems (often flailing in sleep) are common. Diffuse inc muscle tone: cog wheel rigidity = ratchet-like resistance in passive ROM of the limbs (Pearl: check as opposite hand is drawing small circles or boxes in the air as a distraction). Also see a flexion posture of body, hypokinesia, bradykinesia, festinating gait. "Masked facies" (dec facial expression), difficulty with handwriting, dec smell, dec voice volume/ stuttering, echolalia, stiff/clumsy, fatigue, slow blink rate.

Other common: Seborrhea, changes in speech (dec volume, rate prosody), easy fatigability, malaise, loss of motor skills (ability to play golf or tennis), handwriting (ded size and speed), personality changes, drooling due to swallowing problems, constipation, autonomic dysfunction (urinary, GI), depression, anxiety, sleep problems, cognitive. Hypokinesia (dec blinking, soft speech due to loss of inflection (aprosody), dec manual dexterity, slowed walking, short steps, shuffling gait, difficulty rising or turning.

dx: clinical via the neuropathology exam (2 of 3 triad sx’s), yet wrong in 25%. 90% respond to levodopa, no response is an important clue to an alternative dx. Do not need neuroimaging unless atypical features such as focal weakness, asymptomatically brisk reflexes, unilateral Babinski. No PD: no tremor, poor response to Levodopa, early hallucinations (unrelated to meds during 1st 3 mo, consider Levy body dementia). Unlikely PD: prominent postural instability or freezing phenomena in the 1st 3yrs, dementia preceding motor sx’s (or in 1st yr), supranuclear gaze palsy, severe symptomatic dysautonomia unrelated to meds. Atypical Parkinson’s:

**Stage 1:** sx’s only on one side, mild sx’s that are an inconvenience (not disabling), friends notice change in posture, locomotion and facial expression. 

**Stage 2:** sx’s are bilateral, minimal instability, posture & gait affected.

**Stage 3:** significant slowing of body movement, early impairment of equilibrium on walking or standing. Generalized dysfunction that is moderately severe.

**Stage 4:** severe sx’s, can still walk to a limited extent, rigidity & bradykinesia, no longer able to live alone, tremors may be less.

**Stage 5:** cachectic, invalidism complete, cannot stand or walk, requires constant nursing care.

**Tx basics:** goal to decrease sx’s and slow the progression, maintain activity levels via exercise, meds to inc DA and dec Ach levels. Levodopa (L-Dopa, Sinemet): the best drug, start this or amantadine if age >70yo. The treatment goal is to improve mobility with minimal SE’s. Treating the tremor is the most difficult aspect, one may never get rid of it. It is also hard to treat postural instability/ falling (try PT), speech impairment, dysphagia, bladder/ bowel sx’s (constipation), dyskinesias (early motor fluctuations). Best to start with combo therapy using an agonist and Levodopa together to decrease dyskinesias. Excessive daytime sleepiness common, warn pt to avoid driving if they doze in unusual circumstances.

If age <70yo: best to delay Sinemet use by 6-12 mo with dopamine agonists and metabolite inhibitors or with low dose Levodopa. Levodopa is the most effective antiparkinsonian drug, all PD pt’s eventually require levodopa. Levodopa continues to provide antiparkinsonian benefit over the course of the disease. There is no evidence that levodopa causes or accelerates neuronal cell death in PD.

**Bibliotherapy:** www.wemove.org

**Patient diary:** for period of 2-3 days, note on (good) periods, and off (bad periods to assess response to tx.

**Music therapy:** moving with and creating soothing music may help pt’s move more quickly and improves mood. Regular exercise to improve mobility and mood.

**Basic Algorithm for managing PD at different phases:**

For all patients: Education, physical or exercise therapy, good nutrition

For patients with no clinically significant disability: Consider selegiline. Consider referral to study centers for trials of new neuroprotective strategies

For patients with clinically significant disability: If job security is threatened or health endangered; Levodopa (usually controlled-release formulation). If job security NOT threatened and health NOT endangered: Young and tremor-predominant disease try anticholinergic drugs or amantadine. If older patient try Amantadine, dopamine agonists. In the very elderly patients (>80) use Levodopa.

**Above patients with progressive disability:** Add levodopa either as controlled-release or standard formulation

**PD Meds:**

Links: Inc DA Levels: Dec DA Breakdown: Stimulate DA (agonists): Other

**Pearls:** Only modest benefit with anticholinergics & amantadine, with inc SE’s. The average pt requires 400-1,000 mg/d of Levodopa, take the “regular” form on an empty stomach and CR form with meals. Depression seen in 40% of PD pt’s, rx with SSRI. If hallucinations avoid typical antipsychotics, use Seroquel (Quetiapine) 12.5mg, titrate to 25-50mg BID-TID. Coenzyme Q10 @ 1200 mg may slow functional decline in PD (Arch Neurol 2002;59:1523,1541-1550).

**Increase DA Levels:**

**Sinemet (Levodopa/ Carbidopa):** combines Carbidopa, a peripheral dopa decarboxylase inhibitor; decreases peripheral conversion of L-Dopa to DA. Levodopa replenishes the nigrostriatal dopaminergic system that is depleted due to degeneration. Levodopa (DA precursor) in ratio of 4:1 (most common) and 10:1 ratios. 25/100 (25mg carbidopa, 100mg levodopa) or 50/200mg, 10/100, 25/100, 25/250mg TID with meals.

**Start:** at 25/100 TID. Immediate release had peak effect in 1hr. Introduce and titrate slow, sx’s diminishing returns is 2.5 tabs/ dose of 25/100. If severe nausea, add additional 25mg carbidopa TID. Ineffective for postural instability and reflex abnormalities.

**Sinemet CR:** 25/100, 50/200mg: peak effect in 2 hr, lasts 60-90 min longer than immediate release. Best to use sustained
release in pt with early dz. When switch to sustained, inc levodopa content/dose by 30-50% as dec bioavailability & longer interval (inc total levodopa ~12% more/day). dec dose interval by 60-90min, give ½ tab of 25/100 immediate release in AM to facilitate initial effects.

SE of DA: Peripheral: N/V, orthostatic hypotension (need more Carbidopa by Dupont).

Central: dyskinesias, psych disturbances such as psychosis and visual hallucinations (illusion of presence). “Sinemet” means “w/o vomiting”.

Carbidopa (Lodosyn): 25mg tabs. Can only be gotten directly from the manufacturer. Often needed if pt is on low-dose Sinemet as needed 75-100mg of Carbidopa to sufficiently inhibit peripheral dopa decarboxylase and relieve nausea. Competitively transported across BBB, thus high protein meal affects as amino acids also transported.

Amanadiine (Symmetrel): mildly dopaminergic. Good for mild sx’s and tremors or used late in dz for sx’s of dyskinesia. @ 100mg 2-3x/d.

SE: dry mouth, constipation, memory problems, benign livedo reticularis, pedal edema. May lose efficacy in 6-8wks.

Meds that Inhibit DA Metabolism:

Tasmar (Tolcapone): @ 100-200mg PO TID, the first dose of day should be taken with levo/carbidopa. Good if getting waning benefits from Sinemet as it prolongs effective duration of action of levodopa to reduce “off” time. Give with each dose of Sinemet to “smooth the effects”, very expensive. A COMPT inhibitor (catechol-o-methyltransferase), inhibits DA metabolism in the plasma (peripherally). SE: dyskinesias, diarrhea (5%), orthostasis, hepatitis: Check: LFT’s q2wks X 1yr, then q4wks X6mo, then q8wks for life.

Comtan (Entacapone): 200mg with each levodopa dose, max of 8 doses/d. COMPT inhibitor. No hepatotoxic problems. May cause urine to be brownish-orange.

Selegline (Edepryl/ Deprenyl-cap, Carbox-tab): inhibit MAO-B @5mg BID, last dose given at mid-day. Potential neuro protection, not that effective, may slow the progression, but this effect wanes. Avoid on SSRI. Symptomatic improvement when added to levodopa. SE: dyskinesias, nausea, orthostatic hypotension, psychosis, insomnia, H-A, sweating.

Agonists That Stimulate DA Receptors (Agonists):

Pt’s who receive initial tx with these agents develop less motor complications compared to Levodopa therapy. Good as monotherapy in younger pt as less treatment induced SE’s. Also useful as adjunctive tx with levodopa to improve sx’s (especially if on >400mg/d of levodopa) and diminish motor fluctuations in early dz., tricyclics, antihistamines (but may alter MS in age >70). Start slowly and titrate over 6-8wks. Aim for lowest dose that improves. When switching among this class, stop the 1st drug with the last dose of the day, start the newer drug using an equivalent conversion dose the following day.

Bromocriptine (Parlodel): (2.5, 5mg) an Ergot, start at 1.25mg BID, inc 2.5mg/wk to maintenance of 5-15mg TID (max 60mg/d). $$$ Ergots have mild vasoconstrictive effects, thus avoid if CAD or Raynaud’s.

Pergolide (Permax): (0.05, 0.25, 0.1mg an Ergot, 0.05mg qHS. Inc by 0.05mg q2d to 0.25mg TID, then by 0.25mg q3d to maintenance dose of 0.5-1.5mg TID (max 6mg/d). $$

Pramipexole (Mirapex): (0.125, 0.25, 0.5, 1, 1.5mg): 0.125mg TID week 1, then 0.25mg TID weeks 2-7 to maintenance of 0.5-1.5mg TID (max 8mg/d). SE: Sleep attacks.

Ropinirole (Requip): (0.25, 0.5, 1, 2.5mg): 0.25mg TID. Inc 0.25mg TID weeks 1-4, inc 1mg TID weeks 5-12, to maintenance of 1-8mg TID (max 27mg/d).

Other Meds: Mild sx’s tx with: Anticholinergics (avoid in elderly), also good for tremor predominant sx’s: Testosterone supplementation may improve Parkinson’s symptoms (Arch Neurol 2002:59:1750-1753).

Benztrypine (Cogentin): 1-2mg BID. Trihexyphenidyl (Artane): 0.5-1mg/d for tremors.

Diphenhydramine (Benadryl): 25mg qHS for acute dystonia.

New (atypical) antipsychotics: Risperdal, Seroquel.

Motor Response Fluctuations and other Problems:

Links: Chorea: Dystonia: Gait Freezing: Hallucinations: Sleep: Other:

Levodopa response duration will not be the same each time. Physical exercise can “burn the fuel faster”, any emotional state will often produce tremor or dyskinesias.

Meals with protein compete with levodopa for transport and negate its effect, so best to take on empty stomach or with carbo. No take 2-3o after meal, avoid protein snacks, shift meal times around social events, but avoid malnutrition.

Dyskinesias: 2 types:

1. Chorea: rapidly flowing, non stereotyped involuntary movements of one limb or side of body. A levodopa effect. Usually at peak of levodopa effect -->

“Peak-dose Dyskinesias ”: Dec individual dosages of levodopa by the smallest amount possible (25mg), if this does not work change the dosing times to when the effects less troublesome (later in PM). Add DA agonist & dec Sinemet dose or switch to sustained release Sinemet. Add Amantadine 100mg 1-3x/d or Propranolol 10-20mg TID.

2. Dystonia: involuntary sustained posture. In absence of chorea, a PD sx, especially if painful and cramping of toes/ foot.

“Wearing off” phenomena: As the dz progresses get a waning of the effects of the last dose of Sinemet, may have abrupt change. Use combination of meds, switch to longer acting agent, inc dose, add DA agonist, dose more frequently. Add liquid Sinemet (rescue therapy) as onset in 20 min; dissolve entire usually daily dose in glass of water/ soft drink/ juice, stir well, sip at all day. Or Once back “on”, take usual dose as liquid wears off in 60-90min. Can pre-prepare liquid if mix 2mg Vit-C + 1mg levodopa/ ml of liquid.

“On-off ”: Rapid unpredictable change in sx’s as levodopa often only works for 1-2 hours (late SE), 20% get at 5yrs. Add DA agonists, SC apomorphine. Delayed “on” of no “on”: add COMT inhibitor, redistribute dietary protein, manipulate time & dose of DA therapy.

Diphasic Dyskinesia (begin & end of cycle): “D-I-D” response of dysk-improve-dysk, biphasic. Dec dosing interval and levodopa dose, add DA agonist (pergolide). Take a nap during this period or add a short acting benzo Alprazolam just before the anticipated period.

End of dose Dysotina: add DA agonist, add Baclofen, inc/dac Sinemet dose, add anticholinergic such as Trihexyphenidyl 2mg TID.

Gait Freezing: inability to initiate walking (magnetic gait = apraxia): May be end of dose or due to excessive DA. Inc/dac Sinemet dose, add DA agonist, use sensory cues (auditory- counting, or visual- tape on floor). Try marching in place, place feet on targets (imaginary, “pretend like stepping over lines/cracks”, place stickers for clues on the floor or use laser pointer), use inverted cane as target to step over, use a stil-legged, goose type step.

Early morning off: at Sinemet CR qHS, add DA agonist.
Hallucinations, psychosis: All meds are capable of this. Just observe if minimal or not bothersome. Stop unnecessary psychoactive meds such as tranquiliizers. Gradually taper meds with a lower therapeutic index such as anticholinergics, selegiline, amantadine, DA agonists and evening Sinemet. Add low dose Clozapine 12.5-50mg/d (need blood monitoring, avoid if h/o sz), atypical neuroleptics such as, Risperidone 0.5-2mg/d (may worsen EPS at doses > 1 –2 mg/day), Zyprexa 2.5 – 15 mg/day for early onset, Serquelax 25 – 200 mg/day.

Insomnia: /o depression, pain, respiratory causes. D/c Selegiline as causes insomnia. Add qHS Sinemet CR as PD sx’s inhibit sleep and thus does pointing to perform bedtime. Add low dose TCA/ chloral hydrate or benzo qHS. If awaken in middle of night and unable to sleep a dose of immediate release may be helpful.

Daytime sleepiness: often due to insomnia. May need Ritalin or Modafinil (Provigil).

Restless leg syndrome: need to differentiate from akathisia (med SE), otherwise tx with DA agonist, Clonazeptam, controlled release levodopa or propoxyphene or codeine.

Nightmares: med SE (reduce PM anti-PD meds, hypnotics, TCA), consider dementia, if idopathic consider to sleep center referral.


Dementia: occurs in 10-30%. Simplify the med regimen, manage motor sx’s with Sinemet. Consider a trial of Aricept or Exelon as may have coexistent Alzheimer’s.

Postural Hypotension: liberal salt/ fluid intake, support hose, Fludrocortisone, elevate HOB, ProAmatine.

GI sx’s: May be normal imbalance due to PD, vestibular type due to aging. Need to /o orthostatic hypotension: Check: standing BP, if <90/60 eliminate unnecessary hypotensives, add salt, then fludrocortisone, elevate HOB, compression stockings, Midodore (ProAmatine): 2.5mg TID, EPO, Fludrocortisone.

Urinary sx’s: common, /o BPH or stress incontinence. Consider Flomax, Oxybutynin, Hyoscyamine, reduce evening fluid intake.

Male impotence: treat depression, med SE, trial of Viagra or other agent.

Dysnea: Ergot meds may cause pulmonary fibrosis or constrictive pericarditis. May be a levodopa off effect. R/o primary cardio-pulmonary problem.

Pain/ Dysesthesia: tx parkinsonism, treat motor fluctuations/ dystonia, treat depression.

Sweating: if occurs during “on” period will likely respond to b-blocker.

Hyperpyrexia: if after levodopa withdrawal, may represent a form of NMS. May need to短期 dopamine neuroleptic.

Seborrhea: coal tar shampoo and topical steroids.

Phlebitis: natural tears, warm compresses, steroid cream and eye patch qHS.

Rigidity: stretching, exercises in warm water.


Surgery: eventually resistant to the med and may need surgical procedure. Pallidotomy, deep brain (Thalamic) stimulation (DBS) to subthalamic nucleus, fetal transplant.

Ddx PD: Atypical Parkinsonian Disorders (Syndrome’s):

Parkinsonism has a 15-25% incidence of misdiagnosis as Parkinson’s dz (PD). (PD causes 75-85% of parkinsonism) Have common characteristics to Parkinson’s that include akinesia and rigidity. If due to a med, is develops subacutely within the first weeks of the new med. The med may be mistaken for idiopathic PD. Less responsive to PD meds.

Features Suggestive of Atypical Vs PD: rapid development, poor response to levodopa, supranuclear gaze palsy, early dementia, hallucinations unrelated to tx, early autonomic failure, pyramidal signs (Babinski), cerebellar signs, alien limb syndrome (pt feel a limb that is not his own and it moves w/o the patients volition), severe ideomotor apraxia (pt’s inability to perform voluntary movements, not withstanding preservation of motor and sensory function), young or late onset, early onset dementia, strong FHzs, rapid progression, symmetrical onset, no tremor, dystonia or myoclonus (muscle twitches), early postural instability. These syndromes may also overlap features of Alzheimer’s disease and related disorders.

Etiology: toxins: CO, cyanide, manganese, MPTP, methanol.

Meds: neuroleptics, Reglan, Aldomet, resepine, Dillazem, Haldol, Li, Amiodarone, Compazine.

Other: Multi-infarct state, trauma (dementia pugilistica), calcification of basal ganglia (familial (Wilson’s, Huntington’s), primary dentoting/neurodegenerative dz illness: Azt’s, CJD, Lewy body, multisystem degeneration (supranuclear palsy..), ALS, NPH, psychogenic parkinsonism.

Wilson’s Dz: AR, chromo13, copper transporting ATPase: inc hepatic Copper (Cu) that spills to other tissue.

Sx’s: dystarthritis, tremor, drooling, dystonia, ataxia, chorea, gait o/d, change in personality, drop off in school performance, bothersome.

Lab screen: ceruloplasmin, 24hr Ur copper, KF-ring on SLE.

Multiple System Atrophy (MSA): has early dysautonomia (bladder dysfunction, OH, erectile dysf), cerebellar dysfunction and pyramidal signs, extreme forward neck flexion, stimulus-sensitive myoclonus of the hands & face, cold/mottled hands, prominent dystarthritis. 20% have good initial response to Levodopa, but sustained in only 13%. May have predominantly cerebellar signs/ sensory sx’s, early postural instability, lack of resting tremor.

Progressive Supranuclear Palsy (PSP): Resembles Parkinson’s in most ways (dyskinesias, abnormal gait, incr. tone, mild dementia). Except have no resting tremor, vertical ophthalmoplegia (inability to gaze downward = vertical gaze palsy), other oculomotor eyelid disturbances, early falls, cognitive changes, HTN. Prominent axial or nuchal rigidity, lack of resting tremor. Tend to have an erect posture with hyperextension of the neck (as opposed to the flexed posture in PD). Within 2 years develop the classic sx of vertical ophthalmoplegia in which the pt cannot voluntarily look up or down. After another few months, the pt has difficulty reading, eating, walking down stairs, after 2-3 years, unable to walk. No good Rx s poor-partial response to Levodopa.


Vascular Parkinsonism: “lower-half” sx’s or gait disturbances. Poor response to Levodopa.

Dementia with Lewy Bodies: early dementia, rigidity more prominent than bradykinesia or tremor, hallucinations. Motor features may respond to Levodopa.

Huntington’s Dz: involuntary movements, cognitive and behavior problems, chorea, loose tone, early dementia.


**Transient Loss of Consciousness ( Spells):**

**Link:** Etiology of Sz: Seizures:

Either a bi-cerebral hemispheric or brainstem (RAS) dysfunction. All have a brain problem, not always a primary brain problem.

**W/u of spells:** H&P. Direct tests toward this, but cast a wide but defensible diagnostic net. Check: CBC with diff, lyses, BS, Cr, Ca, P, LFT, total protein, U/A. Consider: 24hr metanephrine, 5H-indolonic acid.

1. **Impaired cerebral perfusion:** vascular dz, cardiac syncope (arrrhythmia/ outflow tract obstruction/ angina. With syncope, common to have repetitive clonic, myoclonic, dystonic movements on fainting, but they rarely persist >10sec, no organized progression from tonic to clonic), hypotension (orthostatic, vasovagal), pulmonary edema, labile HTN, autonomic neuropathy.

2. **Acute stroke:** causes ~22% of all cases of status epilepticus in adults. Stroke seen in 14% lobar ICH, 8% SAH, 6% of lobar infarcts, 4% deep ICH, 0.6% deep infarcts (Neurology 2001;57:200-06)

3. **Basilar Migraine:** more common in younger. Have brainstem aura: bilateral visual sx’s, ataxia, bilateral numbness, tingling, LOC, vertigo, dysartrhia.

4. **Hyperventilation Syndrome:** May be able to reproduce sx’s: dx, have pt blow into open hand: paresthesias, lightheadedness, dizziness, visual.

5. **Metabolic:** hypoxia, anemia, hypoglycemia, thyrotoxicosis, hypocalcemia, hypomagnesemia, hypoparathyroidism, hyponatremia.

6. **Pheochromocytoma:** perspiration, palpitation, pain, pallor, plethora of tremors/ anxiety/ N/C/ SOG/ weakness, lasts 10-60min.

7. **Carcinoid Syndrome:** flushing/ diarrhea/ cardiac valvular dz, hypotension, nasal congestion, bronchospasm. Lasts 2-5min.

8. **Mastocytosis:** sudden release of mast cell mediators causing flushing/ warmth/ palpitations/ lightheadedness/ SOB, CP/ pruritis/ fatigue and lethargy afterwards. Triggered by heat/ exertion/ emotions/ drugs, lasting 15-30min daily to 3X/yr.

9. **Raised ICP:** mass lesions, blocked CSF flow, CSF production/ absorption.

10. **Cushing Triad/ response:** inc BP, dec HR, respiratory irregularity (usually hypoventilation).

11. **Sleep D/o:** Parasomnias, Narcolepsy: begins in 20-30’s, cataplexy (sudden loss of muscle tone assoc. with LOC, often an emotional stimulus), hypoglycic hallucinations (about to fall asleep), sleep paralysis (awake, but can’t move for 30-60s, not 1-2s).

12. **Tx:** brief preventive naps throughout the day. Pemoline @18.75mg on awakening and gradually inc as tolerated to 150mg/d divided. Or Ritalin 5mg BID. If cataplexy a problem use Protriptyline 5-30mg divided or Imipramine 25-200mg/d or Fluoxetine 10-60mg/d. See Psych chapter.

13. **Psychiatric D/o:** anxiety, panic attack, hyperventilation. Catatonia (awake, eyes open, don’t move), Conversion reaction (somatic manifestation of stress/ disturbance of subconscious), Malingering (conscious), pseudo sz’s (must be hooked up to EEG with spell).

14. **Seizures:** electric discharges from gray matter (don’t occur in brainstem). Ictus (the event, call all witnesses to ask what they saw/ how long), Postictal (20-30min of confusion for generalized tonic-clonic Vs 20-30sec for syncope).

15. **Drugs causing sz:** Flagyl, Cipro, acyclovir, Wellbutrin, high dose PCN, withdrawal (from ETOH, benzo, barbiturates), PCP, theophylline, Demerol, isoniazid, clonazepam, phenothiazines, radiocontrast dyes, lidocaine, SSRIs, cocaine, MDMA (ecstasy), brain mass.

16. **Pharmacologic:** withdrawal of adrenergic inhibitor, MAOI + tyramine or sympathomimetic med, sympathomimetic ingestion, illegal drug. Vancomycin (Red man flush), Chlorpropamide (alcohol flush), Flagyl + ETOH.

17. **Narcolepsy:** begins in 20-30’s, cataplexy (sudden loss of muscle tone assoc. with LOC, often an emotional stimulus), hypnagogic hallucinations (about to fall asleep), sleep paralysis (awake, but can’t move for 30-60s, not 1-2s).

18. **Child Bearing:** Either a bi-cerebral hemispheric or brainstem (RAS) dysfunction. All have a brain problem, not always a primary brain problem.


**Seizures (Sz):**

Lifetime risk is 10% by age 80, 2/3 sz never develop epilepsy especially if provoked, 3% pop with epilepsy, 100,000 new cases per year in USA.

**Hx:** Was it a sz or a spell?

**Q’s for Bystanders:** Was there an event that seemed to cause the sz, abnormal motor activity, how did the abnormal movement begin, sequential development, abnormal eye movement, LOC, how long, postictal recovery. PT tends to “look away” from the sz focus (Vs stroke on looks away/neglects the bad/parietal side). Pt may fall on face if standing as suddenly lose motor control. Vs with syncope they slump over, may see 3-4 myoclonic jerks in the distal portions of the extremities with a convulsive syncope, due to brain lacking O2.

**Q’s for Patient:** Hx of past sz/neuro d/o, FHx, recent illness/ injury/ travel/ new meds, patterns of ETOH/drug use, any unusual sensory distortions (premonitory sx) or stimuli (flickering lights) before sz. Any sleep deprivation or unusual stress (emotional trauma).

**Exam:** look for evidence of head trauma, ear/sinus infections, congenital abnormalities (tuberosus sclerosis, neurofibromatosis), focal or diffuse neuro abnormalities, ETOH, drug abuse, cancer. Hyperventilate pt for 3min to try and
trigger an absence sz. Check: Babinski as common after a sz and a good test to r/o malingering. Look for pronator drift (subtle weakness). Check O2 sat and auscultate chest for possible aspiration. Check orthostatics, auscultate carotids. Nonconvulsive status epilepticus is often mistaken for a postictal state or a psychiatric d/o, pt has a blank stare, altered consciousness, may be tremulous and have subtle periorbital/facial/limb myoclonus or other automatisms. Pt may have dec speech, rambling speech or be mute, they are usually mildly agitated but easy to restrain. They may have inappropriate laughing, crying or singing.

Complex status characterized by hallucinations, the pt has complete amnesia for the attacks. Focal status can be simple (nl consciousness) or complex (impaired consciousness but no overt jerking) and often presents with continuous clonic movements of one or two extremities. Psychogenic status usually has out-of-phase or asynchronous jerking movements with pelvic thrusting, screaming with the pt keeping their eyes deviated from the examiner. The pt may speak between movements.

Myoclonic status is often seen in comatose pt’s after a cardiac arrest, electrical injury, decompression sickness, toxic exposure, Creutzfeldt-Jacob dz or asphyxia. It consists of brief asynchronous jerks of the limbs, face and diaphragm often provoked by touch or intubation. The eyes episodically gaze upward, pathologic withdrawal and extensor motor responses are often seen.

Classification:

Links: Partial: Generalized:

Epilepsy: a chronic/recurrent brain d/o characterized by paroxysmal brain dysfunction due to excessive neuronal discharge, which is usually associated with some alteration of consciousness. Idiopathic epilepsy has an average onset at age 12-14y and affects 0.7% of the pop at some point in their lives (~1 in 1,000). Up to 30% of pt’s have sz’s despite therapy. Asymptomatic epilepsy, onset age 9, spontaneously resolves at age 16, idiopathic with strong genetic component. Starts in one hemisphere, affects 0.7% of the pop at some point in their lives (~1 in 1,000). Up to 30% of pt’s have sz’s despite therapy. Asymptomatic epilepsy, onset age 9, spontaneously resolves at age 16, idiopathic with strong genetic component. Starts in one hemisphere.

1. Partial Seizures: Involve only part of the brain at onset (part of one hemisphere), can spread to both hemispheres and become secondarily generalized. May or may not have impaired mentation/convsulsions. 70% of adults with epilepsy have partial onset sz’s, 50% of these get secondary generalized tonic-clonic sz’s. The first sz is often the best indicator of the site of the sz origin.

Tx: start with CMZ or Phenytoin as 1st line. Epilepsy Syndromes: May need to add-on: Gabapentin, Lamotrigine, Phenobarbital, Primidone, Tiagabine, Topiramate, Valproate, Levetiracetam, Zonisamide or Felbamate based on pt characteristics & SE profile.

A. Simple Partial Sz: (focal/local) lip smacking, automatism’s, repeat things without impaired mentation. Simple partial with motor/autonomic/sensory/psychic sx’s. Psychic sx’s such as feelings of fear, sadness, depersonalization may be misdiagnosed as a psychic d/o. Focal EEG abnormality is common, often with h/o febrile sz.

B. Complex Partial Sz (temporal lobe/psychomotor): The most common sz. Has impaired consciousness/mentation at the onset or progressing to. Lasts >1min, often with an aura and confusion after event. Lip smacking is common. Frontal lobe sz often lasts <1min and may include kicking, “bicycling”, pelvic thrusting, genital manipulation and cursing. May lack a post-ictal state. “Fencing sz” if arm is extended and head turns. Benign childhood epilepsy with centrotemporal spikes: onset age 9, spontaneously resolves at age 16, idiopathic with strong genetic component. Starts in one part of the brain, EEG show temporal slowing or sharp waves.

C. Partial Sz with secondary generalized (tonic/clonic or grand mal): Simple or complex. Sz begins with motor, sensory, autonomic or psychic sx’s, then consciousness is lost. Get a tonic increase in muscle tone with subsequent rhythmic (clonic) jerks that slowly subside. Comatose after sz.

2. Generalized Sz: convulsive or nonconvulsive. Both hemispheres (whole brain) at onset.

A. Absence sz (petit mal): have odd affect lasting for 10-15sec, “Staring Spell”, benign, usually grow out of. R/o complex partial sz as both may have loss of consciousness with or w/o automatic behavior. EEG shows a pattern of spike & wave at 3Hz. If it interferes with school learning tx with meds. Otherwise normal child, strong genetic component. Tx with Ethosuximide, Felbamate or Divalproex/Valproate.

B. Myoclonic: Onset at puberty, brief myoclonic sz that usually affects the arms, may have other sx types. The pt has frequent myoclonic jerks in the setting of altered mental status. Responds well to Clonazepam, can use Valproate. Pearls: most pt’s with both myoclonus and altered consciousness are far more likely to be suffering from a metabolic encephalopathy (particularly uremic or hepatic encephalopathy) than from true myoclonic status epilepticus.

C. Primarily Generalized Tonic-clonic (GTC) (Grand mal): Loss of consciousness occurs w/o warning or is preceded by myoclonic jerks. Onset may be during sleep/awake, any posture. Starts with a sudden tonic contraction of the muscles associated with loss of consciousness. A loud cry or stridor may occur if respiratory muscles force air out a contracted glottis. The pt may become cyanotic if prolonged. Lateral tongue biting and urinary loss are common. The tonic phase transitions to clonic convulsive movements that last 90-120 seconds. During the convulsion phase, grunting or labored respiratory noises, saliva may froth from the mouth. Duration usually 1-2min (Vs 0.5-10min with psychogenic sz), if >5min, start tx. See inc muscle tone, incontinence, tongue biting, flushed color, petechial hemorrhages in the conjunctiva/cheek/neck, hot/sweaty skin (same as secondary generalized). Occasionally get bone fx, “shudder dislocation”, hyperglycemia or aspiration. A sz is typically followed by 5+ min of a dazed state or agitation resulting in labored breathing and deep sleep. Very short attacks may occur that are not associated with postictal drowsiness or confusion. For primary can use Felbamate, Lamotrigine, Phenobarbital, Phenytoin, Primidone, Topiramate or Valproate. For secondary can use CMZ, Felbamate, Gabapentin, Lamotrigine, Phenobarbital, Phenytoin, Primidone, Tiagabine, Topiramate or Valproate.

D. Clonic (rigid jerking).

E. Tonic (stiff and rigid).

F. Atonic: Drop attacks. Tx: Valproate, Clonazepam or Felbamate.

Other: Pseudozeure:...
Periodic Lateralized Epileptiform Discharges (PLEDS): periodic complexes consisting of a spike, polyspike, or sharp wave followed by a slow wave occurring every one to two seconds on the EEG. Controversial whether PLEDs are an ictal or interictal phenomenon. Tx: Phenytoin, aim for a plasma level of ~15µg/mL (15 mg/L). R/o status if pt has persistently altered mental status.

Electroencephalogram (EEG): Give 3 types of info (abnormal electrical activity, info on type of sz, location). Have
abnormal spikes/ waves, interictal may be nl, 15% pop have nonspecific abnormalities. Sleep deprivation, stroboscopic photopic stimulation improves dx yield. A single EEG in a pt with known epilepsy will be normal 50% of the time, repeat if have high suspicion. Ultimately 10% with true sz's have a normal EEG. 83% of untreated idiopathic 1st sz will recur if abn EEG, VS 41% with nonspecific abv VS 12% with nl EEG. If H/A precedes sz and have N/V likely a non epileptic event (NEE). EEG is done by placing scalp surface electrodes using the international 10-20 system based on standard scalp landmarks such as nasion and ear canals. EEG waves into 4 main classes. Delta waves at 0-4 Hz, Theta waves at 4-8 Hz, Alpha waves at 8-14 Hz and Beta waves at 14-30 Hz. EEG helps assess sleep disorders, sz, ischemic conditions, dx brain death and quantify drug affects on the cerebral metabolism.

Diagnosis limitations: cannot exclude epilepsy, cannot exclude focal pathology (or suggest a structural nature), cannot be used to assess the adequacy of AED's.

**Status Epilepticus:**

>30 min of sz activity or repeated sz’s w/o clearing of mental status. Refractory status (RSE) seen in up to 30% of pt’s.

Causes: withdrawal from anticonvulsant med or benzo, change in med, drugs/ ETOH, bacterial menigitis, encephalitis, stroke, intracranial mass, AVM, hyper/hypoglycemia, hyponatremia, preeclampsia, electroconvulsive therapy, IV contrast agent.

0-5min: Monitor temp/ BP/ pulse/ RR/ EKG/ EEG. Consider intubation and O₂. Check blood sugar. Start NS IV, Check: convulsant levels, lytes, BUN, Ca, CBC. Give rectal antipyretics PRN.

If no IV can give IM Fosphenytoin (12-20mg/kg), rectal Diazepam (0.5mg/kg), IM Midazolam (5mg) or intranasal Midazolam (0.1-0.2mg/kg) or an inhalational anesthetic (isoflurane @ 0.5%) then get a saphenous vein cutdown at the ankle.

**Adult in Status** (in ER, ICU Or monitored bed):

6-9min: Bolus 50ml of 50% Glucose. Add Vitamin B complex to IV.

0-20min: Infuse Lorazepam at rate of 0.1mg/min to max dose of 5mg. Or give IV Diazepam at rate up to 2mg/min to total of 20mg. 20min: Cerebyx (Fosphenytoin): 15 to 20mg PE/kg IV, then infuse at 100-150 mg/min rate or just repeat dose @ 10mg/kg if no response in 20 min. Can mix in NS or 5% dextrose. IM volume of 10-20ml (12-20mg/kg) in 1-3 injections. Or Follow with Phenytin @ 20mg/kg at rate no faster than 50mg/min. If still not controlled, repeat Phenytoin at 10mg/kg.

60min: Phenobarbital 5-10mg/kg load, then 2mg/kg/hr (0.2-0.4 mg/kg/min) or 100mg/min to loading dose of 20mg/kg, anesthesia and intubate if persists. Alternative strategies for status include benzodiazepine drip (eg midazolam 0.1-0.2 mg/kg/hr) or rapid Depakote (Depakene IV) load.

Caveat: check STAT phenytoin levels immediately after loading patient to ensure adequate serum levels are achieved, and to plan maintenance dosing schedule (target 20 – 30 ug/ml). R/o CNS bleed/ infection.

Other: Propofol @ 1-3mg/kg, the 6-10mg/kg/hr. Versed drip.

**Child in Status:**

ABC’s, then O₂, IV. Get glucose, CBC, chem panel, AED levels. If hypoglycemia, bolus with 2cc/kg 50% glucose (10ml/kg D10W if neonate, 4ml/kg D525w in <2yo, 2ml/kg D50w if >2yo). Add 100mg Thiamine if malfurnished.

#1 DOC: Lorazepam (Ativan): @ 0.1-0.15mg/kg IV, (max rate at 2mg/min), may repeat q5min X2 to max dose of 5mg. (Rectal --> 0.1-0.2mg/kg) Or

Diazepam: 0.2-0.3 mg/kg IV, max rate <1mg/min, repeat q5min X2 (max 10mg age >5yo, 5mg @age 30d-5yo). Rectal --> 0.5mg/kg age 2-5yo, max 20mg, 0.3 mg/kg age 6-11yo, 0.2mg/kg age >11yo Or Midazolam (Versed): 0.1-0.3mg/kg bolus then infuse at 0.1-0.4mg/kg/hr, nasal @0.1-0.3 mg/kg).

#2: Then IV Phenytin at 18-20mg/kg at rate no faster than 1mg/kg/min (50mg/min). Or Fosphenytoin (Cerebyx): 18-20mg/kg IV, max rate 1mg/kg/min. Monitor ECG & BP, anticipate intubation.

#3: If sz still present at 30-60min give IV Phenobarbital: 20mg/kg load dose at rate no faster than 50mg/min, can repeat with a dose of 5-10mg/kg. Or

If not already given use: Midazolam (above dose), or Lorazepam (above dose) or Diazepam 50mg diluted in NS or D5W and run at 1ml/kg/hr (2mg/kg/hr).

#4: Intubate: give Pentobarbital:15mg/kg, then 1-5 mg/kg/hr to produce burst suppression pattern on EEG. Or use Propofol (Diprivan) 1-2mg/kg IV initially, then 1-15 mg/kg/hr. Or Midazolam 0.15-2mg/kg IV, then 1-18 ug/kg/min aiming for burst suppression.

**1st Sz work up:**

Link: **Spells & Ddx**: Etiology of Sz:

CBC, BS, lytes, BUN, Ca, Mg, P, Tox, MRI head (CT if urgent, new focal deficit, fever, head trauma, persistent altered MS/ H-A, CA, anticoagulated, immunocompromised). EGG (look for prolonged QT, arrhythmia or ischemia). EP, LFT’s (pseudos sx has no inc CPK, met acidosis or prolactin). Consider serum prolactin in generalized seizure if drawn within 20-30 mins of event (will increase many fold after true tonic-clonic seizure Vs non-epileptic event). ABG can essentially show any pattern. Consider EEG: Decisions to treat an isolated seizure vary for each individual, and depend upon risks of recurrent seizures, and the implications for such sz’s for that pt. Inc risk of 2nd seizure is ~15-60% depending on risk factors, but 80–90% for “epilepsy” after 2nd or 3rd event. Remember to warn patients of risks of operating dangerous equipment (inc. cars) and make appropriate reports to Division of Motor Vehicles where statutes apply. One option for isolated seizure: treat with "non-toxic" level of chosen AED for 1–2 years, then consider withdrawal of AED if sz-free.

**Neuroimaging: Get a stat CT scan if:** suspect a structural lesion or a new focal deficit, persistently altered mental status, fever, recent trauma, h/o cancer, persistent H-A, HIV, on anticoagulants, age >40yo, s/p a partial sz, status epilepticus.

All others as outpatient. Includes child with sz of focal onset, age <1yo & non febrile, no known cause for the sz. (NEJM 2001;344:15) (Ann EM 1996;114).

**Tx Considerations:** goal is to control sz’s completely w/o unacceptable SE’s. Educate pt & family that if another sz they need to turn pt onto side so secretions come out of the mouth, call 911 if lasts >5min, it is normal to be confused for ~1hr.
When to definitely start long term meds for single sz: When a 2nd sz occurs within 1 day.

When structural lesions: tumor, infectious abscess/ encephalitis, AVM).

No structural lesion: h/o sibling with epilepsy (not parent), EEG with epileptic pattern, h/o of any prior acute onset/ febrile sz, h/o brain injury such as stroke/ infection/ trauma that precipitated the sz, prolonged Todd's (postictal) paralysis or status epilepticus at onset.

Not necessary to consider short term meds: ETOH withdrawal, drug abuse, sz in context of illness/ fever/ dehydration/ hypoglycemia. Post-traumatic sz, benign epilepsy syndrome, sz provoked by sleep deprivation (college student at exam time).

Intractable sz’s: 20% have, refer to epilepsy center if fail 2-3 first line meds as sz have risk of dying and psychosocial consequences. Vagus n. stimulator at the left infraclavicular region stims 30 sec q5min 30% success, can wave a magnet over the area if get a sz to initiate it. Surgery of ant temporal lobe with 80% success.

Ketogenic diet: A non drug tx for drug refractory sz’s. 80-90% calories from fat or medium chain trig’s, low carbs, moderate protein. The diet is four parts butter/ cream/ oils and one part protein/ carbs. Calories are adjusted for growth and body weight maintenance. Vitamin supplements are given. The diet leads to anorexia, works in 2/3, but 50% quit (noncompliance) diet by 2yrs. When stopping, switch from cream to whole milk then to skim milk, then stop in no sz’s. A ketogenic diet (3 parts fat to 1 part carbohydrate/protein diet) has been traditionally used in children, but it can actually work as well in older patients. After 6 months to 2 years of follow-up, 50% of patients experienced a more than 50% reduction in seizures. The 3:1 diet seemed to be more acceptable than the 4:1 diet

When Stop meds?: Must be individualized. If pt had a single sz, normal initial head CT, nl EEG, no FHx and has gone 3mo w/o a sz can stop. Otherwise wait until sz free for 2-3 yrs, give trial by weaning off (decl daily dose by 25% q2-4wks). Warn pt that they have a 20-50% chance of sz, some pt’s may want to stay on meds (fear of another sz, avoid losing driving privileges).

Likely to be successful if onset <16yo, normal IQ, normal neuro exam, single sz, a remitting epilepsy syndrome, nl EEG, was easily controlled on one AED. After Discontinue meds: 50% relapse, 80% in 1st 4mo.

High recurrence if: known structural lesion, EEG abnormal, onset during adolescence, severe epilepsy (frequent sz’s, on multiple meds), neuro abnormalities.

Epilepsy & Driving: Six states require physician to report (CA, DW, OR, NV, PN, NJ), no driving for 6mo after a sz. Other info: Epilepsy Foundation 800-EFA-1000. WWW.efa.org

Antiepileptic Hypersensitivity Reactions/ Syndrome: Typically appears 1-3 mo after starting the drug. Has been reported with Phenytoin, Carbamazepine, Primidone, Phenobarbital, Lamotrigine and Felbamate. May be a type of GVH reaction.

Risks: Africans, Fh, alcohol abusers, brain radiation therapy.

S/s: rash (90%), fever (38-40C in >90%), tender generalized lymphadenopathy (70%), hepatitis (55%), eosinophilia/ anemia/ thrombocytopenia (50%), periorbital or facial edema (25%). The rash starts with patchy erythema that evolves to a pruritic flesh-colored maculopapular rash that may generalize into a severe exfoliative dermatitis with sterile follicular-centered pustules. Usually no mucous membrane involvement.

Ddx: TEN (urticarial plaques with epidermal sloughing, leukopenia), SJS, CMV, EBV, SSSS, CVD, hepatitis, syphilis, ricketsial, gonococcal sepsis.

Tx: Immediately stop meds if get a rash, consider high dose PO steroids X 30 days with taper, oral antihistamines, moisturizers. Have pt go to ER to load up on a new med. Start an antigenically unrelated anticonvulsant (remember that phenytoin, carbamazepine and barbiturates share some cross-allergenicity). Benzo’s can be used short term to control the sz’s, Gabapentin is the DOC to switch to if the sz’s are partial or secondarily generalized. Valproic acid can be used after the phenytoin, carbamazepine and barbiturates share some cross-allergenicity. Benzo’s can be used short term to control the sz’s, Gabapentin is the DOC to switch to if the sz’s are partial or secondarily generalized. Valproic acid can be used after the

Antiepileptic Drugs (AED’s)/ Anticonvulsants:

Tips: If giving IV loads, can check level 1hr after load and re-dose based on volume of distribution

Other:

Risks:

S/s:

Ddx:

Tx:

Antiepileptic Drugs (AED’s)/ Anticonvulsants:

Tips:

Other:

Most work via voltage gated Na channel by blocking the receptor. Also have Benzo’s that block GABA receptor, Gabapentin (a GABA analog) and Ethosuximide.

Start med: increase dose until experience dose-related SE (dizzy, somnolence, ataxia, diplopia or fatigue), then reduce to max tolerated and maintain at this level, once steady state, check level as a reference. If sz occurs at this “level”, = med failure. Similar noncompliance rate as MTN & DM, ~35% do not take their meds. If need to change drugs for inadequate control, keep pt on initial drug until 2nd drug is titrated to full dose. May need two drugs to control sz’s, but monotherapy should be tried if possible. Usually only get 15% inc in sz-free with the second drug and 4% more with the 3rd drug.

Long-term use of AED’s has been linked to bone dz that can be prevented with Ca and Vit-D (Arch Neurol 2001;58:1369).

Seizure triggers such as sleep deprivation, alcohol intake, and stress, may be modifiable, thus, steps taken limiting exposure to these triggers to enhance drug therapy. Noncompliance is seen in up to 50%, improve it with frequent office visits and simple med regimens.

Serum levels: Clarify if level is trough, random or peak. They are only a rough indication of likelihood of response, most require levels at upper therapeutic limits. Use the clinical status (sz control and SE’s) to guide dosing and toxicity. Toxicity is usually reversible and not life threatening (unlike toxic levels of dig, Li, theo).

Also used for: documenting max tolerated dose, pt compliance if have breakthrough sz, ensure appropriate level in pt unable to report SE’s (young child, cognitively impaired adult), titrating dose during pregnancy, sort out nonspecific/ weird SE’s if on multiple meds.

No reason for routine levels. If giving IV loads, can check level 1hr after load and re-dose based on volume of distribution as needed. Indiscriminate use of blood level determination should be avoided.

Indications for Antiepileptic Drug Monitoring:

1) after initiation of therapy, usually several weeks later, to confirm first value.

2) once or twice a year to confirm compliance.

3) after each change in the drug regimen or change in other meds.

4) When a pt: complains of toxic signs, possibly dosage-related, is insidiously deteriorating, and it is not clear whether the
condition is dz or drug-related.

5) To check for compliance, when sz’s are not controlled despite an adequate prescription.

6) When a pt receiving an antiepileptic drug exhibiting zero-order kinetics is not controlled, for calculation of the dosage increment.

7) When a particular rate of metabolism is suspected: persisting sz’s despite large doses of an appropriate drug, relapse concomitant with hepatic or renal dz, with prescription of a non-antiepileptic drug, during pregnancy.

8) In polytherapy: to monitor drug-to-drug interactions, when an antiepileptic drug is discontinued.

9) When an abnormal ratio between total and free plasma levels is suspected: during pregnancy, renal failure.

10) When a metabolite is suspected of playing a significant role in the clinical condition.

***Use of serum or plasma levels only to adjust drug levels to a published “therapeutic” range is not recommended. It may be dangerous to change an effective and well-tolerated regimen simply to get drug levels within a published range. Each patient should have a target range based on severity of the epilepsy and tolerance to side effects. A patient who is seizure free and does not complain of side effects probably does not need blood level monitoring. If drug levels are not available or are unreliable, clinical judgment can usually recognize the most common dose-related side effects (drowsiness, dizziness, gastrointestinal disturbances, etc.).

SE Profile of AED’s:

Less sedating
(Lamotrigine, Felbamate), wt loss (Topiramate, Zonisamide, Felbamate), wt gain (Valproate, Gabapentin), kidney stone (Zonisamide), mood stabilizer (Carbamazepine, Valproate, Lamotrigine), cheap (Phenobarbital, Phenytoin), dd dose (Phenytoin, Phenobarbital, Zonisamide), quick titration (Phenytoin, Phenobarbital, Valproate, Gabapentin), renal excretion (Gabapentin, Levetiracetam, Topiramate), possibly less teratogenicity (Levetiracetam, Lamotrigine, Gabapentin), less rash (Valproate, Gabapentin, Topiramate), good for cephalgia (Gabapentin, Valproate, Topiramate). Minimal drug interactions: Gabapentin and Levetiracetam.

Diazepam (Diastat): Prefilled unit dose applicators (2.5, 5, 10, 15, 20mg) Gel form for rectal administration for refractory epileptics on stable med, but require intermittent control of bouts of increased sz activity. Age 2-5@ 0.5mg/kg, 6-11@0.3, >12@0.2. A 2nd dose is given 4hr after 1st, and a 3rd dose given 8hr after 2nd dose. Avoid preg/ breast feeding, narrow angle glaucoma. SE: somnolence. Stable at room temp: useful for traveling and a reassuring safety net. Not for recurrent febrile sz’s. PO Diazepam (Valium) @ 2-10mg.

Divalproex Sodium (Depakote): [125, 250, 500mg caps, 250mg/5ml elixir, 125mg sprinkles] start at 250mg QID, titrate 250mg/wk to 1,500 –4,000 mg/d (15-80mg/kg) divided TID. Child @ 20-40mg/kg (max 250mg) divided BID. Depakote ER [250, 500mg tab] 1-2 qd for migraine prophylaxis. Sprinkle Capsules. Monitor Valproate level (aim for 50-150 ug/ml). Steady state in 2-4 days. For petit, grand mal, myoclonic, atomic sz. Check: LFT and CBC, then Check: LFT q2mo for 6mo, then qyr. Link: Valproate (Depakene):

Carbamazepine (Tegretol, Carbropol) (CBZ): [100mg chewable and 200, 300mg scored tabs, 100mg/5ml elixir] start @ 200mg BID, titrate at 200mg/wk to TID-QID dosing of 1,200mg/d (15-30mg/kg). Child @ 20-40mg/kg divided BID (max 100-200mg BID). SE: dizzy, somnolence, ataxia, nausea, diplopia, blurred vision. Idiosyncratic reactions such as dec Na , SJS, leukopenia, aplastic anemia, hepatolysis.

Therapeutic level is 4-14 ug/ml (optimal is 4-8). Steady state in 3-4 days. For grand mal, partial (focal), psychomotor sz.

Carbopol: Gel cap with extended release and immediate release parts. Chewable: quick dissolving. CBZ decreases effectiveness of Haldol, OCP’s, Doxy, folic acid, theo, warfarin.

Inc CBZ levels with: Citrماليد، Danazol, Diltiazem, Emyc, Fluoxetine, Impamine, INH, Nicotinamide, Propoxyphene, Verapamil.

Dec CBZ levels with: long term ETH use, folic acid, auto induction.

Clonazepam (Klonopin): Daily oral dose of 0.01-0.02mg/kg.

Therapeutic level of 0.013-0.072ug/ml (20-80 ng/ml). For myoclonic, atomic sz. SE: drowsiness, ataxia, irritability, behavioral changes, exacerbation of tonic-clinic sz.

Ethosuximide (Zarontin): start at 250mg/wk by titrate, start 250mg/wk to 750mg/d (20-30mg/kg) divided BID. SE: anorexia, N/V, drowsiness, H-A, dizzy. Idiosyncratic such as rash, SJS, cytopenia from BM suppression. Therapeutic level of 40-100 ug/ml, steady state in 5-10 days. For petit mal sz only, used as an adjunct.

Felbamate (Felbatol): [400, 600mg scored tabs] start at 400mg BID titrate 400-600mg/wk to 3,600mg/d. SE: N/V, insomnia, H-A, dizzy. Idiosyncratic: aplastic anemia with hepatic failure in 1 in 2000-5000. Reserved for use by specialists.

Fosphenytoin:Cerebyx: [75mg/ml = 50mg/ml phenytoin] All dosing in mg “phenytoin equivalents” (PE), 2ml (100mg PE) and 10ml (500 mg PE) vials. 1mg phenytoin equiv. =1mg IV phenytoin. Water-soluble produg that is metabolized to phenytoin (in ~15 min), has liver metabolism, renal excretion.

Status epilepticus: 15 to 20mg PE/kg IV, then infuse at 100-150 mg/min rate. Can mix in NS or 5% dextrose. IM volume of 10-20ml in 1-3 inj.

Non emergent loading dose:10-20mg/kg IV/ IM with max IV rate of 150mg PE/kg and initial maintenance dose of 4-6mg/min. Monitor phenytoin level 2hr after IV, 4hr after IM. Contra: hypersensitivity to hydantoin, sinus bradycardia, 2nd or 3rd degree AV block, Adams-Stokes syndrome. SE: Nystagmus, dizzy, pruritus, paresthesia, rash, hypotension, cytopenia (can be fatal), phosphate load (renal insufficiency), N/V. Hypocalcemia-like ECG changes (QT prolongation with merging of T & P waves), slow infusion if QT >450 ms, stop if <500, give Ca-glucnate & Mg if VT or sz.

Gabapentin (Neurontin) (GBP): [100, 300, 400mg caps, 250mg/5ml strawberry elixir] start @ 300mg qHS, increase to 300-800mg QID over 2wks (max 3600mg/day). For chronic pain, neuropathy, partial and 2nd generalized sz’s. 100% renal elimination (safe in renal dz), excreted unchanged. Minimal drug interactions, a great add-on agent, especially pt on multiple meds, elderly or need quick titration or prior drug OD. SE: somnolence, ataxia, dizzy, amnesia. Ped’s start @15mg/kg/d . Give up if on high dose and levels are 10-15. Idiosyncratic reaction: rash, wt gain, behavior change, peripheral edema.

Lamotrigine (Lamictal): [925, 100, 150, 200mg scored tabs and 2mg chewable] Start @25mg qod with Valproate or 25mg BID with CMZ/ phenobarbital. Use 1/6 the usual start dose if on Phenobarbital. Inc 25mg q2wks to 300mg BID . Any sedation is usually minimal. SE: dizzy, ataxia, somnolence, H-A, diplopia. Idiosyncratic: rash, SJS, TEN, transaminitis. For partial sz in adults, also used for Lennox-Gastaut, primary generalized and absence sz. Best to avoid with VPA – warn patient of rash, which occurs ~10 %, but severe in 0.3%

Levetiracetam (Keppra): [250, 500, 750 mg scored tabs]. Start at 500mg BID, increase at 2wk intervals by 1gd to max of 3gd. Adjust for renal impairment. SE: somnolence, asthenia, infection, dizzy, ataxia. Adjunctive to partial onsl sz in age >16yo.
Risk of malformation:

Discuss birth control, pregnancy, childbearing. Determine risk for pregnancy. The conversion ratio os 1.5mg of oxcarbazepine to 1mg of CMZ.

Phenobarbital (Solfoton) (PB): start at 100mg qd titrate 15-30mg qwk to 200mg (3-5mg/kg). Elixir 20mg/5ml.

SE: somnolence, cognitive/behavioral deficits. Idiosyncratic: rash, SJS, cytopenia, transaminisits. Therapeutic level is 10-40 ug/ml.

Therapeutic level of 10-40ug/ml, steady state in 14-21 days. For grand mal sz.

PB dec effectiveness of: chloramphenicol, Oxcarb, Phenytoin, Cimetidine, Cyclosporine, Desipramine, Doxy, Folic acid, Haldol, Meperidene, Methadone, Nortriptyline, OCP’s, Theo, Warfarin.

Dec PB level with: Chlorzoxazone, Phosphate, Quinidine.

Phenytoin (Dilantin) (PHT or DPH): [30, 100mg caps, 50 mg chewable, 125mg5ml elixir] start at 300mg qd (4-5mg/kg) titrate 25-30mg/kg to 400mg/d (5-10mg/kg). Elixir 30 & 50mg/ml. IV load dose is 18-20 mg/kg (give over 30-60min or get hypotensive), then give 100mg IV/P0 TID-QID 6-12hr after the infusion. Pt’s first receive an oral loading dose of 15-20 mg/kg divided in 3 doses q2-4h, then start maintenance dose in 12hr divided TID. Neonate@ 5-8 mg/kg/d, 6mo-3yo@ 7.5-9, 7-9yo@ 7-8, 10-16yo@ 6-7 and adults@ 4-6 mg/kg/d. For grand mal/ generalized, partial (focal), psychomotor sz.

SE: ataxia, diplopia, slurred speech, confusion. It can be given qd, but often given divided to minimize SE’s.

Idiosyncratic: rash, SJS, cytopenia (aplastic anemia), gingival hyperplasia (floss & brush teeth BID to dec, if severe can restrict gums or change to another med), coarsening facial features, transaminisits, hepatic failure.

Therapeutic level is 10-20 ug/mI unbound (1-2 bound), 20-30 nystagmus, 30-50 dysarthria & ataxia. Some need a level of 20-25 for control. T-½ is 24hr, thus five half-lives is ~5-8 days until stable after dose change. Hepatic metabolism. Has nonlinear pharmacokinetics such that when the plasma level is >10 an dose inc give a disproportionate inc in serum concentration, thus inc dose only by 30-50mg/d (10mg if elderly) if level >1.0. Can change by 100mg increments if level <1.0 (switch from first or order kinetics when hepatic enzymes saturated.

Adjusted level for albumen: Adjusted Level = measured Dilantin/ [0.2 ( Alb +0.1)]. Follow CBC and LFT’s.

Uremic plasma displaces it from it protein binding sites : Inc free DHP levels and thus toxicity at lower levels.

PHT dec levels of: Chloramphenicol, Cyclosporine, Dexamethasone, Doxy, Folic acid, Furosemide, Haldol, Meperidene, Methadone, OCP’s, Quinidine, Theo, V-D. PHT inc levels of: Warfarin.

Dec PHT levels with: ETOH long term use, antacids, folic acid, rifampin.

PHT inc levels with: ETOH short term, Amiodarone, Chloramphenicol, Chlorpheniramine, Cimetidine, Disulfiram, Fluconazole, Fluoxetine, Imipramine, INH, Flagyl, Omeprazole, Propoxyphene, Sulfonamides, Trazodone.

If need redosingIV: low level: dose in mg = (0.8) (wt in kg) (20-current level). (Dose = Vol distrub X concentration. 20 is the max level, 0.8 is the volume of distribution, use 0.6 for Valproate).

Phenytek: extended release capsule [200, 300mg]. Start at with regular Dilantin @100mg TID, inc q7-10d to 200mg TID. Once stable can switch to 300mg Phenytek qd. Ped start @ 5mg/kg/d divided BID-TID with maintenance at 4-8mg/kg/d (max 300mg/d).

Primidone (Mysoline): [50, 250, 500mg scored tabs] 10-25mg/kg dose. Elixir 250mg/5ml. Adults @ 250mg PO BID-TID.

Therapeutic level of 5-15 ug/ml, steady state in 4-7 days. For grand mal, partial, psychomotor sz. Reserved for use by specialists. SE: sedation, nystagmus, ataxia, vertigo, nausea, skin rashes, megaloblastic anemia.

Tiagabine (Gabitril): [4, 12, 16, 20mg tabs], GABA uptake inhibitor for adjunct tx of partial sz in >12yo. Start at 4mg/d increased weekly by 4mg to a max of 32-56mg divided BID-QID. SE: dizziness, N/V, H-A, somnolence, tremor.

Topiramate (Topamax): [25, 100, 200mg tabs, sprinkles @15, 25mg] start at 25mg BID, titrate 50mg qwk to 400mg/qd. Sprinkle capsules can be swallowed whole or put in soft food. Peds age 2-16 with partial-onset sz @5-10 mg/kg/d divided BID. Start at 25mg qHS, inc q10d by 1-3mg/kg. Works via multiple mechanisms including GABA potentiation and sodium channel blockade. Good choice if break-through sz on Dilantin, once therapeutic start to taper the Dilantin. Also used as adjunctive tx of Lennox-Gastaut syndrome. SE: somnolence, dizzy, ataxia, slurred speech, anorexia, fatigue, nervousness, concentration difficulty, aggression, and memory loss.

Idiosyncratic: anemia, acne, alopecia, wt loss, transaminisits, nephrolithiasis. Acute myopia and secondary angle closure glaucoma (decreased visual acuity & ocular pain, usually occurs in 1st mo of tx).

Valproate (Valproic Acid = VPA): The broadest spectrum antiepileptic.

Therapeutic level is 50-100 ug/ml, some neurologist aim for 80-150 to control partial complex or secondary generalized sz’s. Steady state in 2-4 days. For petit, grand mal, myoclonic, atonic sz. Check: LFT and CBC, then LFT and CBC, then LFT q2mo for.

Depakene: [250mg cap, 250mg/5ml, 125mg spray] works the same, rarely used as more GI upset (no GI “kote”, a soft gel capsule).

Depacon: [100mg/ml] IV solution. Give at same dosing interval as PO VPA and in same mg/mg basis. For age >2yo. SE: N/V, tremor, throbocytopenia. Idiosyncratic: wt gain, hair loss, hepatotoxicity, hepatic failure, rash, SJS, pancreatitis.

Zonisamide (Zonegran): [100mg caps] Start @100-200mg, increase dose q2wks to 400-600mg divided BID. T-½ >60 hrs. An adjunct for partial sz’s in adults. A sulfonamide, 2% of pt’s may get a rash. Have increased risk of kidney stones, drink 6-8 glasses of water/d. Blocks both Ca and Na channels and increases DA & 5HT transmission. No effect on levels of phenytoin, CMZ or VPA. CYP3A4 metabolism.

Reason to Refer Adult Pt to Neurology:

Unclear if event was a sz, focal neuro findings on FE, focality on EEG. Hx consistent with focal sz, pt demands reassurance, complicated med adjustments, pt wishes to discontinue maintenance, change in sz pattern, poor response to meds, pt wishes to become pregnant, does not fully recover between sz’s (refractory status is most common in tonic-clonic epilepsy, usually need IV Benzo + Fosphenytoin). If pt is having periodic lateralized epileptiform discharges (PLEDS).

Antiepileptic Drugs in Women of Child Bearing Age:

Discuss birth control, pregnancy, childbearing. Determine risk for pregnancy. Sz frequency is unchanged in 50%, increased in 35% decreased in 15% with pregnancy. A sz during pregnancy is worse than med SE on the baby, can consider going off meds during the 1st month of pregnancy if low risk.

Risk of malformation: 2-6% (Vs 2-4% of general pop). ~2-3X risk. Tonic-clonic sz would harm the fetus/ mother and may
cause miscarriage.

Establish whether pt needs meds: if >2year sz-free period, consider withdrawal before any pregnancy.

Eliminate other risk factors: tobacco, drugs, ETOH. Try and achieve monotherapy at lowest effective dose with the most appropriate drug for their sz type. If Valproic acid is used, divide TIQ-QID. Avoid Valproic or CMZ if FHx of neural tube defects. Avoid combining Valproic/CMZ/Phenobarbital. Begin folate supplementation at 4mg/d. Give Vit-K 10mg/d during the last month of pregnancy as anticonvulsants are associated with deficiency that may lead to coagulopathy. Discuss care with her OBGYN, once pregnant monitor levels (preferably free/unbound drug) monthly and after delivery. Obtain drug level as baseline. Offer pt intrauterine testing with high resolution U/S or amniocentesis if taking Valproic Acid or Carbamazepine or more than one antiepileptic med.

Phenytoin: facial clitting, distal phalangeal hypoplasia, hypertelorism, neonatal coagulopathy.

Phenobarbital or Primidone: neonatal withdrawal, coagulopathy.

CMZ: facial dysmorphism, neural tube defects, distal phalangeal hypoplasia.


Tx for Pregnancy with Epilepsy: Avoid Valproate (Depakote).

- Wk 1-16: AED levels (free and total), serum folate.
- Wk 15-16: MSAFP, amniocentesis (If on Valproic acid or CBZ), AED levels.
- Wk 22-24: U/S for oral clefts and heart anomalies.
- Wk 28: AED levels.
- Wk 34-36: AED levels, maternal V-K.

Breast Feeding: Most are generally ok. % Serum Concentration in breast milk: 90% Ethosuximide, 70% Primidone, 40% CBZ, 36% Phenobarbital, 18% Phenytoin, 5% Valproic acid.

Neurosurgical Treatment of Epilepsy:

Candidates: The 20% of those with epilepsy have medically intractable sz’s with high therapeutic doses. Have a well-defined epileptogenic zone that can be localized. Have had >2yrs of stable and persistent epilepsy and all major antiepileptic drugs have been pushed to their therapeutic limit.

Hemispherectomy: for children with congenital or post-encephalitic hemiplegia.

Corpus callosotomy if post traumatic or having atonic sz’s.

Vagal nerve stimulation is an alternative. Give intermittent electrical current 30 sec q5 min giving 35% of pt’s a ~50% reduction in sz’s.

Substances causing Sz’s:

Link: Spells & Ddx:

“CAMPHOR BALLS”

C: Camphor, CO, cocaine, cyanide, clonidine, carbamazepine, caffeine, chlorinated hydrocarbons (DDT, Lindane), cholinerigics, Clozapine.

A: amphetamines, ASA, anticholinergics (TCA, antihistamines), Abx.

M: Methylxanthines (theophylline), Meperidine.

P: pesticides, PCP, phenothiazines, propoxyphene (Darvon).

H: hypoglycemics, heavy metals, hypoxia, hypocaclemia.

O: organophosphates, opioids (withdrawal).

R: rodenticides (strychnine, thallium, arsenic).

B: barbiturates, benzo’s (withdrawal sz), beta-blockers.

A: alcohols (methyl alcohol, ethylene glycol).

L: local anesthetics (lidocaine), INH, Li, lead, Lindane.

S: salicylates, strychnine, sympathomimetics, Serotonin agonists.

Other Causes:

Trauma: SAH, subdural, intraventricular/ intracerebral hemorrhage, anoxia/hypoxia (intrauterine, perinatal), contusion.

Vascular Tumor --> AVM, ICH, cerebral emboli, cerebral infarct, eclampsia.

Infection: meningitis, encephalitis, brain abscess, toxo, cysticercosis.

Hereditary: CNS malformation, neurocutaaneous d/o, aminoaciduria (PKU, maple syrup dz), urea cycle defect.


Degenerative process: Alzheimer, MS.

Other: HTN encephalopathy.

Low Sz risk: Trazodone and MAOIs.

Epilepsy and Sports:

Most SE’s with CMZ and Phenytoin.

Sports contraindicated: boxing, full-contact karate, unsupervised scuba diving/ mountain climbing, solo hang gliding/ parachuting.

Contraindicated if uncontrolled: aviation sports, gymnastics, horseback riding, ice hockey/skating, motor sports, mountain climbing, scuba diving, unsupervised downhill skiing/ sailing/ water sports, water-skiing, wind surfing.


Childhood Seizures:

Links: Febrile Seizure; Child Status Epilepticus; Epilepsy Syndromes;
**Etiology by age:**

**Day 1:** hypoxemia (perinatal, intrauterine), birth trauma (SAH, subdural), drugs (cocaine), inc/dec BS, infectious (GBS, E. colii), pyridoxine def.

**Day 2-3:** hypoxemia, infection, drug withdrawal (narcotics), inc/dec BS, developmental malformations, intracranial hemorrhage, inborn error of metabolism, inc/dec Na.

**Days 4-30:** infection, dec Ca, inc P, dec Na, developmental malformation, drug withdrawal, inborn errors of metabolism (aminoaciduria, organic aciduria, urea cycle).

**PE Neonates:** Macrocephaly/ bulging fontanelle: inc ICP, meningitis, subdural hematoma, hydrocephalus, non accidental trauma.

**Microcephaly:** CMV, toxo, rubella, congenital malformation.

**Ddx:** jitteriness (withdrawal), tremor, apnea (>20sec with cyanosis), micturitional shivering, dysrhythmia, Sandifer syndrome (GE reflux).

**Months 1-6:** same as above 1st mo.

**Year 0.5-3:** febrile sz, toxins, trauma, cerebral degeneration.

**Year 3+:** idiopathic, infection, trauma, cerebral degeneration.

**PE Child:** facial hemangioma (Sturge-Webber), Café au lait spots (neurofibromatosis), depigmented lesions (tuberous sclerosis, subungual tumor, shagreen patches, adenoma sebaceum), petechia (meningitis). Cherry-red macular spot (Tay-Sachs), chorioretinitis (CMV, toxo), retinal hemorrhages (trauma), papilledema (inc ICP).

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**Febrile Seizure:**

### 2-5% all children before age 5yo, often as early as 3mo old, 2X in Asians, 17% parents, 22% siblings, 5.6% FHx non febrile sz.

Previous brain injury/ epilepsy have sz threshold lowered by fever but should be treated as epileptic sz. Most due to URI's, 86% viral, OM, pharyngitis. <5% go on to have epilepsy.

### Risk factors for additional febrile sz's:

1. Young age at onset,
2. History of febrile seizures in a first degree relative,
3. Low degree of fever while in the Emergency Department,
4. A brief interval between the onset of fever and the initial seizure.

### Clinical:

- Temp, initial cry, LOC, 30sec tonic phase (rigidity), clonic phase of repetitive mov't, postictal sleep/ lethargy or may be just staring with stiffening, focal movements. Less than 18% longer than 15min. If no focal, prolonged or multiple sz and normal exam (no petechiae, nuchal rigidity, persistent drowsiness, paresis or paralysis) then meningitis is unlikely (BJM 2001;323:1114).

### Complex Febrile Sz: >15min (or >1/d), focal motor features, abnormal neuro status, afebrile sz's in parent or sibling.

### Sz Labs:

- Glucose (if <80mg/dl, give 25% Dextrose 2ml/kg), lyses, BUN/Cr, Ca, Mg, toxicology screen, anticonvulsant levels.

### Check:

- LP if meningeval signs, on Abx already, age <12mo.

1. **Reassure** that even though scary to witness, not suffered brain damage (no cognitive or structural damage with febrile sz's), not likely to have epilepsy. Anticonvulsants not proven to prevent subsequent sz.

2. **Risk of Recurrence:** another convulsion after another illness, small risk of another w/in 24hr. 1/3 get 2nd, of those ½ will have again, 9% Have 3+, 90% of recurrences w/in 2yrs. Consider adding a multivitamin with zinc, as in one study there was an association between low zinc levels in cerebrospinal fluid and childhood febrile convulsions (Indian J Pediatrics 2002;69:859-861).

### Tx:

- Identify source/ treat any infection: r/o bacterial meningitis, hypnometrexic dehydr, CVA, toxic encephalopathy. Give antipyretics.

### Check:

- LP if meningeval signs, on Abx already, age <12mo.

1. **Reassure** that even though scary to witness, not suffered brain damage (no cognitive or structural damage with febrile sz's), not likely to have epilepsy. Anticonvulsants not proven to prevent subsequent sz.

2. **Risk of Recurrence:** another convulsion after another illness, small risk of another w/in 24hr. 1/3 get 2nd, of those ½ will have again, 9% Have 3+, 90% of recurrences w/in 2yrs. Consider adding a multivitamin with zinc, as in one study there was an association between low zinc levels in cerebrospinal fluid and childhood febrile convulsions (Indian J Pediatrics 2002;69:859-861).

### Inc risk:

- If FHx, Temp <40C during initial, multiple initial sz's. Have 2.5% risk of another if 1 risk factor (Vs 1% if none), 8% risk of epilepsy if >3 above risk factors.

### 3. If recurs,

- Stay calm, place on side/ stomach with face down, observe and time, if longer than 10min bring to nearest medical via car/ ambulance.

### 4. Avoid

- Over wrapping child, avoid high fever with sponging and antipyretics (also for 48hr after Td and @ day 7-10 MMR).

### Can’t prevent with long term antipyretics as sz only first sign of fever. Earlier the age of initial the more likely the recurrence, no future risk of intellectual deficit. If prolonged/ multiple (>15min): rectal diazepam gel (0.5mg/kg) or Intranasal Midazolam @ 0.2mg/kg. (Arch Ped Adolesc Med 1998;152). Can reduce by 44% with intermittent oral diazepam, however only give if parental anxiety is extreme as sedative SE's may obscure a CNS infection.

### Epilepsy Syndrome:

- Link: Febrile Seizure: Childhood Sz:

### Epilepsy:

- A chronic/ recurrent brain d/o characterized by paroxysmal brain dysfunction due to excessive neuronal discharge, which is usually associated with alteration of consciousness. Idiopathic epilepsy has an average onset at age 12-14yo and affects 0.7-3% of the pop at some point in their lives. Up to 30% of pt's have sz's despite therapy.

### Ddx in child:

- Breath holding spells (cyanotic/classic, pallid), micturition/ cough syncope, night tremor/ terror, migraine, tics.

### Temporal Lobe Epilepsy:

- An important cause of adult-onset sz, yet may begin in children as well. 90% are caused by scarrring in the hippocampal region (mesial temporal sclerosis). The cause is usually obscure. A FHz of epilepsy is common and the pt often has a h/o febrile sz's. Unprovoked sz's begin in childhood or young adulthood. Memory deficits are common. Sz's may become more frequent after years and are commonly intractable. Temporal lobectomy achieves a sz freedom in 85% of those with refractory sz's of mesiobasal origin. On MRI see hippocampal atrophy. Auras common (visceral, psychic phenomena, fear, gustatory or olfactory hallucinations). Déjà vu: an abnormality in the sense of time, a flashback or a sense that a certain experience has been experienced before. Jamais vu is an abnormal sense that a previous experience had not been experienced before.

**Benign Childhood Epilepsy with Centrottemporal Spikes:** begins at age 3-14yo with the development of focal motor or sensory sz's that affect the hands or face. Speech arrest, excessive salivation, drooling, may become secondarily generalized. EEG shows characteristic pattern of high-amplitude centrotemporal spikes. Both the sz's and EEG abnormalities disappear spontaneously by the second decade of life.

**Nonepileptic Staring Spells in Children:** Has dazed vacant expression. Often identified by a teacher. They tend to be
response to touch, have body rocking. Do not need EEG to dx, just Hx. In absence sz; limb switching, upward eye movements, urinary incontinence.

**Frontal Lobe sz’s**: arise in the frontal lobe and are characterized as simple partial, complex partial or secondary generalized. They are generally shorter in duration compared to temporal lobe sz and are more commonly associated with rapid secondary generalization. Todd paralysis is common. Orbital/ frontal sz’s are commonly associated with ophthalmic illusions or hallucinations. Opercular sz is associated with gustatory hallucination, an epigastic sensation, fear or autonomic ss with mastication or speech arrest.

**Parietal Lobe Epilepsy**: simple partial or secondary generalized. Predominantly sensory. May have “pins and needles” phenomena, visual hallucination, contralateral pain, contralateral motor arrest or tonic posturing. May have nonspecific ss’s (disorientation, language dysfunction, ideomotor apraxia or vertigo). Spread to the temporal lobe is common.

**Occipital Lobe Epilepsies**: relatively uncommon area of origin. Have negative or positive visual phenomena. Tonic or clonic eye movements may be noted. May spread to the temporal lobe.

**Reflex Epilepsy**: the epileptic phenomena is controllable by internal or external factors. Flickering light, a loud noise, certain musical tones (musicogenic epilepsy). Startle epilepsy. Sz’s may be induced by certain acts of eating. Need to identify and avoid the triggering activity.

**Benign Focal (Rolandic sz)**: age 3-13yo. Abnormal EEG. Tx with CMZ and Valproic.

**Complex Partial Szs**: any age, usually with abnormal EEG. Tx with various anticonvulsants. Sx: glassy-eyed, drugged, dazed, far-away look. May have lip-smacking, drooling, gurgling, N/V, epigastic sensation. Usually have a post-ictal confusion, sleep or H-A. 1/3 get secondary generalization (tonic-clonic). Best to get EEG during sleep. Check: MRI to r/o temporal lobe abnormality to predict refractory cases.

**Juvenile Myoclonic Epilepsy (JME)**: begins at puberty (age 12-18yo) with myoclonus upon awakening. Generalized convulsions or absence sz’s may develop. Photosensitivity. Familial with variable penetrance. The most common adolescent-onset epilepsy syndrome, may persist into adulthood. Abnormal EEG. Responds well to meds such as Valproic.

Genetic (14% concordance is 1st deg relatives). Most have a combo of 3 sz types (generalized, absence and myoclonic). Worse with sleep deprivation. 1/3 have a photoconvulsive effect. 50% need lifelong meds.

**Video Game-Related Epilepsy**: any age, mostly adolescent. 50% with abnormal EEG. Tx with video game abstinence. Due to the flicker frequency of the video games (full or handheld screen). Variable sz type.

**West Syndrome**: infantile spasms, psychomotor developmental arrest. EEG pattern called hypsarrhythmia. Poor prognosis. Genetically (50% concordance is 1st deg relatives). Most have a combo of 3 sz types (generalized, absence and myoclonic). Worse with sleep deprivation. 1/3 have a photoconvulsive effect. 50% need lifelong meds. Common. Pt’s with LGS can have dozens (some 50-60/s) sz’s a day, they are often resistant to most anti-epileptic drugs. Have pt wear helmet, onset age 1-7, will improve over years, but inc mental/psych sx’s. Topamax approved as an adjunctive tx.


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**Psychogenic Seizures (Pseudoseizure)**:

**Link**: Spells:
Not malingering as not planned, just the way pt manifests their neuropsychiatric stress. Consider in situations where there are bilateral motor movements with preserved consciousness.

**Features**: has gradual onset, less self injury and bite tip, rather than lateral tongue, fail to have typical 3X increase of serum Prolactin at 20min from beginning of sz seen in 96% generalized and 60% partial complex. (n in pseudo/ simple partial and frontal lobe sz’s). Often precipitated by stress. Occurs/ worsens in the presence of others. Sz despite therapeutic levels, multiple different physician consultations, lingering prodrome or gradual ictal onset (over minutes). Prolonged duration (>5min), S/s resolved by distraction, suggestive/inducible sz, intermittent arrhythmia and out-of-phase convulsive activity, fluctuating intensity and severity during sz, side-side rolling, pelvic thrusting and wild movements. Bilateral motor activity with preserved consciousness, non physiologic spread of neuro signs, no labored breathing of drooling after sz, expression of relief or indifference, crying/whispering, non postictal confusion or lethargy, absence of stereotypy, disproportionate postictal MS.


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**Stroke**:

**Intro**: Stroke is an Interruption of normal cerebral blood flow causing neurological deficits. 15% turn out to be a TIA. 75% of the strokes are ischemic (thrombotic, embolic, hypoperfusion), 25% hemorrhagic (intracerebral or subarachnoid). The 3rd leading cause of death and the leading cause of long-term disability in the USA. 25% die, 15% risk re-stroke in next month w/o tx. H-A is most common sx, MS change, focal deficit. Need to clear C-spine if falls. 50% have HTN, 30% smoke, 40% with inc chol.

**Risk**: Afib - rheumatic heart dz (18X), prior TIA/stroke (10X), HTN (6X), Afib (6X), CHF (5X), angina/AMI (3X), DM (3X), heavy ETOH use (3X), smoking (3X), valvular dz.

**PP**: Cerebral cortex: neuron cell bodies (gray matter). Immediately below is the centrum semiovale with myelinated axons (white matter). Surrounding the axons is supporting tissue (gia).
Location:

Anterior Circulation: motor dysfunction in contralateral face & extremities (clumsy, weak, paralysis, slurred speech), homonymous hemianopia (loss of vision in ipsilateral eye), aphasia (dominant hemisphere), sensory deficits of contralateral face & extremities (paresthesias, loss of sensation).

Posterior Circulation: motor dysfunction in ipsilateral face & extremities, loss of vision in one or both homonymous visual fields, signs such as ataxia, vertigo, diplopia, dysphagia, dysarthria and sensory deficits in ipsilateral face & contralateral extremities.

Supratentorial: due to injury to the hemisphere, high risk of herniation (lateral/uncal leads to compression of occulomotor nerve. Central with early dec level of conciseness).

Infratentorial: due to destruction of compression of the brainstem.

Hx: time onset symptoms, risk factors. Have symptoms worsened/improved since onset. ?h/o similar episodes.

An acute focal neuro deficit ischemia until proven otherwise. Must be a negative (loss), not a buzz, a tingle, a bright light, not evolving over minutes, but in a large stable distribution is not a single finger or toe. A focal deficit is not dizziness, wooziness or generalized weakness. A CVA is not tone: vertigo, syncope, dysphagia, dysarthria, confusion, amnesia, tonic/clinonic activity, need multiple combinations of these.

Exam: Initially need a brief but accurate exam. The pt’s level of consciousness and fluency of speech can rapidly be assessed in a dialogue with the pt. The pt’s head should be evaluated for signs of trauma. Pupillary size, reactivity, and extraocular movements provide important information about brain stem function, particularly CN 3-6 (an abnormal 3rd nerve function may be the first sign of tentorial herniation). Gaze preference suggests brain stem or cortical involvement. Funduscopic evaluation may reveal papilledema, hypertensive changes, diabetic retinopathy, or the Roth spots of endocarditis. Central facial nerve weakness from a stroke should be distinguished from the peripheral causes of CN 7 weakness. With a peripheral lesion, the patient is unable to wrinkle the forehead. Determination of facial sensation, eyebrow elevation and squinting, smiling symmetry, gross auditory acuity, gag reflex, shoulder elevation, sternocleidomastoid strength, and tongue protrusion complete the cranial nerve evaluation. Muscle tone is assessed by moving a relaxed limb. Prox & distal strength should be assessed against resistance. Truncal ataxia and pronator drift of the arm, which is a sensitive sign of weakness, can be tested simultaneously by having the patient sit with eyes closed, arms outstretched, and palms toward the ceiling. Asymptomatic sensation to pain and light touch may be subtle and difficult to detect. Double simultaneous extinction is easily tested by the simultaneous light touch of right and left limbs. The pt may feel both the right and left sides being touched individually but may not discern one side being touched simultaneously. Similarly, a number gently scratched on a forearm, graphesthesia, is another easily tested cortical parietal lobe function. These tests can help differentiate a pure motor deficit of a lacunar stroke from a sensorimotor middle cerebral artery deficit. Cerebellar testing and the assess of reflexes and gait complete the examination. Finger-to-nose and heel-to-shin for cerebellar functions. Asymmetry of the DTR or a unilateral Babinski sign may be an early finding of corticospinal tract dysfunction.

Cincinnati Pre-hospital Stroke Scale (3 Items):

1. Facial droop: have pt show teeth or smile.
2. Arm drift: pt close eyes and hold arms out for 10 sec.

NIH Stroke Scale (15 items, 0-42pts): a rapid tool for quantifying neurologic deficit in patients and the most powerful predictor of outcome after ischemic stroke. 0-1 is normal or near-normal. 1-4 is minor stroke. 5-15 is moderate stroke. >10 strongly indicates a large vessel occlusion. 15-20 is moderately severe, >20 is severe. Pt’s with severe impairments (NIH-SS score >15) have less than a 20% chance of achieving an excellent outcome. 90% of pt’s with a score of 4 to 6 have a good or excellent outcome at 3 months whereas approximately 40% of patients with a score of 16 to 22 have a similar rate of recovery.

1.b. Level of consciousness- Q’s: Answers both correctly-0. Answers one correctly-1. Both incorrect-2.
1.c. Level of consciousness- Commands: Obeys both correctly-0. Obeys one correctly-1. Both incorrect-2

Total score (0-42)

15. Change from baseline:Same-S. Better-B. Worse-W.

Initial eval:

- EKG, CBC, PT/PTT, BUN/Cr, LFT’s, lipids, CXR (major cause of morbidity), non contrast CT/ MRI (i/o mass, hemorrhage, can re-Check: in ?hr if not sure, but H&P should dx), Check: pO2 and blood sugar (hyperglycemia is very deleterious). Ischemic/ Embolic: Hemorrhagic:

Imaging Study: Non contrast CT to rule out hemorrhage and/ or neoplasia (2% have stroke-like onset), not to see the thrombotic stroke (in the hyperacute phase only see 30% of infarcts @3hr, 60% @24hr, 100% @7d). Hyperacute stroke (25%) may have neg CT. Otherwise see subtle mass effect or density change. Most will enhance with IV contrast by day 6, CT mainly as triage to differentiate spontaneous intracerebral hemorrhage & SAH from ischemic infarct.

Bright on CT = fresh blood (false neg if HCT <20%), bone and contrast. In the elderly it is normal to have calcifications in the pinal gland and choroids plexus. In 24-72h consider MRI to eval PP, infarct size, location of other strokes.

MRI: may soon replace CT as it is more sensitive for intraparenchymal hemorrhage detection.

Diffusion-weighted: images can differentiate between old & new stroke core. Good for acute infarctions. When blood supply <20% normal, ATP pump fails and cytotoxic edema develops, the inc intracellular water limits diffusion within cells. Appears within minutes (takes 8-12hr for conventional MRI to see), lasts 2 days. TIA may not show up.

Perfusion-weighted: detects the random mov’t of water molecules, enables us to predict prognosis (size of ischemic
penumbral). Involves rapid IV injection of contrast to provide info on the blood supply to a particular area.

**Fluid-attenuated inversion recovery (FLAIR):** a type of pulse sequence similar to spin-echo and gradient-echo. A rapid scan that gives T2 images without interference with CSF, thus lesion of the periventricular & cortical surface are more conspicuous (meningeal dz and SAH).

**Links:** 
- NIH Scale:
  - Consider: ESR, RPR, ABG if hypoxia suspected, drug/ETOH screen, fibrinogen. **Check:** LP if suspect SAH or encephalitis and CT is neg, EEG if sz, blood Ox if suspect endocarditis, s-spine if trauma. **Secondary eval:** carotid U/S for anterior circulation and lacunar strokes, Check: MRA for posterior circulation and lacunar strokes. Consider cardiac monitoring (check for arrhythmia), video-fluoroscopic evaluation of swallowing function: 2X length of stay in hospital if aspirate (Gag reflex does not correlate with swallowing). **Consider:** TEE (2-D), transcranial Doppler, MRI/MRA, coagulopathy.

**Younger Person with stroke (age <45yo):** HIV, urine tox screen, FTA-ABS, MRI for cysticercosis/MS.

**Etiology:** cardioembolic, blood abnormality (SS, polycythemia, hypercoagulable state, Vascular causes: migraine, dissection, atherosclerosis, vasculitis, toxemia of pregnancy, congenital aneurysm (Berry), HTN.

**Approach to focal deficit:** what area of CNS (ant or post circulation), what is the most likely PP, neuro-resuscitation (tPA), medically control BP, airway, keep NPO until proven safe to swallow, consider secondary PV (ASA, Coumadin).

**Ddx of a focal Neuro deficit:** Todd’s paralysis (post-sz), hypoglycemia, complicated migraine, conversion d/o, malingering, brain tumor, drug OD, Bell’s palsy, SAH.

**Stroke Syndromes:**

**Link:** Brainstem: Lacunar:

If loss of consciousness think intracranial hemorrhage (ICH), SAH or brainstem infarct. If crossed defects (LE Vs UE), think brainstem lesion.

In general carotid strokes tend to have unilateral weakness (face & arm > leg), aphasic, monocular vision defect, gaze away from the affected side in hemiparesis. With vertebrobasilar stroke the weakness is unilateral or bilateral, the pt is usually stuporous with a dense visual field or bilateral blindness, gaze is toward the affected side or dysconjugate and they commonly have ataxia.

**Cryptogenetic/ Uncertain:** “stroke syndrome” with some impaired cortical function. CT/MRI evidence of infarction (>1.5cm) but little evidence of large artery dz or cardioembolism.

**Anterior Cerebral Artery (ACA):** contra hemiparesis & contra hemianesthesia (shoulder, leg & foot > arm & face), head/eye turning toward lesion, L-sided ideomotor apraxia or tactile anaesthesia, impaired responsiveness (akinetic mutism, abulia), grasp and reaching reflex.

**Main Stem of Middle Cerebral Artery (MCA):** contra hemiplegia/hemianesthesia/homonymous hemianopsia, head turn toward lesion, dysphagia, uninhibited bowel/bladder.

**Dominant MCA Stem Occlusion:** global aphasia, contralateral sensory impairment of face, arm, leg. Paralysis of contralateral face, arm, leg (less if inferior division occlusion). If nondominant get same as above plus contralateral neglect (anosognosia).

**MCA Dominant Hemisphere:** global aphasia, ideomotor apraxia, Nondominant: aprosody, affective agnosia, visuospatial d/o (field cut as hit optic radiations), hemi-attention.

**Superior (upper) branch MCA:contra hemiplegia (hand & face) > leg), contra hemianesthesia/homonymous hemianopsia, head/eye turn toward lesion, dysphagia, bowel/bladder uninhibited. Dominant: Broca’s, ideomotor apraxia. Nondominant: aprosody, hemi-attention, visuospatial d/o.


**Lenticulostriate Arteries (penetrating branch of MCA):** Sub-cortical CVA. Pure motor hemiparesis (lacunar syndrome).

**Posterior Cerebral Artery (PCA):** visual field disturbance, contralateral sensory loss, amnesia, alexia or color anomia.

**Basilar artery paramedian branches:** knocks out the base of the pons to give locked-in-syndrome as quadriplegia, may move eyes vertically.

**Wallenberg’s syndrome:** PICA to lateral medulla gives ipsilateral facial sensory loss, contralateral body sensory loss, vertigo, ataxia, dysarthria, dysphagia and Horner’s syndrome.

**Common Carotid:** asymptomatic.

**Internal Carotid:** knocks out the frontal, parietal and temporal lobes to give an ipsilateral blindness (hemianopia), contralateral hemiparesis and hemianesthesia. Aphasia (dominant hemisphere) or denial and hemineglect (nondominant hemisphere).

**Brainstem Syndromes:**

**Medulla Oblongata:** Medial Medulla: ipsilateral hemipara/paralysis of tongue (CN 12).

**Lateral Medulla (Wallenberg):** Horner’s ataxia (ipsilateral) and CN 9 & 10 lesions leading to dysphagia, hoarseness, ipsilateral vocal cord paralysis, vertigo, nystagmus, ipsilateral facial analgesia.

**Lateral Pontine Infarct:** (Caudal/ inferior) (anti inferior cerebellar artery) get a similar lesion as a lateral medullary infarct.

**Rostral/ mid-pons (sup cerebellary artery) same except no CN 7 or 8 lesion but get ipsilateral jaw muscle paresis (CN 5).

**Posterior Fossa:** paramedian pontis give ataxic hemiparesis with contralateral weakness and ataxia or clumsy-hand dysmetria. Can also get sx’s mimicking acute labyrinthitis (vertigo, N/V, nystagmus) if infarct the inferior cerebellum or occlude the internal auditory artery.

**Midbrain Infarction:** Weber Syndrome (cerebral peduncle) = ipsilateral oculomotor (CN3) palsy with contralateral hemiparesis.

**Pseudobulbar Palsy:** after >2 major cerebral infarcts at different sites or numerous lacunes on both sides.

**Locked-in Syndrome:** is the result of occlusion of the perforating arteries of the paramedian basilar artery, leading to dysfunction of the corticospinal tract, corticobulbar tract and exiting 6th nerve fibers leading to a normal level of consciousness, but only able to communicate via vertical eye movements and blinking.

**Bilateral Upper Brainstem:** coma due to reticular activating system destruction. If at the level of the pons get miotic pupils
Absolute Contra: awaken with stroke, onset assumed to be at time that sleep commenced.

Indications: meds are able to saturate plasminogen receptors. Utilized in the future with advanced imaging techniques, however higher local concentrations are not necessarily needed as IV strokes, but >30% have no disability in 1yr if get it. Local intra-arterial thrombolysis has an intuitive advantage and may be (Thrombolytic treatment of ischemic stroke. Mayo Clin Proc 2002;77:542) No change in mortality, no prevention of future Coumadin. May want to wait up to 7 days if it is a large stroke.

Deterioration: unable to walk. If sx’s suddenly worsen after stable it’s likely secondary to edema (blow a pupil, up going toes). Consider DVT prophylaxis if CVA, stuttering onset (stroke in evolution), critical carotid stenosis. Give if A-fib (embolic event) or recent AMI in past 24hrs.

Heparin: (within 48hr) of ischemic CVA, hold for 24hr if pt gets thrombolytics and avoid altogether if have a hemorrhagic CVA. Goal: only if have a sz.

Fluids: avoid over replacement unless volume depleted. Most need 2-2.5L/d of NS, up to 30% become dehydrated. Avoid excessive fluids. Give thiamin 100mg if malnourished or alcoholic. O₂ & pulse ox. Keep NPO as risk aspiration. Phenytion only if have a sz.

Goa: resuscitate the ischemic penumbra around the necrotic/ hypoperfused areas. ASA 160-325mg PO always given ASAP (within 48hr) of ischemic CVA, hold for 24hr if pt gets thrombolytics and avoid altogether if have a hemorrhagic CVA.

Complications: HTN: Etiology: Hypercoagulability W/...
SAH. Any history of an prior IC hem or IC neoplasia/ aneurysm/ AVM. Serum platelets<100,000, bleeding diathesis/ active internal bleeding. Courmadien, Heparin or Lovonox in past 48hr or if PT >1.5, INR >1.3. BP >185/110, glucose <50. A rapidly improving neurologic deficit or mild neuro signs like isolated sensory deficit. Radiographic (CT) evidence of and IC hemorrhage.

Relative Contra: major surgery/ organ Bx/ GI or GU bleed or postpartum in past 14d. GI, CPR with rib fx, pregnancy, SBE, diabetic hemorrhagic retinopathy. Recent AMI. Sz at onset of stroke, arterial puncture at a non-compressible site in the past 7 days.

Risk: 1:15 has serious brain hemorrhage (~6%, the higher the NIH-SSS the higher the risk).

If get intracranial hemorrhage (sudden deterioration), d/c IKA, get immediate CT, check PT, PTT, fibrinogen, platelets. Prepare cryoprecipitate & fibrinogen (8-8 units), platelets (8-8 units), neurological consult, follow progression on CT.

Anistreplase=TPA=Activase: 0.9 mg/kg (max 90mg) infused over 60 min. 10% is given as IV bolus over 1 min, avoid antithrombotic/platelets for 24hr. Or 15mg bolus IV, then 50mg over 30min. Use in Strokes (AMI, PE) 80% strokes thrombotic, IKA catalyzes the conversion of plasminogen to plasmin, which is fibrinolytic. (streptokinase converts more circulating and less fibrin-bound). $2,500. No ASA, anticoagulants, central lines, Foley cath etc. for 24hr.

Antistreplase (Eminase): 30 U IV over 2-5min. $2,300.

Retepetase (Retavase): 10 U IV bolus, repeat in 30min. $2,700.

Streptokinase (KabiKinase, Streptase): 1.5 MU IV over 60 min. $500.

Anorch: purified fraction of venom from the Malaysian pit valler Calloselasma rhodostoma.

HTN in Thrombolytic Candidates:

Pretreatment: SBP >185 or DBP >110 mmHg: 1-2” Nitro Paste or 1-2 doses of 10-20mg Labetalol IV push before IKA. If BP not reduced to or maintained at <185/110 mmHg, should not give TPA.

During and After tx infusion: Monitor BP q15min X2hr, then q30min X6hr, then q1hr X 16hr.

SBP 180-230 or DBP 105-120: Labetalol 10mg IV over 1-2moin, may be repeated or doubled q10min up to a total dose of 150mg.

SBP >230 or DBP 121-140:Labetalol 10mg IV push over 1-2 min, can repeat or double q10min to max of 150mg/24hr. Or start Labetalol drip @ 2-8 mg/min. Change to Nitroprusside @ 0.5-10 ug/kg/min if not controlled.

If DBP >140: Nitroprusside 0.5-10 ug/kg/min.

HTN in Non-Thrombolytic Candidate:

Do not treat if SBP>230 or DBP>120, unless proven cerebral hemorrhage, or CHF, ARF, AMI or aortic dissection as need inc BP for autoperfusion. Do not lower MAP >20 mmHg. Aim for MAP ~130 mmHg, treating persistent surges of MAP.

DBP >140 mmHg: Nitroprusside 0.5 ug/kg/min. Aim for 10-20% dec DBP.

SBP >220 or DBP 120-140 or MAP >130: Labetalol (Normodyne) 10-20mg IV push over 1-2 min. Double q20min to max of 150mg. Or use Esmolol 200 mg/kg. If COPD use Enalaprilat 1.25mg q6hr. Give NS at ~200ml/hr to correct for insensible losses. Once stable can drop NGT and start giving PO such as Captopril, Inderal, or CCB.

SBP <220, DBP <120 or MAP <130: Defer HTN tx in the absence of aortic dissection, AMI, severe CHF or HTN encephalopathy.

Causes of Ischemic Strokes:

1. Large artery artherosclerosis (Embolic): Atherothrombosis. Previous TIA’s (lasting 5-15min) in 50%. CT shows wedge shaped infarct. Systemic risk of atherosclerosis. Cognitive deficits common. Stuttering, gradual onset. May have carotid bruit, onset often during sleep. Check: Duplex US, MRA of neck (extracranial large vessels), Transcranial Doppler, MRA of neck (intracranial large vessels), cerebral angiogram. See plaques at branch points on angiography.

2. Cardioembolic: May occur in any age group but more common in young adults. Sudden onset in underlying heart dz, cognitive deficits common (Wernicke’s aphasia), multifocal signs. Depressed level of consciousness at the onset correlates highly with cardioembolic disease. Pt often collapses then awakens with a hemiparesis. May have contralateral findings (different vascular territories). Multifocal infarcts on CT. Usually sudden onset, may have an abnormal cardiac exam, usually no antecedent TIA in same distribution, often have evidence of other strokes in other vascular territories, no large artery source for emboli found and no evidence of systemic embolization. Algb, LV aneurysm, prosthetic valve, AUS, VSD, endocarditis, dilated cardiomyopathy, MS, MVP, recent AMI, patent foramen ovale (mechanical latency in 25% of population, test via echo bubble study as shake up saline and inject looking for >25 echogenic bubbles in the Left atrium.

Check: transthorasic & transesophageal echo, Holter. Stroke pt’s with a PFO and ASD are at inc risk of recurrence, but not with either one alone (NEJM 2001;345:1740).

3. Lacunar; = small vessel dz. A small subcortical thrombotic stroke confined to the territory of a single penetrating vessel (<2mm in D), 25% of all strokes, often in clinically silent areas. Usually do to the occlusion of a single penetrating blood vessel. These vessels are under unusually high pressure for a small artery as they are direct branches of a major artery. The arterial damage is usually due to long-standing HTN or DM leading to “lipohyalinosis”. The vessels are from the medial and lateral lenticulostriate (middle cerebral a.) and the paramedian penetrating (basilar a) arteries supplying the internal capsule, basal ganglia, thalamus, corona radiata and paramedian regions of the brainstem. Generally have a good prognosis with lifestyle modification as less disabling. No cognitive deficits. See small (0.3-2cm) subcortical lesions on CT (may be normal).

Risks: HTN & DM causing lipohyalinosis.

Lacunar Stroke Syndromes:

*Cortical functions are intact. CT/MRI evidence of a subcortical hypodense area (<1.5cm) with minimal evidence of large vessel dz or cardioembolism.

1. Pure motor (hemiparesis) (57%); posterior limb of internal capsule, basis pontis, cerebral peduncle, medullary pyramid, corona radiata. Significant weakness of face, arm and leg (isolated contra hemiplegia), may be worse at proximal portions. Often with dysarthria. US & LE of one side of the body, with inc DTR and Babinski.


3. Ataxic-hemiparesis (10%); upper pons, posterior limb of internal capsule, thalamus or middle-lower pons. Unilateral weakness with cerebellar signs on that side. May have a mild hypotonia.

4. Pure sensory (hemisensory) (7%): Usually progresses over seconds to hours. Lesion of the ventral posterior thalamus, occasionally due to pons lesion, cortical surface or deep white matter infarct. Sensory loss (isolated hemianesthesia) on one side of the body only.

5. Dysarthria-clumsy hand syndrome (unilateral) (6%): basis pontis, genu (anterior limb) of internal capsule, corona radiata, cortical lesion. Often with dysarthria and ipsilateral lower facial paralysis. +Babinski, deviation of tongue, dysphagia, clumsy hand
4. Miscellaneous: no specific syndrome of CT finding. Seen in hemotologic d/o such as polycythemia, sickle cell, coagulopathy, inflammatory dz, migraines, cerebral venous thrombosis: dissection, hyperviscosity, vasculitis. Systemic hypotension/hypovolemia: Low Perfusion state. Non atherosclerotic: dissection, vasculitis (see "string of Pearls" skip lesions on angiography), fibromuscular dysplasia.


7. Cryptogenic Infarct: undetermined despite efforts to dx. Pt has no bruit or TIA or history suggestive of cardiac embolism. CT or MRI within 7 days is normal, or in a territory of a surface branch or shows a large zone of infarction not accounted by a single artery territory.

8. Other: drug abuse, migraine, venous infarct (postpartum sagittal sinus thrombosis).

Complications of Ischemic Stroke:

Cerebral edema: Swelling of neurons and glia (cystotox), then fluid accumulated in extracellular space (vasogenic) in 24-48hr.

See loss of spontaneous venous pulsations of ophthalmoscopic exam, enlargement of pupil ipsilateral to infarct, progression of focal neuro deficit, corticospinal signs (weakness, hypertreflexia) on the side that was not initially affected by the stroke. If somnolence threatens airway or have danger of herniation, give Dexamethasone 4-10mg IV q6hr with taper. Add 20ntac 50mg IV q8-12hr for ulcer prophylaxis. If pupillary abnormalities develop, give Mannitol 25-50mg (max 100mg) IV q4hr (only used in T2 24hr or Glycerol 50g in 500ml of 5% glucose (can be used long-term). Furosemide 20-80 mg IV q4-12hr. Follow serial CT scans. Replacement fluids given to maintain a calculated serum osmolality at 300-320 mOsm/kg water. If persist or progresses hyperventilate to PC02 of 25-30 mmHg. As deteriorates see manifestations of mesencephalon (mid position of pupils, pathologic withdrawal) or pontine compression (pinpoint pupils, absent oculeocephalic responses, extensor posturing). Often see Cheyne-Stokes breathing.

Seizures: 5-10% of pt's get. Load with phenytoin 1,000mg IV (15mg/kg) in saline at rate of 50mg/min. Maintenance with 100mg PO/Iv 3-4x/d to keep serum level at 10-20/100g/m of plasma. If continuous sz, give Diazepam 5-10mg IV until phenytoin takes effect. May need Phenobarbital, up to 5mg/kg (300mg).

Vascular Dementia: No definitive surgical or medical tx.

Hemorrhagic Strokes (10%):

Intracranial hemorrhage is from rupture of a vessel anywhere within the cranial cavity. Classify by location (extradural, subdural, subarachnoid, intracerebral, intraventricular) and type of vessel (arterial, capillary, venous). Intracerebral (75%, most either basal ganglia, pons or cerebellar) or subarachnoid (25%). Sudden onset, have a hyperdense mass (blood) on CT, along with N/V, altered MS. 80% are due to HTN cerebrovascular dz, which causes degeneration of the media of the arterial wall. 40% in the basal ganglia, 25% in the subcortical white matter, 20% in the thalamus, 15% in the cerebellum, 5% in the pons.

CT findings suggestion cause: coagulopathy (multiple compartments, fluid levels in the clot), amyloid angiopathy (superficial location, irregular border, recurrent, white matter hypodensities), tumoral (central or eccentric location of hemorrhage, tumor mass visible, proportionally more white matter edema), AVM (calcifications in the hemorrhage mass, enhancement with contrast media).

Intraventricular Hemorrhage: unilateral ventricle (caudate or thalamic hemorrhage), biventricular (AVM of ependymal lining or choroid, ependymoma, amphetamine), 4th ventricle only (PICA aneurysm), cavum septum pellucidum (anterior artery complex aneurysm).

SBP <230 or DBP >120 mmHg : Nitroprusside @ 0.5-10 ug/kg/min or NTG drip @10-20ug/min.

SBP 181-230 or DBP 106-120: Labelatol 10mg IV push, repeat or double q 10-20min to max of 300mg.

HTN relative to pre stroke condition: try and approximate premorbid BP.

1. Nontraumatic Intraparenchymal/ Intracerebral:

Bleeding into the parenchyma of the brain. Commonly extends into the ventricle, may extend into the subarachnoid space. High mortality as only 38% survive at 1yr. HTN (chronic, 60% of cases, 2%/yr risk if uncontrolled), tumor, vascular malformation (18% recurrence/yr), vasculitis, hematologic (thrombocytopenia, bleeding diathesis), amyloid (lobar, 10.5% recurrence/yr), excessive alcohol (impairs coagulation).


Putamen/ internal capsule: contralateral hemiparesis, usually with sensory loss & hemianopsia, nearly indistinguishable from MCA infarct.

Thalamus: contralateral hemiplegia & hemianesthesia, sensory > motor.

Pons: coma, pinpoint pupils, complete paralysis, decerebrate posture common.

Cerebellum: acute dizzy, ataxia, N/V, no change in mentation, no loss of consciousness.

Tx: consult neurosurgery, reverse any anticoagulants, treat HTN, antiedemic agents: Dexamethasone to prevent herniation, 10-12mg IV, then 4mg IV q6hr. Mannitol 100mg IV q4hr. Intubate if GCS is <8. If sz at onset give anticonvulsants, can usually be discontinued after 1mo if no recurrence, but sz >2wks after bleed at high risk of recurrence and needs lifelong therapy. If hydrocephalus needs an intraventricular catheter. Surgical evacuation warranted if basal ganglionic volume >30ml, expanding, progressive deterioration or if diameter >5cm, especially if GCS is <14. Any shift of the midline structures on CT predicts clinical deterioration. Can measure the volume in cubic CM using the ellipsoid method on the CT = [(AXBXC)/2] with A the max diameter, B the diameter perpendicular to A and C the number of slice the hematoma is seen (usually have 10mm cuts) as a CT >6hr after ictus with a volume <25 cm3 will unlikely grows to cause further deterioration of the pt.

2. Intracranial Hematoma: Subdural/ epidural. All types need prompt surgical evacuation.

Epidural: Most from minor trauma, usually from a temporal skull fx rupturing the middle meningeal artery running along the inside of the skull, may cause minimal brain injury. Present after traumatic LOC, then 1-2hr lucid interval, then obtundation, ipsilateral pupillary dilatation. Sx’s relieved when clot is evacuated and pressure relieved.

Acute Subdural: Most from severe trauma, usually have marked brain injury from the shearing force that injures the bridging vein or tears a parenchymal vessel. Can be spontaneous. Mortality is 60% untreated, 30% surgically repaired in <4hrs. Seizure prophylaxis with phenytoin 1g IV. For hemiation may need bur hole placement to relieve inc ICP preferably done by neurosurgery or physicians trained in trephination.

Chronic Subdural: usually elderly with trivial trauma. Presents with H-A, confusion, language difficulties or TIA-like sx’s.

3. Subarachnoid Hemorrhage (SAH): Head trauma is the most common cause of SAH. Often they are from aneurysm or AVM. Non-traumatic SAH are due to
ruptured aneurysm 80% (seen in 0.5-1% of pop. 1.5% rupture/yr). Most are saccular (Berry) aneurysms in at Circle of Willis, usually at sites of vessel bifurcations in age 35-65yo. Most aneurysms that rupture are ≥8mm in diameter (If smaller than 10mm, then low risk as <0.05%/yr rupture), 1% of ruptures occur at rest, can rupture with wt lifting, orgasm, brawling, 25% with multiple aneurysms (remaining cases of non-traumatic due to mycotic, AVM's, dissection, sickle cell dz, coagulation disorder, neoplasms, mycotic aneurysm, ONS vasculitis). If find incidental aneurysm, may need clipping if ≥5-7mm as 1%-2%/yr risk. If FHx, screening not recommended unless PCKD or Marfan’s as risk 1% stroke with angiogram, could get an MRA for re-assurance.

Risk Factors: Mean age 50yo, F=M (M=F <40yo), If FHx of SAH (4X), previous h/o SAH (6X). Other: polycystic kidney dz, CVD, cocaine, amphetamine, tobacco, ETOH, and HTN. Conditions predisposing to cerebral aneurysms (polycystic kidney, essential HTN, aortic coarctation, Ehlers-Danlos, Wegener’s, PAN, SBE, renal artery stenosis due to fibromuscular dysplasia).

S/s: One second “normal”, next (“thunderclap”) have a severe, usually generalized H-A, (don’t rely on ‘worst H-A of my life’ following by a stiff neck. 40-50% have sentinel H-A (warning leak) or other suspicious sx days to weeks prior. Sx’s may develop during exertion, there may be an initial transient LOC, vomiting (may be profuse and override the H-A), back pain, leg pain, photophobia and meningeval pain.

Hx tips: Isolated neck pain or stiffness (meningismus), apparent “viral” meningitis frequent led to missed dx.

A 3rd nerve palsy: 30% aneurysmal, may be incomplete or complete (does not spare the pupil) (diabetic 3rd nerve palsy does).

R/o cavernous sinus syndrome, midbrain/ orbit lesions, uncal herniation. The H-A can improve spontaneously.

EKG changes or arrhythmias in 90%: T-wave flattening, prolonged QTc, arrhythmias (tachy, Brady, life-threatening 40%), ST-T change, U wave.

DDx: Thunderclap migraine (rare), cannot clinically distinguish.

CT Scan: misses 10%. Sensitivity <12hrs from onset 98% if have 3rd generation scanner, taking 3mm cuts through Circle of Willis and pl not must be anemic (Hgb<10). @ 12-24hrs 93-95%, 1-3 days 85-92% and >3 days 30-40%. If suspicion still high with -CT do LP (after CT excludes IC mass), pick up an additional 2% (99% total).

Reevaluates 2hr for RBC’s to reach lumbar cistern, xanthochromia occurs after 6-12hr (r/o inc protein as cause)-LP: cerebrospinal to r/o aneurysm. Day 1-3 non contrast CT = in 97% as blood is hypodense area. CT normal on day 5 in 30%.

LP: 100% sensitive if performed after 12hrs after onset. Fluid should be centrifuged with the supernatant examined for xanthochromia (is present in 100% 12hrs to 14 days. Compare to a tube of water in sunlight or with spectroscopy).

RBC’s: In a bloody tap tube 3 or 4 should have less RBC’s than tube 1. In non-bloody tap >50-75 RBC’s may be significant. Lack of xanthochromia confirms bloody tap if >12 hrs after onset of sx’s.

In SAH (Vs Traumatic tap): Inc #RBC’s will be constant in all tubes, no clotted blood, inc RBC relative to WBC’s, inc protein, +dimer assay, +hemoglobin containing macrophages.

Hunt & Hess Scale for SAH (Hospital Mortality%):

Grade 1: asymptomatic, “Warning” leak usually Grade 1-2%, (1%).

Grade 2: H-A, nuchal rigidity, nl neuro, (5%).

Grade 3: drowsy, minimal neuro deficit, GSC 14-14, (19%).

Grade 4: stuporous, mod-severe hemiparesis, GCS 7-12, (42%).

Grade 5: deep coma, cerebrate posturing, GCS 3-6, (77%).

Management: Intubate if: loss of protective airway reflexes, GCS <10 major bleeds, inc ICP. IV NS, O2, monitor, tx arrhythmias per ACLS protocols. (NS is hyponatremia-30% from excessive natriuresis = cerebral salt wasting, not SIADH).

Mild HTN ok (150/90) as physiologic for cerebral perfusion. Add Peridex 20ml PO BID to dec asperiration pneumonia. Avoid reducing BP too much or too quickly, treat for goal SBP<150 or DBP<90mmHg or within 5% of baseline with Labetalol, esmolol or hydralazine. Seizure prophylaxis per neurosurgeon or if documented sz (Phenytoin loading @17mg/kg or Fosphenytoin 20mg/kg IV).

Prevention and Medical Management of Stroke:

Aspirin: ASA 75-1,300mg/d inhibits platelet function for the 8-10 day lifetime of the platelet or Ticlid or warfarin. Overall ASA has been shown to reduce the number of strokes by 20% and AMI’s by 30% in pt’s at risk, with a favorable benefit-to-risk profile. ASA still a risk factor up to age 70 (primary prevention), continue tx if active or if for secondary prevention.

TIA or stroke: ASA 75-1,300mg/d inhibits platelet function for the B-10 day lifetime of the platelet or Ticlid or warfarin. Overall ASA has been shown to reduce the number of strokes by 20% and AML’s by 30% in pt’s at risk, with a favorable benefit-to-risk profile –2.5x risk GI bleed, but no reported deaths, 18% reduction in death (Arch Int Med 2002;162:2197-2202).

If TIA or stroke on ASA or ASA contraindicated: Ticlid or warfarin.

Non vascul ar Afer, primary prevention: Warfarin (INR 1.5-3), ASA 325mg/d. Warfarin (INR 2-4.5), ASA 325mg/d if contra to warfarin.

Asymmetric Carotid Stenosis → ASA 325 (75-1300)mg/d.

Asymptomatic and age >60yo → no therapy or ASA 75-325mg/d if vascular risk factors.

Antiplatelet therapy:

ASA: 80mg/d (13-20% RR reduction), use 160mg if DM. To prevent recurrence of nonembolic strokes, ASA is safer than Warfarin (NEJM 2001;345:1444)

Ticlopidine (Ticlid): 250mg Bid PO (10% risk reduction), need to monitor WBC q2wk X 3mo as 2% leukopenia (agranulocytosis). Inhibits platelet aggregation by blocking ADP receptor to inhibit fibrinogen from binding to receptor.

Clidogrel (Plavix): 75mg qd X 3-12 mo with ASA to prevent recurrent events (10% risk reduction vs placebo, NEJM 2001;345:492).

Same action as Ticlid.

Dipyridamole (Persantine) + ASA = (Aggrenox): 200mg BID (30% reduction). Extended release for of Dipyridamole.
Inhibits phosphodiesterase (PDE) to prevent aggregation. ~390/mo. Add extra ASA.

Cilostazol (Pletal): 50mg BID then, 100mg tabs BID at least 30min before or 2hr after meals.

Contra: CHF. SE: GI (44%), H-A (20%), palpitations (17%), dizzy. Metabolism via CYP3A4.

Other blood thinners: Warfarin @ INR 2-3 gives 30% risk reduction, especially important if atrial fibrillation. INR of 3-4 if valvular (mechanical) heart dz.

Carotids:
Noninvasive Doppler US misclassifies 28%, giving False- in 22.5% and False- in 5.6%. MRA gives 18% misclassification, 9.1% false- & false+. Clinicians need to be prudent when ordering these studies (Neurology 2001;56:1009)

Carotid U/S: If <70% carotid stenosis: check an MRA, if >70% get a CEA, if occlusion use Warfarin, if <70%: Check: Angiography, if >70% get CEA, if <70% use antiplatelet agent (ASA, Ticlid, Clopidogrel). If no severe carotid stenosis the attacks tend to last longer and are often associated with an embolism. If responsive to CCB, then suggests vasospasm.

Indications for CEA: age <70yo, hemispheric/ nonlacunar sx’s, ulcerated plaque, absent collateral/ heart-lung dz/ intracranial stenosis, sx’s within last 6mo.

Medical tx if: <75yo, female. , <69% stenosis, retinal/ lacunar sx’s, smooth plaque, presence of collaterals/ heart-lung dz/ intracranial stenosis. >6mo since sx’s, stroke >3mo earlier, visual sx’s alone, no intracranial stenosis. Goal is to stabilize or halt the progression of the plaque. Strict control of HTN, diabetes, lipids. Eliminate excessive alcohol, stop smoking and exercise regularly. All patients should be on an antiplatelet drug such as ASA, clopidogrel or ASA + Dipyridamole. (NEJM 2001;345:15)

Carotid endarterectomy (CEA): surgery recommended if >70% stenosis. Even if symptomatic, still need 8 surgeries to prevent one stroke. Thus some experts recommend surgery only if >80% for asymptomatics. For symptomatic patients consider even if only 50-69% stenosis. The benefit strongly depends on the surgical risk and life expectancy. Lacunar and cardioembolic strokes which make up >60% of the stroke risk in pt’s with asymptomatic carotid stenosis cannot be prevented by endarterectomy. The rate of major adverse events after carotid artery stenting using a capture device is about half that of conventional carotid endarterectomy (SAPPHIRE trial), the stent procedure involves placement of an embol capture device (Angioguard XP Embol Guideewire) distal to the stenosis. After the stent was in place, the umbrella-like device was collapsed and removed.


Carotid occlusion for bruit: not recommended as a screen as 4% of adults have asymptomatic bruit. It is a poor predictor of extracranial carotid artery dz or high-grade stenosis.

Complications & Recovery of Stroke:

Sinemet 100/25 mg given in the AM 30-45min before physiotherapy may increase motor recovery (Lancet 2001;358:787).


Poorer Stroke Outcome: males, age >75yo, previous stroke, A-lib, diabetes mellitus, decreased level of consciousness, gaze deviation, headache, temp >38.5C, severe HTN, large vessel disease, CRP >10.1 mg/L.

Shoulder Pain: common (50%) after CVA, more frequent if have spasticity than if have paralysis. Spasticity (UMN lesion) often contributes to functional weakness, gait abnormalities and pain. Tx with Tizanidine (Zanaflex), Dantrolene, localized injections with phenol or botulinum toxin. Use Amitriptyline (Elavil) and Hydrocodone for pain.

Mood d/o: give Antidepressants: improve recovery as depression occurs in 50%. Methylphenidate (Ritalin) is affective, give up to 15mg at 8AM and 12 noon as adjunctive therapy with SSRI.

Prevent with early mobilization: contractures, shoulder-hand syndrome, decubital ulcer, deconditioning, DVT.

Other: pneumonia/ sepsis (50% or stroke deaths), malnutrition, depression, UTI, falls, sz, septic ulcer, constipation, osteoporosis, URI, musculoskeletal pain, dementia, central pain syndromes, cerebral edema. Unilateral spatial neglect (often left side) occurs most frequently in nondominant parietal strokes, but has been reported in frontal, thalamic and basal ganglia strokes, pt need frequent cuing by family to pay attention to the neglected side, Bromocriptine at ~15 mg/d may help.

Dysphagia: Seen in ~55% of acute stroke pt’s, risk of aspiration. Silent aspiration occur in 40-70%, Check: Videofluoroscopic swallow study (VFSS) or a modified barium swallow (MBS). Speech therapy evaluation should perform a full bedside exam to eval the oral-pharyngeal function.

Predictors of aspiration risk: dysphonia (pitch or intensity), dysarthria (poor muscle control), abnormal gag (weak pharyngeal wall contraction, unilateral or bilateral), abnormal volitional cough (weak response when given command to cough), cough after swallow (immediate or within one minute of ingestion of calibrated volumes or 5, 10, 20 ml water), voice change after swallow (calibrated volume of water).

Transient Ischemic Attacks (TIA):

Temporary (<24 hr) focal neuro deficit due to brief interruption of local cerebral blood flow. Most last minutes to hours. If takes longer than 24 hr to resolve (25-72hr), then called a Reversible Ischemic Neurologic Deficit (RIND). 1/3 of full stroke pt’s have had a TIA. 8% with a TIA will proceed to a CVA @1mo, 15% @1yr, 33% @5yr. In the carotid territory, usually only last 10-14min. Vertebrobasilar TIA’s last ~8min, often have a hemodynamic basis such as hypotension and cardiac arrhythmia.

Crescendo TIA’s are >2 attacks in 24hr, a medical emergency.

Subclavian steal syndrome: stenosis of the L subclavian proximal to the origin of the vertebral artery leads to cerebral/ cerebellar sx’s during exertion and are accompanied by L arm claudication.

Carotid Circulation: atheroma or emboli.

Post cerebral circulation:

cerebellar sx’s during exertion and are accompanied by L arm claudication.

Crescendo TIA’s are >2 attacks in 24hr, a medical emergency.

Subclavian steal syndrome: stenosis of the L subclavian proximal to the origin of the vertebral artery leads to cerebral/ cerebellar sx’s during exertion and are accompanied by L arm claudication.

Carotid Circulation: atheroma or emboli.

Post cerebral circulation: atheroma, cervical osteophyte or osteoarthritis compressing the artery.

Transient Monocular Blindness (amaurosis fugax): from ischemia in the territory of the central retina artery. Presents with blurring or darkening of the vision (“a curtain had descended”) that peaks in seconds. May see embolic particles (Hollenhorst plaques) in the retinal artery branches. Confers a lower risk of subsequent stroke than hemispheric TIA, thus CEA only beneficial in high-risk pt’s (NEJM 2001;345:1084).

W/u: CBC, lyses, LFT’s, glucose, HDL/ LDL, ESR, RPR, PT/PT, ECG, Carotid duplex U/S study, CT, homocysteine, C-reactive protein, anticardiolipin antibody, factor 5 Leiden.

2nd Line tests: transthoracic/esophageal echo, transcranial Doppler, MRA, cerebral angiography, prothrombic w/u, ambulatory ECG, LP.

Tx: Supportive with O2, glucose, control fever, keep SBP <160, DBP <90, hydrate. Can treat as outpatient if low risk (current episode prior to 2wks, small neuro deficit, infrequent events, monocular vision loss).

Hospitalize if high risk (current episode within 2wks, frequent events, large neuro deficit). Start secondary prevention as with acute stroke.
If ischemic: Start ASA 81-325mg/d. If unable to use ASA use Clopidogrel 75mg/d (an ADP blocker). If recurrent on ASA use Aggronex (ASA + Dipyridamole) BID or Clopidogrel. Start statin & risk factor therapy.

If cardioembolic: Multiple stroke sites, +AF/ mitral stenosis/ mechanical valve/ recent AMI/ LV aneurysm or patent foramen ovale, start IV Heparin / Warfarin + statin & risk factor therapy. Stroke pt’s with a FPO and ASD are at inc risk of recurrence, but not with either one alone (NEJM 2001;345:1740). Links: Carotids:

Ddx: complicated migraine, arrhythmia, sz (Todd’s paralysis), hypoglycemia, subdural bleed, neurosis.


### Cephalgia / Headaches (H-A):


31% people have regular, periodic functional impairment for H-A. 90% will have a debilitating one in their lifetime. 16% migraines (6% of males, 19% of females), 78% tension, 15% sinus, 5% trauma, 0.1% nonvascular IC dz.

**Neurogenic theory:** serotonergic (disinhibited) neuronal dysfunction in midbrain region: diffuse cortical and secondary vasculature changes. PAIN. DHE and Cefagot act as agonist that fire and inhibit. Chemical Imbalance: changes in vessels, can modify with diet and meds.

**Headache Eval --> Hx:** how many different types of H-A’s do you have? Age began, changes in past 6mo, any event or injury trigger onset. #days of headache in past 30 days, average intensity (1-10), # hours it lasts in typical 24 hr, days/ wk analgesics used, Med list, FHx H-A, PQRST of H-A, where H-A begins and evolves, time to peak intensity, associated sx’s/ triggers/ aura, menses, past H-A evaluations & Tx’s, sleep, weekend sx’s, work hours, caffeine/ ETOH/ Tob/ drug use, exercise. Have you recently had a dental procedure? What do you think is causing your H-A’s?

**Exam:** fundus should be checked for evidence of papilledema (loss of venous pulsations), glaucoma, retinal emboli, subhyaloidal hemorrhages (seen in SAH). Visual fields should be normal on finger counting confrontation test. Visual -acuity should be reasonably normal with correction. Pay special attention to CN 5 & 7 by testing facial sensation, corneal reflex and motor function of facial muscles. Look for subtle weakness by checking for pronator drift, Romberg test and gait. Check reflexes.

**Labs to consider:** ESR (temporal arteritis or lupus), HIV, Lyme Ab, prolactin level & TSH (pituitary adenoma), CBC (TTP), drug SE (Li, NSAIDs, valproic acid) or metabolic dz (CBC, ECLP, TSH).

**Ddx: H-A:** SAH, meningitis (chronic in TB, crypto, cocci), ischemic stroke/ TIA, AVM, tumor (primary or metastatic), temporal arteritis, subdural hematoma, partial sz, snow flakes H-A, severe HTN (must be >170/110 to trigger a H-A), thalamic pain (severe, refractory pain/ hemianesthesia beginning weeks to years after a thalamic infarct).

**Reasons to Refer:** refractory H-A. pt’s tolerance to tx is increasing, habitation or rebound H-A’s, comorbid conditions are being affected (asthma, epilepsy, HTN, CAD, DM), economic burden of H-A (substantial last time at work or decreased productivity), psychological problems that necessitate a comprehensive approach. **Consider if:** pt request referral, physician uncertain of dx.

**Worst H-A Ever:** /r/o meningitis or SAH, need LP, but _1st_ /r/o papilledema or Check: CT.

**Neuroimaging:** MRI best. “Alarm Sx’s:” DANGER sx’s: only need if: Disk swelling, Alerntness or cognition decreased, Neck stiffness (nuchal rigidity), Gait or motor abnormality, Epileptic sz or syncope, Recent onset (in young/old).

**Other:** change in well-established H-A pattern, focal neuro finding, to /r/o structural dz, tumor, abscess, hydrocephalus, stroke. Has papilledema, worst H-A ever, onset after physical exertion or valsalva, worsening condition during observation, first severe H-A in age >50, after trauma, new onset that persists >2mo in age >40, GCS score <9, depressed skull flx, acute signs if inc ICP. New H-A and immunosuppressed or cancer 18% of normal have incidental finding on brain MRI (JAMA 1999 282:1)

Aura symptoms always on the same side of the body, aura symptoms with acute onset that does not spread, aura symptoms that are very brief (< 5 minutes) or very long (> 60 minutes) in duration, sudden and substantial increase in attack frequency (Patients with a high attack frequency should be checked for substance misuse.), aura without headache, associated with high fever (Migraine. Lancet. 1998; 351: 1043-1051).

**Brain tumor:** 67% awakened from sleep or awake with H-A, 80% have emesis with, 94% have neurological or ocular sign with H-A, 50% have ataxia in 2wks.

**No CT/ MRI if All Conditions Present:** previous identical H-A, normal VS, alertness and cognition intact, supple neck, no neurologic signs, improvement w/o analgesics or abortive meds.

**Normal CT & H-A with:** Infections such as meningitis, encephalitis, sphenoidal sinusitis. Pressure alterations such as cancer, low CSF pressure, glaucoma, idiopathic intracranial HTN (pseudotumor cerebri). Vascular problems such as SAH, venous sinus thrombosis, arterial dissection (carotid, vertebral), vasculitis. Neoplastic process such as posterior fossa lesion, infiltration of dura or leptomeningeal.

**Needs LP:** first or worst H-A to /r/o SAH or meningitis. Fever or signs of infection. Immunocompromised. Orthostatic H-A (low CSF pressure).

**Criteria to Admit:** Prolonged, unrelenting H-A with N/V. Status Migrainous. Dependence on analgesics with significant drug toxicity. Habituation to ergots, if stop get withdrawal H-A. Pain the worsens other medical dz, organic cause to H-A needing emergent consultation. Severe H-A necessitating frequent parental meds, comorbid dz, psychological health concerns as impaired coping ability.

**Nonpharmacologic/ Lifestyle changes:**

**Link:** Triggers:

Reassure pt that their problem is not unique and that it has been overcome by many others.

#1: Inc aerobic exercise the best thing one can do, start with daily walks (avoid on hot days) for 30-45min. A 45min aerobic exercise regimen performed 3days/wk can half the # of tension and migraine H-A’s in half after 2-3mo.

#2: Build up resistance to stress from within: Progressive self-relaxation techniques such as deep breathing, guided imagery/ self hypnosis (get tapes from self-help section of bookstores). Biofeedback: two forms: thermal (to raise finger temp >95F) and electromyographic (measure muscle activity to dec tension), meditation, assertive training, avoid triggers, adequate sleep. Stop all meds that may potentiate.
#3: Eat regular meals, avoid excessive fatigue. Spread work load evenly to avoid peaks and troughs in stress. Limit consumption of caffeine (max 2 cups/d), keep good posture, avoid glare, loud noise, strong smells. Moderation in all things.

#4: Keep a H-A diary: goal is to find triggers. Record all food & beverages consumed. Rate H-A on scale of 1-10 during 3 time periods (6AM-12, 12PM-6PM, 6PM-12AM). A trigger exists if a new H-A develops or an existing H-A worsens within 24hr after exposure to the trigger. Define trigger (>50% association), possible (25-50%) and unlikely (<25% association). Next step is to avoid trigger for 3mo and observe effect on the H-A pattern.

### Avoid Common Triggers:
- stress/ anxiety (72%),
- changes in sleep (52%),
- physical exertion (45%),
- skipping meals (45%),
- strong odors (55%),
- glare (39%),
- change in weather (barometric pressure, 45%),
- menstruation (68%),
- chocolate (22%),
- ETOH (35%),
- aspartame (9%),
- cheese (9%),
- emotions,
- change in routine,
- prolonged lack of foods, smells, noise, hormone changes (use OCP’s, 40%),
- travel,
- high altitude,
- high winds,
- hot baths,
- strong smells.

### Certain foods:
- Diet effects 35% of pt’s: tyramine (aged cheese, pickled herring, chicken liver, canned figs, pods of broad beans), chocolate, smoked fish, eggs, dairy, nuts, tomatoes, cured meats (Na-nitrate), yeast containing foods or additives such as saccharin, sulfites, nitrates, MSG.

### Certain Drugs:
- Cimetidine,
- Nifedipine,
- Theophylline,
- Indomethacin,
- Nitroglycerine,
- Estrogen,
- Reserpine containing meds.

### Avoid:
- Common Triggers:
- Motion sickness a common trigger, especially in children.
- Certain foods:
- Diet effects 35% of pt’s: tyramine (aged cheese, pickled herring, chicken liver, canned figs, pods of broad beans), chocolate, smoked fish, eggs, dairy, nuts, tomatoes, cured meats (Na-nitrate), yeast containing foods or additives such as saccharin, sulfites, nitrates, MSG.
- Certain Drugs:
- Cimetidine,
- Nifedipine,
- Theophylline,
- Indomethacin,
- Nitroglycerine,
- Estrogen,
- Reserpine containing meds.

### Try:
- OTC Migraine Ice (cooling pads that fit neck, forehead or temple), massages, taking a quiet at home vacation.

### Mg supplements @400-600mg/d, massage, peppermint oil (aromatherapy) may have analgesic effects. Avoid triggers (certain foods, lack of sleep, stress).

### Riboflavin (B2): 400mg qd, takes 3 mo for significant effect. Deficit in mitochondrial metabolism may play role in pathogenesis, a precursor to flavoenzyme that inc metabolism. For pts who want to avoid other meds and have 2+ H-A/wk. (Neurology 1998:50).

### Coenzyme Q10: 150 mg/day.

#### Migraine:

**Links:** Phases; S/s; Variations; Rx; Tx; Females; H-A Meds; Non-pharm Tx;

A sterile inflammatory response, have dec 5HT1 --> neurovascular response. 3:1 F:M. ¼ have onset as child. Average onset 11yo in M, 16yo F, peaks in 20’s, most prevalent in 40’s. In the United States, 4% of women and 1% of men suffer true migraine headaches each year. Without aura in 80%. Tends to abate after sleep. Often appears gradually after sustained exertion. Often occurs peri menstrual or at time of let-down after periods of activity or stress. The 20% with “classic” aura: 5 phases:

1. **Prodrome:** hrs to days. Some crave chocolate.
2. **Aura:** visual disturbance that develops over 5-20min and last 30-60min just prior to H-A. 75% report + visual phenomena such as scintillation or bright lights, fortification spectra (geometric pattern), flashing/ flickering lights. Negative sx’s in 56%, includes scotoma (blind spot), hemianopsia, foggy vision, tunnel vision. Sensory aphasic and motor aurae can occur. Periodic neurologic dysfunction may be part of the aura, can occur w/o H-A (acephalic migraine).
3. **H-A:** Lasts 4-72hr.
4. **Resolution:** sleep (ven a brief 1-2hr nap) is the most natural method. Biofeedback and relaxation exercises help.
5. **Postdrome:** most feel drained and washed out for 8-24hrs. Occasionally may feel euphoria, others have a low-grade, background H-A for 24-48hr and are still sensitive to light, sound and movement.

### S/s:

#### Migraine aura symptoms:

- Unilateral (often bilateral), throbbing, worse with activity, often occurs upon awakening, gradual onset, slowly subsiding in 4-72hr. 90% with nausea, 33% with emesis, most have sensory excitability (phonophobia, photophobia, osmophobia) causing them to seek a dark, quiet room. + sx’s: tingle, extra visual phenomena. Vs Stroke have - sx’s (numb, loss vision). If awakens from sleep then more likely a migraine than a tension H-A. Often causes neck and jaw pain. Can be seasonal, worse with weather patterns and withdrawal of decongestants stimulating “sinus” H-A. Check: **Fundoscopy:** use green/blue filter to lessen pt reactivity and still see disc, vessels, retina.

If lasts >72hr: **Status Migrainous**. Teichopsia (bright shimmering or wavy lines), photopsia (flashing lights), fortification...
Receptor Antagonists (Triptans)

First line therapy as 60% of pts respond with them being effective in 2/3 of H-A’s. Ok to take with an SSRI. Do not mix triptan

Ibuprofen:
Ketorolac (Toradol):
Tolfenamic Acid:
Excedrin Migraine (acetaminophen 250mg + ASA 250mg + Caffeine 65mg):
Tylenol

Confusional Migraine:
A H-A accompanied by inattention, distractibility, difficulty with speech and motor activities.

Ocular Migraine:
flushes of light in one eye lasting ~20min, no H-A.

Complicated Migraine (Migrainous Stroke):
hemiplegic migraine. Aura outlasts the H-A. Usually occurs in younger person with aura and involves the territory of the PCA. 7% risk of stroke in the young, especially if female using OCP’s and smoking. Familial, (AD).

Basilar Migraine:
Bickerstaff’s migraine: involves basilar artery, seen in teens, F>>M. Have brainstem aura, bilateral visual sx’s, ataxia, bilateral paresthesia (numbness), tingling, LOC, vertigo, dysartria, diplopia, tinnitus, N/V. They may initially manifest by total blindness, confusion, inability to speak, double vision or vertigo.

Confusional Migraine:
A H-A accompanied by inattention, distractibility, difficulty with speech and motor activities.

Intranasal Sumatriptan: 20mg, 50mg, 100mg nasal spray; 50mg, 100mg, 200mg intranasal solution.

Oral Sumatriptan: 50mg, 100mg tablets; 50mg, 100mg, 200mg capsules.

Subcutaneous Sumatriptan: 6mg, 12mg injection.

Intravenous Sumatriptan: 10mg or 40mg injection.

NSAIDs:

Opioids:

Antiemetic:

Serotonin receptor antagonists (Triptans):

5-HT1 Receptor Antagonists (Triptans):

First line therapy as 60% of pt’s respond with them being effective in 2/3 of H-A’s. Ok to take with an SSRI. Do not mix triptan
agents within 24 hours (except imitrex types). Persons may respond favorably to one triptan and not to others—thus, should treat at least several attacks with each agent sequentially until an effective one is found. Consider "fortifying" the tx of an acute migraine with loading dose of an NSAID (helps prevent H-A recurrence), or using an anti-emetic. Use Migranal (DHE)

Nasal Spray kit if triptans fail. Consider opioid back-up when all else "fails" (avoid ER visits; e.g. Dilaudid supp 3 mg q3–4 hrs PRN severe H-A with vomiting).

Contra: uncontrolled HTN, angina, PVD/CAD, male >50yo, Emyc use, smoking, Raynaud’s, basilar migraine, pregnancy, lactation. SE: cramps, nausea, dizzy, paresthesias, diarrhea, syncope, tremor, MI, CVA, confusion, sz d/o, hepatic dysfunction.

Warning: Assoc with Ischemic Collitis. Best not to use triptans more than 3 days/week. Triptan overuse results in medication-overuse headache (MOH) faster and with lower drug exposure it seems useful to restrict the intake of triptans to a maximum of 10 single dosages per month (Neurology 2002;59:1011-1014).

Axert (Almotriptan): [6.25, 12.5mg tab] 1 PO at onset of H-A, may repeat after 2hr. Max 2 doses/24hr. For age >18yo. Selective 5-HT 1B/1D agonist. Least expensive triptan, only $10.50/pill. Efficacy and tolerability better than sumatriptan and most other triptans (NEJM 2002;346:4).

Imitrex (Sumatriptan): Nasal Spray: 5, 10 & 20mg. 5HT agonist, one spray unit in pack of six, may be repeated in 2hr, max 40mg/d. Relief in 10min, max at 2hr. Avoid if on MAO or Ergotamines. Bad taste. Rhinorrhea interferes. Equivalent to a 50mg tab. Squirt, do not snort as need to be absorbed at ant nose ("look at toes, hold breath & spray, then pinch nose for 20 sec).

SQ: 6mg, 2nd dose in 60min if incomplete relief. Max 2/24hr. 3rd can be given 24hr after 2nd. SE: full/tight sensation in head and chest. Inc price and SE, but quickest onset and most effective/consistent, H-A gone but still feel wiped out and slow. Comes in canister that holds two inj’s, apply to clean/dry skin of thigh/arm, pull back trigger and press against thigh.

PO: [25, 50 or 100 mg tabs, triangle shape, can split] Start @50-100mg, repeat in q2hr if partial response, max 200mg. Onset in 30-180min.

Naratriptan (Amerge): 1 & 2.5mg tabs PO repeat q4hr, max 5mg/24hr. Has less SE and longer T½ than other triptans. By Gallaxo-Welcome, like Imitrex.

Maxalt (RizatRIPTAN): PO for migraine. 5-10mg self dissolving tab or wafer (no need H2O). Repeat dose q2hr, max 30mg/d. Zomig (Zolmitriptan): [2.5 & 5mg] one PO for H-A, repeat q2hr, max 10mg/24hr, 30mg/30wk, avoid if CVD. Good if pt awakens with H-A, and is not vomiting. Zomig-ZMT: 2.5mg oral disintegrating tab, orange flavor. 5HT1 agonist.

Frovatriptan (Frova): a 2.5 mg tab, can be repeated after 2hrs if recurs, max 3/d. For acute treatment of migraine with or without aura. Longer-acting triptan with a 26hr T½. Marketed in Europe under the brand name Migard. May be less effective than other triptans (Med Let 2002;1124).

Eliptiran: [40, 80 mg]. Not yet approved in USA, but may be superior to sumatriptan (50 or 100 mg) for migraine relief (Neurology 2002;59:1210-1217).

Ergot Alkaloids:

Contra: HTN, angina, PVD/CAD, Emyc use, smoking, Raynaud’s, basilar migraine. SE: cramps, nausea, dizzy, paresthesias, diarrhea, syncope, tremor, MI, CVA, confusion.

Dihydroergotamine (DHE): 90% effective @ 1mg IM (1.5” 22g needle m.). IV. SC PRN up to 3d or 5/wk, excite all 5HT receptors (Observe 30min-2hr, once able, release home with instructions to record SE’s and time H-A resolved as may take up to 12hr) (H-A J 1992:32:1). More effective than Meperidine (Ann Emerg Med 1998;32:2).

IV DHE 45 Protocol: 75% respond. 50mg Promethazine IV/PO or 10mg of Metoclopramide IV/PO or Compazine IV in 50ml D5W. 30 min after IV or 60 min after PO, give a test dose @ DHE 0.3-0.5mg IV over 1min (can dilute in 50ml NS or DSW and give over 30 min).

If not improved: 1-2mg IM or SPR improved—> 0.5-0.1mg DHE q45-60 min until 2.25mg or until eliminated. To reduce adverse SE, can give IV piggyback over 30min (dilute DHE in 50 ml NS) or slow IV push over 3min. (or, if admit, give q5 waking until eliminated, then q1hr for 2-3 doses with PRN, usually need 2-3 days). Can add Dexamethasone 8mg IV.

If not improved after test dose: give 0.5mg 1hr after test, the q8hr for a total of 9 (8.5mg total) doses or until improved.

Child: age 6-9yo give 0.1mg DHE/dose, age 9-12you give 0.15mg/dose, 12-16yo give 0.2mg/dose.

Migranal (DHE): Nasal Spray kit, 2mg glass ampule (doses) per tx = 1 spray (0.5mg) each nostril, repeat in 15min. Later 2mg/dose, max 3mg/24hr. Costs $10.21/dose.

Ergotamine 2mg + 100mg Caffeine (Cafetera, Ercaf, Wigraine, Gotamine) Spray: 2 tabs (2mg) SL, can repeat 1 tab in 30min X 2 PRN, max 3 tabs/24h. Or 1 suppository PR, can repeat once in 1-3hr.

Ergotamine (Ergonam): 2mg SL, may be repeated in 30min. Not used often as significant SE’s.

Opioids:

Link: Narcotics: Only 25% on non-migraine H-A’s respond to narcotics. Best used as a last resort as they usually do not get rid of the migraine, only mask the pain. If a person has reached middle age w/o a h/o drug abuse or alcoholism, using narcotics to treat pain is not going to lead to addiction unless the H-A occurs more than 1/wk or 3/mo. Beware of psychiatric comorbidity such as severe Axis I or Axis II, cluster B disorders. Do not risk opioid dependence unless the H-A fails to respond to anything else, occurs daily or lasts >6 or limits the pt’s occupational, recreational or familial activities. Some pt’s may not respond to doses <150mg. If the pt’s minimal analgesic dose is 100mg, they will not get 75% relief from 75mg.

Nubain (Nalbuphine) 10mg per 70kg IM/SC/IV q3-6hr.

Butorphanol (Stadol) 2mg Transanal/ IM, 1mg spray in 1 nostril qhr or both nostrils q3hr. SE: sedation, hallucinations.

Meperidine (Demerol): 50-150mg IM q3-4hr PRN. Give with 10mg Compazine + IV hydration.

Morphine and Phenergan: 5/50 IM/IV: if preg/HTN/CAD or recallitran. Can repeat in 30min as necessary to 15mg.

Intranasal Lidocaine:

Relieves 1/3 in 5 min. 60% in 30 min. Pt instills 0.5ml of 4% Lido solution via dropper over 30s as they lie back with head hanging over the end of the bed. Hold position for another 30s, if bilateral repeat in other nostril, then lie flat for 2min.

Butalbital Combinations:

No longer first line as significant SE’s. Patient should avoid driving car, heavy machinery. Attempt to limit use to no more than 3 days per week on average, to avoid analgesic rebound. Contra: Hypersensitivity to any component, porphyria, pregnancy (cat C). SE: Drowsiness, dizziness, dypsnea, N/V, abd. pain, potential for dependence and abuse (barbiturate). T½ is 35 hrs, renal elimination. OD toxicity from acetaminophen and butalbital. Induce emesis and give oral charcoal.

Toxic doses: Butalbital is 1g (20 capsules), acetaminophen: = is 10g (20 capsules), caffeine is 1g (25 capsules).

Midrin: Acetaminophen 325mg + Dichloralphenazone (sedative) 100mg + Isomethetepine (sympathomimetic) 65mg. Migraine/ Tension HA, 2 caps @ onset, then 1qhr until resolved. Max 5/12hr or 8/d.
Medication Overuse

Analgesics before starting prophylactic tx.

and excessive meds. Devise a tapering schedule. Transformed migraines often due to rebound. Must wean off all pain meds. Will spontaneously improve when finally discontinue all meds. Must convince the pt of the relationship to H-A effort. Sx include GI, asthenia, anxiety, irritability, depression, memory/ concentration problems. Withdrawal sx’s if pt taken >50/wk of OTC meds. H-A is nearly daily, often 2-5 AM. Usually occurs in those who use abortive meds in excess (>15-20d/mo). Or Take >8d or >50/wk of OTC meds. H-A varies in type, severity and location. Precipitated by the slightest amount of physical or mental effort. Sx include GI, asthenia, anxiety, irritability, depression, memory/ concentration problems. Withdrawal sx’s if pt taken off pain meds. Will spontaneously improve when finally discontinue all meds. Must convicted the pt of the relationship to H-A and excessive meds. Devise a tapering schedule. Transformed migraines often due to rebound. Must wean off all analgesics before starting prophylactic tx.

Medication Overuse:

At least one of the following for at least 1mo. Simple analgesic use (>1000mg ASA/ Tylenol)
>5/d/wk. Combination analgesics <3d/wk (>3 tabs/d). Narcotics >2d/wk (>1tab/d). Ergotamine use >2d/wk (1mg PO or 0.5mg PR). Best not to use triptans more than 3 days/week. Triptan overuse results in medication-overuse headache (MOH) faster and with lower drug exposure it seems useful to restrict the intake of triptans to a maximum of 10 single dosages per month (Neurology 2002;59:1011-1014).

**Tx:** Give pt a written list of meds to avoid and instructions on rescue meds such as DHE. Keep daily H-A log. **Management of withdrawal:** abrupt cessation of butalbital can cause sz. Some give taper of pheno/phenobarbital: Rx #50, 15mg, take 45mg qHS X1wk, then 30mg qHS X1wk, then 15mg, then qod until finish Rx. **Simple analgesics:** Midrin TID X 1wk or Periactin 4mg TID. **Butalbital containing: As above + Klonopin 0.5-1mg qd X7, then taper. Or Pheno/phenobarbital 30mg TID X7d. + Phenergan 25-50mg q8hr or PRN X 14d. Ergotamine: Naprosyn or Methergine 0.2-0.4mg TID. + Phenergan. **Codeine containing:** Clonidine 0.1-0.2mg TID X 10-14d, then taper + Naprosyn + Phenergan.

**Tension H-A:**
Nonpulsatile (constant), mild-mod, bilateral bandlike/pressing at occipito-nuchal or frontal area. No aggravation with routine physical activity. (N/V or photo & phonophobia excludes.) More common later in the day. May last 30min to 7d. M.F. 1:1. May be due to 5HT imbalance, endogenous endorphin depression, stress, TMJ, cervical injuries.

**Episodic tension:** <15d/mo.
**Chronic:** >15d/mo. Related to psy stress. Cause may be related to myofascial referred pain from neck/ shoulder m’s or arthritic pain from Atlanto-axial/ occipital or cervical joints.

**Tx:** Stepwise approach. regular NSAIDs then prescription NSAIDs, then combination meds, then prophylactic meds such as TCA’s, anticonvulsant (Divalproex 250mg BID) or beta-blockers. A 45min aerobic exercise regimen performed 3 days/wk can half the # of tension and migraine H-A’s in half after 2-3mo.

**Chronic Daily H-A (CDH):**
In 4% of adults. 20% de novo, 80% evolve from intermittent H-A pattern. Probably have a migraine substrate. Can be a ‘transformed migraine’, where it initially had episodic migraine features but became a chronic daily (>15d/mo or >180d/yr).

**Risk factors:** analgesic/ergotamine overuse/ rebound, abnormal personality, stress, traumatic life event, head trauma, illness. LP, med SE. Many LP will consume analgesics in anticipation of H-A. High prevalence of alcoholism.

**Classification:** Primary H-A/d: duration <4hr (cluster, chronic paroxysmal hemicrania, hypnic H-A, idiopathic stabbing H-A), duration >4hr (chronic tension-type, transformed migraine, new daily persistent H-A, hemicrania continua).

**Secondary:** posttraumatic, cervicogenic, H-A assoc. with nonvascular intracranial d/o (infection, neoplasia, intracranial hyper/hypotension), H-A assoc. with vascular d/o (dissection, AV, temporal arteritis), sinus-related, cranial neuralgia.

**Dx Criteria:** Ave freq. of >15d/mo, with ave untreated duration >4hrs for 6mo. Two of the following: pressing/lightening quality, mild-mod severity (may inhibit, but not prohibit activities), bilateral location, no aggravation with routine physical activity. H/o episodic tension-type H-A. Gradual inc (evolution) over >3mo. No vomiting. No evidence of organic dz. Only one of the following: nausea, photophobia or phonophobia.

**Tx:** prophylactic meds, stop caffeine use. The combo of tricyclics and stress management are better than either therapy alone. Break cycle with IV DHE. Consider occipital nerve block if there is TTP at occipital notch near the skull. Pt will often hear a roaring sound in the ipsilateral ear then relief for 6-12 hr, then gradual relief of the H-A. Can do bilateral blocks. Daily NSAIDs + a muscle relaxer 4ml 0.5% Bupivacaine + 6mg Betamethasone into the occipital notch near the occiput. Pt will often hear a roaring sound in the ipsilateral ear then relief for 6-12 hr, then gradual relief of the H-A. Can do bilateral blocks. Daily NSAIDs + a muscle relaxer.

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**Tx:** Stepwise approach. regular NSAIDs then prescription NSAIDs, then combination meds, then prophylactic meds such as TCA’s, anticonvulsant (Divalproex 250mg BID) or beta-blockers. A 45min aerobic exercise regimen performed 3 days/wk can half the # of tension and migraine H-A’s in half after 2-3mo.
Sports H-A: Effort/ exertional/ coital migraine, giggle H-A, altitude H-A, cardiac cephalgia (silent angina), wt lifters cephalgia (tr/o ST injury of post neck, 10% may have post fossa lesion).
Tx: pre-treat with Indocin or Naprosyn.

Coital Cephalgia: Usually short-live and similar to ice-pick H-A (paroxysmal hemicrania). Can be early coital, orgasmic coital or late coital (longer lasting).
Tx: Proranolol or Indocin.

Caffeine Withdrawal: begins 24-48hr after cessation and lasts 1-6 days. Throbbing and bilateral, 25% have nausea. Wine red or white, more common if have other H-A disorder. Many ingredients contribute (tyramine, sulfites, histamine, phenolic flavonoids). With large quantities, alcohol itself leads to a hangover H-A.

Chocolate: contains phenylethylamine, a biogenic amine that crosses the BBB and is metabolized by MAO enzymes. A common trigger if have migraines (20%).

Tyramine: biogenic amine found in cheese, wine, beer, smoked & pickled fish, nonfresh meats, broad beans, sauerkraut, dry sausage, yeast extract. It is metabolized by MAOs and diamine oxidases in the gut and liver it causes the release of NE at sympathetic nerve terminals.

Tab & Jolt: variant of headache. The prime characteristic is a sudden sharp pain followed by a brief (usually less than one minute) of a neurologic deficit (disturbed vision or speech, etc.). Because of the brief duration of the symptoms, treatment is usually focused on prevention rather than elimination of symptoms after onset. Prevention is similar to the techniques used for other migraine type headaches.

HTN H-A: Back of head, worse in AM. DBP >110. H-A is not a sign of HTN emergency. Check: ECG, BUN/Cr, U/A. Tx HTN.

Post Traumatic H-A: Acute: begins within 2wks of trauma and disappears within 2mo. Chronic if the H-A persists for >2 months (may be years) after the trauma. Entire head hurts. May have lightheadedness, malaise. Lasts weeks after injury. Depressed affect is common, may act neurotic.
Tx: Reassurance, best to warn the pt that it may occur, but usually goes away (~15% persistence at 1-3 years) treat as chronic, benign headache or transformed migraine as above with high-dose med.

Traction H-A: Due to inc ICP. Ddx: tumors, infection, bleeding, vascular abnormality. Get more severe and lasts longer over time. Pain may occur immediately upon awakening.

Other: cold-stimulus H-A, benign cough H-A.

Postural: Post-Dural Puncture (Spinal) H-A:
Intracranial hypotension. Occurs in 1/200 lumbar punctures and is due to persistent leak of CSF, may begin immediately or be delayed up to two weeks. 80% resolve within 5 days.

Etiology: LP (dx, spinal anesthesia), traumatic (dural tear, nerve root avulsion), post-op (cricotomy), spontaneous, systemic illness (dehydration. DKA, hyperpnea, uremia, severe systemic infection). Bed rest does not prevent (CMAJ 2001;165L1311).
S/s: a postural HA that worsens when sit up/ stand and improves as soon as lay down. Not enough CSF to "float" the brain when upright. Commonly have visual (nystagmus) and auditory (ear fullness) or even a sinus pressure that improves when lay down again. Usually no need to check the opening pressure as may worsen the leak.

Dx Criteria of Post-Dural Puncture Headache (PDPH):
(1) aggravated by sitting or standing. (2) relieved by lying flat. (3) mainly frontal or occipital. (4) may be accompanied by generalized (nausea, dizziness, neck stiffness) and/or localized (auditory phenomenon, visual hallucinations) sx's. (Anesthesia 1993:48:776-781)

Possible PDPH: (1) not aggravated by changes in position (I am uncertain if relief by lying flat is included in this). (2) if the patient has habitual headaches, then the current headache does not resemble them. (3) otherwise similar to PDPH.
Tx: Resolves spontaneously in 6 wks. Rx bed rest and IV fluids or Caffeine Na-benzoate 500mg IV (75% success rate, Neurology 2000;55:1771-2) or Caffeine 300mg PO (70% success). Can give corticosteroid such as Methylprednisolone 100mg IV BID X 48hr with caffeine. If no relief in 24hr -> Epidural blood patch (EBP) will give instantaneous relief in 85%, can repeat (a second procedure cures 98%) or start intrathecal saline infusion at 20 ml/hr for 2-3d if fails. EBP is done by an anesthesiologist as need to map dural puncture, then drive off 10-20ml of pt's blood and inject via the epidural needle at the same interspace or below the previous puncture. This clots off the hole to seal the leak.


Dx of Spontaneous Intracranial Hypotension: LP with OP <60 mmHg, pleocytosis (up to 40 cells), CSP protein up to 200 mg/dl. MRI head shows diffuse meningeal gadolinium enhancement, flattening of optic chiasm, crowding of posterior fossa, dec ventricle size. Radioisotope collection of the nose may show occult CSF rhinorrhea. Tx is an epidural blood patch.

Link: Abdominal Migraine:
40% of children have a H-A by age 7yo, 75% by age 15.
Prevalence: 1-3% (>M=F) age 3-7yo, 4-8% (>M=F) age 7-11yo and 5-10% age 15yo (>M=F) have migraines. If both parents suffer from migraine, there is a 70% chance child will, 45% if one parent. It is more common for child to awaken from sleep with H-A (often bilateral in fronto-temporal) or be present when awakened. Migraine attacks in child are often shorter than those in adults and vomiting or abd pain are more prominent features. Associated with other childhood periodic syndromes such as cyclic vomiting, paroxysmal torticolis, ab migraine.

Dx of Abdominal Migraine: ≥5 attacks of he following:
1. H-A lasting 4-72hr
2. H-A with at least 2 of: unilateral, pulsating, exacerbation by routine daily activity, mod-severe as to inhibit daily activities.
3. H-A with at least 1 of: nausea and/or vomiting, photophobia and phonophobia.

Dx of Classic:
1. Such as cyclic vomiting, paroxysmal torticollis, abd migraine.
2. Those in adults and vomiting or abd pain are more prominent features. Associated with other childhood periodic syndromes.
3. Those in children are often shorter than those in adults and vomiting or abd pain are more prominent features. Associated with other childhood periodic syndromes such as cyclic vomiting, paroxysmal torticolis, ab migraine.

In Adolescent:
Can also use ergotamine 2mg then 1mg q30min (max 8mg/d, 12mg/wk). Isomethetine. Children do not
necessarily outgrow H-A’s, as they are more likely to develop other problems later in life (psychiatric or multiple physical sx’s in adulthood) and thus may benefit from early psychosocial intervention (BMJ 2001;322:1145).

**Propylaxia:** Cyproheptadine 8-12mg/d divided. Propranolol: age 8-12 @10mg TID X 3wks, then 20mg TID. Age >13 @20mg TID, gradually increase to 80mg TID. Low dose TCA: Protriptyline 5mg TID or Trazodone 1mg/kg/d divided if age >7yr. Can use Valproic acid (max 250mg) or Carbamazepine 2-6mg/kg/d.

**Child CT Scan:** if <3yo, have short stature/ deceleration of growth, abnormal neurologic findings (papilledema, nystagmus, gait, motor abnormality), DI, neurofibromatosis, behavior changes, school performance, recurrent morning H-A, Persistent confusion/ disorientation, emesis, ic vomiting. Persistent H-A of <6mo that is not responding to tx. Persistent H-A not associated with a FHx of migraines. FHx of CNS dis.


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**Pseudotumor Cerebri:**

**Link:** Normal Pressure Hydrocephalus:

Idiopathic (benign) intracranial HTN. **Triad:** Fat-40-Headache. Abnormality in the resorption of CSF.

4 criteria: papilledema, CSF/ ICP >200-250 mmH2O, nl CSF composition, nl to small ventricles. If untreated may have permanent visual loss. Most cases idiopathic.

**Associated with:** pregnancy (1:870 births), OCP’s, TCN, steroids, lead, arsenic, endocrine d/o, inc/dec V-A, rickets, IDA, sinusitis, AOM.

S/s: young, obese, F, H-A, emesis, blurred vision, CN 6 (dioplia), transient obscurcation, pulsatile tinnitus. H-A is nonspecific and tends to worse upon awakening or with changes in position. Exam shows papilledema with or w/o CN 6 palsy are the most common findings. If see “venous pulsations” at the optic disc, then not papilledema (consider pseudo-papilledema). Venous pulsations are normally seen in 80% of the population.

**Eval:** detailed eye exam, including Humphry Visual Field Testing. Check: MRI/CT see silt-like or normal ventricles.

**Dx:** LP with an elevated opening pressure (>250 mm H2O) with no cells and normal protein.

**Tx:** Remove any causative factor. Wt reduction (gastric surgery if necessary) Acetazolamide: start at 125mg BID, titrate to 500 BID (250 TID) or loop diuretic such as Lasix if mild sx’s. If more severe sx’s give Prednisone 40-60mg qd z2wks with 1mo taper. Can lower ICP by repeated LP. Lumboperitoneal shunting (LPS) or optic nerve sheath fenestration (ONSF).

**Ddx:** toxins (heavy metals such as lead), systemic illness (SLE, uremia, Cushing’s dx, steroid withdrawal, hypoparathyroidism, Behcet’s with venous sinus thrombosis), structural dural AV fistula, cerebral venous sinus thrombosis, (Nalidixic Acid, TCN, monocytecin, Li, Indomethacin or Ketoprofen in Barter’s syndrome, Danazol, Vit-A, GH, chemotherapeutic agents).


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**Coma:**

A state of profound unconsciousness from which one cannot be aroused. The pt does not open their eyes to stimulation or spontaneously, nor can they sustain visual pursuit movements when eyes are manually held open. They do not follow commands or demonstrate intentional movements.

**PP:** There are three basic mechanisms for all coma (and related states): supratentorial, infratentorial, diffuse metabolic, multifactorial.

1. **Toxic/metabolic:** causes diffuse cortical dysfunction. Commonly hypoglycemia (ethanol, salicylates, beta-andrenergics), hypoxia, depressed neuronal function (GABA, opiate), toxins-induced $s$ with postictal state, structural lesion from a hematoma (cocaine, amphetamines). Intaventricular hemorrage with or w/o hydrocephalus. Organ disease (lung, liver, kidney).

**Acute metabolic derangement** (Na <110 or >160 mmol/L, Ca >3.4 mmol/L, Mg >5 ug/L, CO2 >70 mmHg, glucose <40 or >800 mg/dL).

2. **Supratentorial:** injury to the hemispheres. An expanding mass in the hemispheres eventually causes herniation lateral (uncal) herniation (as in subdural hematoma). It often compresses the oculomotor, oculocarotid reflex. Ocular and motor paralysis (except for upward and lateral gaze - CN 4,6). Central herniation results in early unconsciousness with little effect on the pupils initially, then its path merges with late uncal herniation compressing the brainstem RAS (herniation) or hemorrhagic contusion from a fall.

**Infratentorial:** a mass lesion or stroke directly affecting the brainstem RAS – remember: RAS begins mid-pons and extends cephalad.

Damage to pons, medulla, cerebellum caused by basilar artery occlusion with pontine infarction, cerebellar infarction, posterior fossa subdural hematoma, pontine or cerebellar hemorrhages, various neoplasms, verteobasilar artery aneurysm, multiple myeloma, central pontine myelolysis can result in upward tentorial herniation or downward herniation through the foramen magnum exam reveals bilateral weakness / paralysis, pinpoint pupils, dysconjugate gaze, irregular breathing or apnea.

**W/u:** CT Finding: Key tests: HCT, WBC, l/tes (Na, K, Cl, CO2, Ca, P), glucose, BUN & Cr, AST, GGT, osmolality. Optional: ammonia, anticonvulsant/ Li Salicylate/ Acetaminophen levels, ABG (pH, PO2, PCO2, HCO3, Hb CO), TSH, T3, T4, screen of Urine/ Blood, LP, blood/ CSF Cx, P7/ PTT, platelets.

**Exam Components:** pupils, eye move’t, motor response, respirations.

1. **Pupils and other physical clues:**
2. **Reflex Eye Movements:**
3. **Posturing:**
4. **Vital signs:** Clinical findings might help physicians to distinguish between pt’s with and w/o anatomic brain lesions: mean SBP & DBP levels were significantly higher and mean pulse rate was significantly lower in pt’s with brain lesions than in those w/o lesions (Using vital signs to diagnose impaired consciousness: Cross sectional observational study. BMJ 2002;325:800-2).

**Respiratory pattern:** Cheyne-Stokes respiration from bilateral or diencephalic insult anywhere from forebrain & pons. If stable have good prognosis, but if unilateral mass lesion, may signify impending herniation. Central neurogenic hyperventilation: usually due to lesion of the central tegmentum of the pons, ventral to the aqueduct/ 4th ventricle. RR of 40-70/min. A Spastic breathing: a prolonged inspiratory gasp with a pause at the end of inspiration. Due to lesion of the dorsolateral lower half of the pons. Cluster breathing is periodic with irregular frequency and amplitude with variable pauses. Due to high medullary
lesion. Ataxic breathing is irregular in rate and rhythm and due to a medullary lesion, often preterminal.

**Other:** CN’s V & VII can be assessed in comatose pt’s by testing corneal reflexes and by observing facial grimacing in response to noxious stimulation (supraorbital pressure or nasal tickle). CN’s IX & X can be assessed by testing the gag reflex (absent in 20% of normal subjects).

**Ddx Coma with a Normal CT:**
- Sepsis, DIC, pancreatitis, vasculitis, TTP, fat emboli, diffuse micrometastases, sz (prolonged post-ictal), basilar/brainstem/cerebellar stroke, malingering, conversion d/o, subarachnoid hemorrhage, bacterial meningitis, encephalitis, subdural empyema, hypo/hyperthermia.
- **Exogenous toxin** --> toxin ETOH, psychotropic drug, opioid, salicylate, anticholinergic, Penicillins, clindidine OD, CO, cyanide, Mel-Hb.
- **Endogenous toxin** --> inc Ca, hypoxia, hypoglycemia, hepatic/uremic encephalopathy, pulmonary insufficiency (inc CO2), osmolar agent (hyperglycemia, hyper/hyponatremia).

**Abnormal CT Findings:**
- Mass lesion (shift, herniation) --> hematoma, hemorrhagic contusion, MCA infarct.
- Hemorrhage in basal cisterns --> aneurysmal SAH, cocaine abuse.
- Intraventricular hemorrhage --> AVM or CVA.
- Multiple hemorrhagic infarcts --> cerebral venous thrombosis.
- Multiple cerebral infarcts --> Endocarditis, coagulopathy, CNS vasculitis.
- Diffuse cerebral edema --> cardiac arrest, fulminating meningitis, acute hepatic necrosis, Rey’s syndrome, encephalitis.
- Acute hydrocephalus --> aqueduct obstruction, colloid cyst, pineal region tumor.
- Pontine or cerebellum hemorrhage --> HTN, AVM, cavernous malformation.

**Ddx Single Intracranial Mass:**
- Not immunocompromised --> astrocytoma, oligodendrogioma, glioblastoma multiforme, solitary met, bacterial abscess, sarcoid, giant aneurysm, histoplasmosis, coccidiomycosis, blastomycosis, MS, meningoia, radiation necrosis.
- If immunocompromised --> Toxo, lymphoma, PML, aspergillus, mucormycosis, nocardia, cysticercosis, echinococcus, schistosomiasis, amebiasis, mycobacteria.

**Reflex Eye Movements:**

**Three steps:**
- **Observe resting, during mov’t, reflexes (Dolls eyes and Caloric testing).**
- Resting vertical displacement (skew) indicates a brainstem lesion. See below for eye mov’t.

**Dolls Eyes:** = Oculocephalic reflex. Check to see if pt is just unconscious/comatose with an intact brainstem (that is neurologically intact (reflects the integrity of the pons). Quick passive side-to-side movement of the head, this stimulates reflex eye movement. A “+test” (good normal conjugate eye movement) = The eyes turn in the direction opposite of the head mov’t, as if staring at you (keep “looking” at the initial direction), then slowly return to midline, not fixed with the head. As the head is passively turned to R, eyes deviate to L (keep facing original direction). = +, a good prognosis (preserved brain stem function despite lack of cortical control). Do not perform unless the c-spine has been cleared. In a metabolic coma, dolls eyes may be lost or retained. The lack of inducible eye movement in the setting of preserved pupillary reactivity is virtually diagnostic of drug toxicity. Normal in vegetative states (cerebral dysfunction). Due to stimulation of the semicircular canals. (*Arch Neurology* 1989; 46:561–3)

**Caloric Testing:** = Oculovestibular reflex. Involves inhibition of the function of one of the vestibular canals by infusing ice water against the tympanic membrane.

**Step #1:** Pt supine with head or upper body tilted forward so that the neck forms an angle of 30 degrees with the horizontal. A syringe is filled with 50-100 mL of ice cold water with a small catheter attached. First R/O TM perforation before performing.

**Step #2:** Irrigate the canal with ~60ml of ice water (the water is injected against the tympanic membrane). A comatose pt with an intact brainstem will have tonic conjugate eye deviation to the same side as the cold stimulus, they will not have a fast (cortical) component. Calorics are not helpful with drug induced comas. “Cold opposite, warm same”. The stimulus has the same effect on the horizontal semicircular canal as sustained turning of the head in the opposite direction; this results in sustained deviation of both eyes toward the ear being stimulated. Absence of this reflex indicates dysfunction of the pons, medulla, or (less commonly) cranial nerves III, VI, or VIII. Unlike the oculocephalic reflex, this reflex is also present in conscious people, producing not only deviation of the eyes toward the stimulated ear but also nystagmus, with the fast component away from the stimulated ear. There is usually no reason to test this reflex in conscious patients, however, because calorlc stimulation can cause severe vertigo and nausea, and the same elements of the nervous system can be tested in much less noxious ways.

**Other eye movements in coma:**
- Ocular bobbing --> repetitive rapid vertical deviations inferiorly with a slow return to midline is seen with pontine lesions.
- Inverse bobbing --> ocular dipping, a slow downward phase followed by a rapid upward phase and preserved reflex movements is seen with diffuse cerebral damage.

**Windshield wiper eye** --> random, nonlocalizing movements seen with CN 3 nucleus lesions.

**Ping-Pong gaze** --> roving, slow, conjugate, side-to-side deviation every 35 sec seen with toxic metabolic encephalopathies or bilateral cerebral dysfunction (lesion above brainstem).

**Basic Management:** ABC’s. Consider: Glucose @ 25ml of D50 if unable to check a fingerstick BS.
- Normal saline (0.9%) @ 1 amp (0.4mg) IVP for suspected narcotic OD (pinpoint pupil, slow respirations…..).
- Thiamine @ 50-100mg IVP (3% of Wernicke’s present with coma).
- Consider (or not): Flumazenil (Mazicion) @ 0.2mg over 30s, wait 30s, give 0.3mg over 30s at 1 minute intervals up to 3mg for Benzo OD, contra if sd do or concomitant TCA OD. Overall, safer just to let the benzod relative off as expensive and dangerous to give.

**Correct metabolic abnormalities:** acid-base, electrolytes (do not change serum Na by more than 15mOsm/day), body temperature (>40C, <35C), body temperature. Treat infections, consider empirical Abs (Cefotaxime 1-2g q6hr, Vanc 2g q12hr)+Acyclovir 10mg/kg q8hr, Pyrimethamine 75mg PO, Sulfadiazine 2-8g PO divided q6hr, Praziquantel 75mg/kg/d. Control agitation-tremulousness with Lorazepam or Haldol.

**Prognosis** good if pt awakens and is talking within hours of onset of coma. Bad outcome (unlikely to return to independent living) if absent brainstem reflexes (pupillary light, corneal, caloric) at 24hr. Prognosis worse if non-metabolic, not drug OD, older, prior brain lesions, multisystem dz.

**Fluctuating Coma:** repeated ingestion/OD (strip search all pt’s), subdural (Check: CT, especially in alcoholics), brief
action of glucose (long acting sulfonylurea), brief acting narcotic/benzo antagonist (Vs long acting opiate, benzo).

Enterofhepatic circulation, secondary effect of hypoxia on consciousness, on & off drug absorption (duodenal storage of med concretions, give cathartic).

Physical Clues to Etiology of Coma:

Link: Reflex Eye Movements: Ddx of Coma s:

Pupils: Oval & mid position pupil may be seen as a transitory sign of brain death. Parasympathetics of eyes run in the 3rd cranial nerve, the sympathetics of the eye run in the internal carotid artery.

Normal pupils: metabolic d/o, ETOH, barbiturates (stage 2-3), early stages of a cerebellar infarct/hemorrhage. Lesions below the pons or above the thalamus usually do not cause pupillary abnormalities (except Horner’s).

Bilateral Miosis (pinpoint): narcotics, phenothiazines, ETOH, barbiturates, propoxyphene, pentazocine, organophosphates, clonidine, nonketotic hyperglycemia, hypercapnia. Lesion of pons (Vs fixed mid position if midbrain), pontine lesions disrupt the sympathetics and are actually reactive to light (may only see through a magnifying glass).

One Pinpoint (miosis): sympathetic nerve problem such as lateral medullary syndrome or hypothalamus injury.

Bilateral Mydriasis: deep coma, cardiorespiratory depression, cerebral hypoxemia. Sublethal coma with atropine, LSD, glutethimide, imipramine, cocaine, ETOH, diphenhydramine, anticholinergics, scopolamine. Also seen with anxiety, pain, sz, botulism, amyl nitrate, hypermagnesemia, NE/ DA/ aminoglycoside or TON OD.

Two Mydriatic unreactive: anoxia, hypothermia, anticholinergic or severe barbiturate OD.

One Dilated & Unreactive: parasympathetic problem such as nerve compression from an uncal herniation or rupture of internal carotid artery aneurysm. A neurosurgical emergency.

Two Midpoint nonreactive: parasympathetic & sympathetic nerve destruction such as anoxia, hypothermia, anticholinergic, severe barbiturate OD.

Nystagmus: phenytoin, barbiturates, PCP.

Other: Mouth findings: Inc salivation: arsenic, organophosphates, strychnine, mushrooms.

Dec Salivation: atropine, belladonna, anticholinergics, narcotics.

Pulmonary Edema: heroin, methadone, meperidine, toxic fumes (PVC), barbiturates, glutethimide.


Edema: acute renal failure.

Pigmentation: Addison’s, hepatic failure.


Other skin: cold, malar flush, yellow tinge, puffy face seen with myxedema coma.

S/s Increased ICP: papilledema, dec level of consciousness, abnormal gait, lateral rectus paresis.

Signs of Posterior Fossa Lesion: initial sx’s of diplopia, vertigo, bilateral limb weakness, ataxia, occipital H-A. Rapid deterioration, miosis, ophthalmoplegia, ocular bobbing, absent calorics to horizontal movements, multiple CN lesions, apneustic/ cluster/ ataxic respirations.

Herniation Syndromes: unilateral sensory or motor deficit, progressive obtundation, unilateral CN 3 palsy, posturing.

Posturing: Spontaneous movement is always a good prognostic sign. Myoclonus is associated with anoxic injuries or metabolic encephalopathies, if rhythmic, it suggests brainstem injury. If no spontaneous, need noxious stimulus to evaluate.

Noxious stimulus: Pain is usually the only sensation that can be assessed in a comatose pt. Should be standardized via either compression of the pt’s nailbed (pen or reflex hammer), temporomandibular joint or supraorbital nerve (supraorbital pressure). In others can squeeze mid portion of clavicle as leaves no residual mark compared to a sternal rub or pinch. May produce triple flexion (dorsiflexion of the ankle, with flexion of the knee and hip) purely as a local withdrawal reflex. To look for purposeful withdrawal, the stimulus should be applied in a location where triple flexion would be an inappropriate response, such as the anterior thigh: hip flexion would indicate purely reflex withdrawal, whereas hip extension would indicate a purposeful movement.

Snout tickling / irritation: wisp of cotton deep into nares is very irritating (reflexic nose brushing action) to any alert pt who may have a “high” pain threshold.

Decerebrate rigidity/ posturing:

Decerebrate rigidity: jaw clenched,ipsosthenotonos (neck & trunk extended), arms/legs stiffly extended (and internally rotated). Wrists extended, feet/ toes planter flexed (extended) and inverted. Midbrain or below (brainstem) lesion, poorer prognosis with 70% mortality if trauma induced.

Decorticate posturing:

Flexion at elbows & wrists): arms flexed and adducted (makes an “O”), legs extended. From removal of corticospinal pathways above the midbrain. Lesion of cerebral white matter, thalamus as injury or disconnection between the cerebral cortex and red nuclei.

Diagonal posturing: opposite arms/ legs extended and flexed, or extended arms with flexed legs. Supratentorial lesion.

Complete Flaccidity: injury of the pontomedullary junction, mortality is usually 75%.

Ddx of Causes of Coma: Toxic/ Metabolic/ Structural:

Etiology of Coma: “AEIOU TIPP”:

Alcohol, Endocrine (inc Ca), Insulin (dec BS), Opiates, Uremia, Trauma, Infection, Poison, Psychogenic. See Toxicology chapter.

Electrolytes: Inc/dec Na, inc/dec Ca, inc BUN/Cr.

Endocrine: Inc/dec glycem, DKA, nonketotic hyperosmolar state, myxedema, Addisonian crisis/ hypothalamerism.

Vascular: DIC, vasculitis, HTN encephalopathy.

Toxic: ETOH, drug OD (narcotics, polypharmacy, barbiturates), lead, CO.

Infection/ Inflammation: meningitis, encephalitis, sepsis, lupus cerebritis, sarcoid, toxic shock syndrome, abscess Subdural empyma.

Neoplastic: leptomeningeal carcinomatosis, rupture of Neoplastic cyst.

Nutritional: Wernicke’s (de Thiamine), B12 def, Niacin or Pyridoxine Def.

Inherited metabolic d/o: porphyria, lactic acidosis.

Organ failure: Uremia, hypoxemia, hepatic encephalopathy, Reys syndrome, anoxic encephalopathy, CO2 narcosis.

Sz d/o: post-ictal state, status epilepticus.

Trauma: contusion, edema.

Herniation from mass effect: branstem RAS or bilateral hemispheric.

Vascular lesion: cortical/ subcortical infarct, bilateral carotid stenosis, bilateral diencephalic infarcts (at medial thalamic area,
pt eventually arouses with apathy, memory loss, vertical gaze paresis.

**Primary neuronal/glial dz:** adrenoleukonecephalopathy, progressive multifocal leukodystrophy.

**Ddx Coma:** locked-in syndrome (a lesion that spares the RAS, but affects the lower brainstem leading to mutism and paralysis), Vegetative state (severe bilateral cerebral dysfunction), brain death.

**Pseudocoma:**

**Locked in syndrome (ventral pontine infarction):** pt has quadriplegia, pseudobulbar palsy with preserved vertical movement of the eyes. The have normal respiratory function, intact sleep-wake cycles and have intact pain sensation. Normal EEG. Can only communicate through vertical eye mov’t and blinking. The lesion is in the brainstem and involves the motor pathways, the efferent abducens nerve fibers and corticobulbar fibers. Usually due to pontine infarct from basilar artery thrombosis or central pontine myelinolysis. Severe GBS may appear to be locked in.

**Akinetic Mutism:** paucity of movement, intact self awareness and sleep-wake cycles, normal respiration and pain sensation. Nonspecific slowing on EEG. **Brain Death:** no sleep-wake cycles or respiratory function. Only reflex spinal movements. Electrocerebral silence on EEG.

**Vegetative State (VS):** The eyes will open spontaneously or to stimulation and the pt will have sleep-wake cycles. They still do not follow commands, move with intention or sustain visual pursuit movements when eyes held open. They still have no ability to communicate or perceive pain. If the patient is deemed in a persistent vegetative state, the family needs to decide issues such as advanced directives and DNR status.

**Minimally Conscious State (MCS):** Can repeatedly done or one more of the following: Follow simple commands, gesture or verbally say yes/no, have intelligible vocalizations, show non-reflexive activity.

**Other:** psychiatric d/o (catatonia, conversion reaction), neuromuscular weakness (GBS, MG).

**Inc ICP:** bradycardia, wide pulse pressure. **Meds to avoid if inc ICP:** hydralazine, Na-nitroprusside, ketamine, CCB (nicardipine, nimodipine), halogenated anesthetics (halothane, isoflurane).

**Persistent Vegetative State (PVS):**

Emerges after severe brain injury, usually anoxic-ischemic, permanent cerebral death. Intact sleep-wake cycles and eyes may open to verbal stimuli. No purposeful movement, no visual tracking, no self awareness, no pain sensation. EEG shows polymorphous delta and theta waves. In a vegetative state pt’s have awakened from coma but have not regained awareness, wakefulness is manifested by eye opening and sleep-wake cycles. The reticul activating system of the brain stem is intact to produce wakefulness, but the connections to the cortical mantle become (or precluding awareness. More complex brain stem reflexes are also seen, such as yawning, chewing, swallowing, and, uncommonly, gular vocalizations. The brain stem reflexes of arousal and startle are preserved as well, so that eye opening occurs with loud sounds and blinking may occur with bright lights. Tearing may be seen. Spontaneous moving eye movements are particularly characteristic: these are very slow movements of constant velocity, uninterrupted by saccadic jerks, and cannot be voluntarily mimicked. These eye movements can be particularly distressing to family members as the patients appear to be looking about the room and at some point the moving eyes are pointed at the observer, who may perceive the patient to be “looking at” or following him or her throughout the room. The PVS is diagnosed after 1 mo in a pt without detectable awareness of the environment. A vegetative state is termed persistent after 2 months if the brain injury was medical and after 12 mo if the brain injury was traumatic. The determination as to when persistent equals permanent cannot be stated absolutely; to predict early in the vegetative state which pt’s will become persistently vegetative is particularly difficult in trauma. Lesions of the corpus callosum and dorsolateral brain stem seen on magnetic resonance imaging (MRI) between 6 and 8 weeks after trauma correlated with persistence of the vegetative state at 1 year. Partial recovery to the level of communication and comprehension has been reported in 3% of pt’s 5 years but improvement to independence in activities of daily living is even more rare.


**Cervical and Lumbar Spine:**

Cervical spine film is not adequate unless all seven cervical vertebrae and the top of the first thoracic vertebra are visualized.

**Anatomy:** C-spine has 7-cervical vertebrae, C1 has no body, C2 has dens (odontoid process). There are 8 cervical nerves which form the brachial plexus. Spinal cord ends at L1, inferior to L1 are the cauda equina.宫殿

**Causes of injury:** >50% MVA, Injury in 7% of ejection’s, 0.33% if vehicle towed. 20% related to Falls, 15% Sports Related.

**Fx Location:** >50% MVA, Injury in 7% of ejection’s, 0.33% if vehicle towed. 20% related to Falls, 15% Sports Related. 1/2 @C, 1/3 @L1, 70% with other major injuries, 10% with other vertebral fx.

Check: **C-spine if:** impaired consciousness, Neck/ back/ limb pain. Significant head/ facial injury, Localized TTP/ deformity/ PVM spasm, Focal neuro deficit. Immobilize-> rigid collar, backboard, tape or blocks.

**Do not need to Check:** (Clinically Clear C-spine if): Pt does not c/o neck pain when asked, pt AAO X3, no cervical pain, not intoxicated, with no posterior cervical midline TTP, normal neuro exam, no other major painful ‘distracting’ injuries (fx rib/ ankle..), no h/o LOC (NEJM 2000;343:94-9).

**Canadian C-Spine Rules:** (JAMA 2001;286:15) Used to obviate the need for C-spine X-ray in alert & stable trauma pt’s. 100% sens, 42.5% spec.

No high risk factors: age >65yo, paresthesias in extremities, dangerous mechanisms (fall >5m or 5 stairs, axial load to head such as diving, MVA speed >100 km/hr, rollover, ejection, bicycle collision, motorized recreational vehicle).

**Low Risk that allow for safe ROM assessment:** actively turn head to L & R 45 deg. +Simple rear end MVA (not a rollover, not hit by a bus/truck or high speed, not pushed into oncoming traffic), +sitting position in ED, +ambulatory at any time, +delayed onset neck pain, +absence of midline C-spine TTP.

**X-ray:** Pt’s neck always need to be fully immobilized until complete C-spine series. **Standard 3 View:** Lateral/ AP/ Open Mouth. Misses up to 20% of fx’s, if see any abnormality, Check: CT, or if neck pain disproportionate to findings. The AP adds very little (1%), look for line up of spinous processes. Oblique views good to r/o spondylodiscitis. Flex-Ext good for
stability or if h/o surgery.
Check: ABCs (alignment/ anatomy, Bony integrity, Cartilage (joint) spaces, Soft tissue) Lateral view is the most important. Need to see C7-T1 junction. If don’t see, can either apply traction to arms no injury or Swimmers view.

1. Alignment: The 4 contour lines (ant & post margins of vertebral bodies, spinolaminar line/ interlaminar/ interspinous distances (base & tips of spinous processes). The posterior cervical vertebral body line (PCL), the most important, should be smooth and uninterrupted. If base of spinous process of C2 >2mm behind PCL r/o Hangman’s fx. Common to see pseudosubluxation at C2-3 & C3-4 in child due to ligamentous laxity, may need flex/ext view to evaluate. Angulation >11deg at any level must be assumed to be ligamentous injury or fx.

2. Bony Changes: Check Frontal Views: inter pedicle and interspinous distance <2mm difference, spinous processes line up,
Atlanto-axial ligm disruption: <3mm btwn ant arch of C1 and
Odontoid View: C2
Jefferson fx: C-1 burst fx from axial force--> spreads lateral masses (Open mouth view).
Hangman’s Fracture: C2 pedicle, from a hyperextension injury.
Other fx’s: Wedge fx’s. Tear drop fx (flexion injury), Clay shoveler’s fx (ext neck against resistance, in wt lifters, break spinous process, stable)


4. Soft Tissue swell of neck. Ligament disruption--> leads to bleeding. Check: Retropharyngeal space (body of C2 to post tracheal wall) should be <6-7mm @ C2. And <22mm @ C6 (<14mm in child), (<5mm C3-4). Not very sensitive, if pt is symptomatic need further radiographs. Check: prevertebral fat stripe, ant displacement indicates underlying inj.

Check: Preodontal space: between ant margin of dens (odontoid process) (C2) and anterior portion of the ring of C1 <3-5mm adult, <3-4mm child, if not consider Jefferson Fx (C1) or odontoid fx.

5. Also check for: displaced prevertebral fat stripe/trachea, loss of lordosis, torticollis, widened interspinous space, rotations, spinal canal (stenotic if less <14mm) and teardrop fx’s.

Harris ring: overlap of images, fx of lower dens or C2 body disrupts the ring. Fat C2 sign: transverse width C2 > C3 =fx.

Additional Views:
Swimmer’s: to pick up C7-T1. Oblique (“5 view”): Check: if see abnormality on the initial 3 views or missed cervicothoracic junction.

Flexion/ Extension Views: pick up subluxation due to ligamentous injury, have pt flex/ext until it just hurts.

Frontal Views:

Vertebral Body Fx’s:

Wedge Fx: Flexion injury. Due to failure of anterior column from a hyperflexion force. If ant or lateral and no fx of the posterior cortex of the vertebral body and no disruption of the posterior neural arch or related ligaments then considered generally stable. Anterior wedge fractures that lose less than 50% of height and have no posterior ligament instability are also generally stable. Pt will need admission if >50% loss of body ht, neuro sx’s or intractable pain.

Compression Fx: Often confused with flexion (wedge) fractures. Usually due to excessive vertical load without flexion, rotation or lateral bending. Most in the mid-lumbar region. Often caused by muscle force alone in an osteoporotic spine.

Generally a stable fx except when the force is severe enough to split the body in two (burst fracture).

Burst Fx: Axial load causes disruption of anterior and middle columns, the vertebral endplates fx’s, nucleus pulposus forced into body causes shattering of body On X-ray see a loss of vertebral height anteriorly and posteriorly with widening of interpedicular distance. If severe the spinal canal may be compressed. Pt should be admitted with ortho or neurosurgery consult.

Wedge fx’s. Tear drop fx (flexion injury), Clay shoveler’s fx (ext neck against resistance, in wt lifters, break spinous process, stable)

Stable injuries:
Flexion: wedge fx, Clay-shoveler’s fx, fx of transverse process.

Extension: post neural arch of C1.

Vertical Compression: Burst fx, fx of articular pillar and vertebral body.

Rotation: unilateral facet dislocation.

Unstable injuries:
Flexion: subluxation, bilateral facet dislocation, flexion teardrop, atlantooccipital dislocation, atlantoaxial dislocation, odontoid fx with lateral displacement.

Extension: Hangman’s fx of C2, teardrop fx, atlantoaxial dislocation.

Vertical compression: Jefferson fx of C1.

Rotation: rotary atlantoaxial dislocation.

Neck Pain:


Very common, even in young (30% of those under 30yo). Incidence inc with age. Approximately 10% of the adult population have neck pain at any one time. This prevalence is similar to low back pain, but few pt’s lose time from work and less than 1% develop neurologic deficits. Cervical strain is commonly caused by the ordinary emotional and physical stresses of everyday life, poor posture, or poor sleeping habits.

Myofascial pain can produce pain: nerve roots, ligaments, facet joints, muscles, capsule, dura, bony.

Anatomically complex: ½ of total flex & ext @ occiput-atlas level. ½ of rotation @ atlanto-axial joint all are true synovial joints. Check an MRI if younger, radicular sx’s, progressive sx’s. Neck pain with neuro deficit ok to wait until “Monday” unless constitutional sx’s, worse at night or pain point of origin. Can manage with careful observation.


Myofascial Pain: Tx Neck Sprain:

Muscle and soft tissue pain assoc. with poor posture, physical stresses of everyday life, poor sleeping habits, obesity,
emotional tension, and mild repetitive trauma. Fibromyalgia in pt’s with disturbed sleep. Irritation and spasm of the muscles of the neck, upper back, or both, cervical strain is the leading cause of neck pain. Due to a Neck Sprain Vs Acute Cervical Myalgia (wryneck).

Pain is reproduced my muscle palpation, area indurated and crepitus with deep palpation. No TTP of spinous process. Neurological exam is normal. Associated with Dec ROM neck and shoulder girdle. Signs: may be gradual or spontaneous onset. Pain, stiffness, and tightness in the upper back or shoulder. Pain is often worse with movement and is accompanied by muscle spasm. Pt’s frequently rub the upper back or base of the neck when describing the symptoms. Tension headache may accompany the neck sx’s and can persist for months.  

Cervical myalgia: can occur w/o trauma Hx, may be due to exposure to cold, tension, anxiety, repetitive motion or prolonged positioning.

Greater occipital neuralgia: unilateral headache with numbness or tingling of the scalp. This headache pattern is the result of intense or chronic paraspinal muscle spasm at the base of the neck; the greater occipital nerve is irritated as it penetrates the paraspinal muscles at the base of the skull.

Consider C-spine X-ray earlier as abnormalities are potentially more catastrophic than LBP. Those with a history of neck trauma, age >50y, those who exhibit conservative care and all pt’s who present with symptoms and signs of radiculopathy.

Tx: Conservatvie:  
Posture modification: sitting straight with the shoulders held back, sleeping with the head and neck aligned with the body (with a small pillow under the neck), driving with the arms slightly shrugged (on arm rests), and avoiding straps over the shoulders. In addition to placing a small pillow under the neck, a helpful sleep position is to have the patient lie flat on his or her back with thighs elevated, thereby flattening the long spinal muscles. Patients should limit improper sitting in front of a computer terminal, prolonged telephone use, and excessive fine motor handwork.

Pain relief: Heat, Ice massage, deep massage → lessen pain and promote mobility. Ice applications to the base of the neck and upper back can be used for temporary relief of pain and muscle spasm. Acetaminophen and nonsteroidal antiinflammatory drugs are effective for mild to moderate pain, although inflammation is not a prominent part of cervical strain.

NSAIDs or short term narcotics if severe, muscle relaxants (consider 2-3wks, work via sedation → sleep). Low dose tricyclic antidepressant (amitriptyline 10-30mg qHS). Muscle relaxants also may be used at night, including cyclobenzaprine (Flexeril 10 mg qHS) and short acting benzodiazepines (oxazepam, 10-30 mg/day).

Heat their neck and upper back in a bathtub, shower, or with moist towels heated in a microwave prior to beginning exercises. The muscles are gently stretched in sets of 10-15 repetitions with each held for 5 seconds. It is best to perform the exercises in the morning and just before sleeping. After the acute pain has resolved, stretching exercises should be continued three times per week to maintain neck flexibility.

Exercise: begin gentle stretching exercises daily, including shoulder rolls and neck stretches, once acute symptoms are under control: Gentle active ROM and stretching (include upper thoracic, scapular, shoulder) and strengthening exercises. As long as pain free, perform for 5min TID.

Neck rotation – Slowly turn the head to the right. Place tension on the chin with the fingertips. Hold for a few seconds and return to the center. Repeat to the left.

Neck tilting – Tilt the head to the right, trying to touch the ear to the tip of the shoulder. Place tension on the temple with the fingertips. Hold for a few seconds and return to the center. Repeat to the left.

Neck bending – Try to touch the chin to the chest. Hold for a few seconds and return to the neutral position. Breathe in gradually, and inhale slowly with each exercise. Relax the neck and back muscles with each neck bend.

Shoulder rolls – In the sitting or standing position, pull the arms backwards. Try to pinch the shoulder blades together, and then roll the arms forward then backward in a rhythmic, rowing motion.

To inc ROM can add shoulder stabilization with a towel draped and held in place by hands, allow neck to relax and fall to opposite shoulder. If pain occurs, the duration of the frequency of the exercises should be decreased. After 2-3 wks, start isometric exercises, avoid pain. Re-Check: x-rays if severe pain persists or sx’s progress after 1wk. Most will recover in 4-6wks. Cervical collar may acutely relieve pain in patients with cervical strain; however, its benefits in the long-term are unclear.

Trigger Point Injection: 1ml steroid & 3-5ml Lido to point of max TTP in the paravertebral musculature or trapezeii. TCA’s, PT/traction. 50% get a dec pain in 2-3 wks, 80% asymptomatic in 3mo.

Acute trauma/ Cervical Hyperextension (Whiplash):

Pain within hours of, loss of lordosis on X-ray, due to micro-tears in the annulus fibrosis, paravertebral m’s stretched or torn. 96% have myofascial trigger points (tender bands of muscle) in the trapezius> splenius> infraspinatus> SCM> latissimus dorsi muscle> levator scapula that reproduce pain when palpated.

Whiplash Associated Disorder (WAD):

Grade 1: neck pain/ stiffness no physical findings.

Grade 2: +musculoskeletal findings.

Grade 3: neurological signs.

Good prognosis: 50% recover in 1mo, 90% in 5-6mo. Longer course if female, age >60y, those with neck pain on palpation, H-A, radiating pain/ numbness, thereby flattening the long spinal muscles. Patients should limit improper sitting in front of a computer terminal, prolonged telephone use, and excessive fine motor handwork.

Other Common Patterns:

Radiculopathy: nerve root, dermatomal pattern of pain.

Myelopathy: rare, spinal cord compression, UMN signs (spastic), pain is not a common presenting sign. Most frequent c/o is arm and leg dysfunction (leg stiffness, foot shuffling, fear of falling). Usually age >55yo and due to combo of osteophyte and Degenerative disc dz.

Hand syndrome: from C3-5 cord compression, can’t open and close hand rapidly (< 20X in 10 sec).

Gas in disc space: in setting of intervertebral narrowing & vertebral collapse almost always excludes infective spondylitis.

Spondylolisthesis = defect in pars interarticularis (neck of Scotty dog on oblique view) without slippage- due to fx or chronic stress.

Spondylothesis is a ventral (ant) subluxation of the vertebra secondary to spondylolyis or DJD (pseudo-spondylothesis), most at L4-S1.
Cervical Disc Dz (HNP):

M>F, can occur at young age as nucleus pulposis degenerates by age 40yo. Usually no precipitation event, most commonly dorsolateral. Nerves exit above the pedicle of its like-numbered vertebra.

Sx: Arm pain is main complaint (radiculopathy). Also have pain that progresses to the scapular area, anterior arm/ chest.

Cervical radicular pain diagram:

Cervical radiculopathy:

**C6-7 (70%):** C7 root compression/ radiculopathy: dec triceps reflex. Weak forearm extension (triceps), weak wrist flexors & extensors (often have wrist drop), may have pronator teres (forearm pronation). Dysesthesia/ sensory loss of fingers 2, 3 & 4 and all fingertips.

**C5-6 (20%):** compresses C6, dec biceps & brachioradialis reflex. Weak forearm flexion (biceps brachii), infraspinatus (external rotation of the arm), deltoid (arm abduction) and pronator teres (forearm pronation). Sensory loss & dysesthesia of lateral forearm and first digit.

**C7-T1 (10%):** (affecting the C8 nerve root) Weak intrinsic hand m’s (interossei, finger flexors), thumb abduction. Fingers 4 & 5 dysesthesia. Sensory loss medial hand and medial forearm. +Hoffman’s reflex.

**C4-5 (2%):** C5 radiculopathy: radiculopathy due to foraminal encroachment almost uniformly responds to traction (gradually over four to six weeks). Radiculopathy due to a herniated disc encroachment found that 90 percent reported symptom improvement. In my experience, radiculopathy due to foraminal encroachment has not been well studied; a small retrospective study in patients with radiculopathy due to foraminal encroachment found that 90 percent reported symptom improvement.[16] In my experience, radiculopathy due to foraminal encroachment almost uniformly responds to traction (gradually over four to six weeks). Radiculopathy due to a herniated disc encroachment found that 90 percent reported symptom improvement. In my experience, radiculopathy due to foraminal encroachment almost uniformly responds to traction (gradually over four to six weeks). Radiculopathy due to a herniated disc encroachment found that 90 percent reported symptom improvement. In my experience, radiculopathy due to foraminal encroachment almost uniformly responds to traction (gradually over four to six weeks). Radiculopathy due to a herniated disc encroachment found that 90 percent reported symptom improvement. In my experience, radiculopathy due to foraminal encroachment almost uniformly responds to traction (gradually over four to six weeks). Radiculopathy due to a herniated disc encroachment found that 90 percent reported symptom improvement. In my experience, radiculopathy due to foraminal encroachment almost uniformly responds to traction (gradually over four to six weeks). Radiculopathy due to a herniated disc encroachment found that 90 percent reported symptom improvement. In my experience, radiculopathy due to foraminal encroachment almost uniformly responds to traction (gradually over four to six weeks). Radiculopathy due to a herniated disc encroachment found that 90 percent reported symptom improvement. In my experience, radiculopathy due to foraminal encroachment almost uniformly responds to traction (gradually over four to six weeks). Radiculopathy due to a herniated disc encroachment found that 90 percent reported symptom improvement. In my experience, radiculopathy due to foraminal encroachment almost uniformly responds to traction (gradually over four to six weeks). Radiculopathy due to a herniated disc encroachment found that 90 percent reported symptom improvement. In my experience, radiculopathy due to foraminal encroachment almost uniformly responds to traction (gradually over four to six weeks). Radiculopathy due to a herniated disc encroachment found that 90 percent reported symptom improvement. In my experience, radiculopathy due to foraminal encroachment almost uniformly responds to traction (gradually over four to six weeks). Radiculopathy due to a herniated disc encroachment found that 90 percent reported symptom improvement. In my experience, radiculopathy due to foraminal encroachment almost uniformly responds to traction (gradually over four to six weeks). Radiculopathy due to a herniated disc encroachment found that 90 percent reported symptom improvement. In my experience, radiculopathy due to foraminal encroachment almost universally responds to traction (gradually over four to six weeks).

**Lhermitte’s sign:** sx of electric shock-like sensation radiating down the back with neck flexion. Reverse Lhermitte’s if radiates up. R/o posterior column dz (MS, B12, cord tumor, Chiarai malformation, spondylosis, myelopathy).

**PE:** Nerve compression test (Spurling’s sign): pt sitting, examiner laterally flexes, slightly rotates and compresses pt’s head => radicular sx’s. Extension or lateral flexion may also inc radicular pain. Manual axial traction of supine pt relieves, as does active shoulder abduction. Ddx: intramedullary problems (demyelinating plaques in MS, tumors, both usually also have myelopathy), focal extramedullary tumors (schwannomas, carcinomatous meningitis), inflammatory/ infectious (Lyme, syphilis, sarcoidosis).

Management: Nonprogressive/ nondisabling:

Conservative: Limited bed rest, analgesics, soft (non foam) pillow, soft cervical collar, NSAIDs, heat, intermittent traction (unless this makes pt more uncomfortable), physical therapy X 2-3wks. Traction begins with neck in comfortable position (slight flexion), 20min QID, start with 5-78 if supine (max 128), 10-12# if sitting (max 25#). Moist heat and gentle massage prior. If improved, continue tx. Gradually d/c cervical collar starting with 15min q2-30, extending in 20-30min increments.

Add isometric and isotonic exercises 3-5X/d for 5-10min. Start general aerobic conditioning. Gentle stretching exercises can reduce muscular irritation and ispassage in the acute setting. However, stretching exercises must be used carefully at first. The extremes of rotation and lateral bending can irritate nerve roots (especially in foraminal encroachment disease). The tolerance of neck stretching should be assessed in the office with manual traction prior to advising home exercise. A muscle relaxer taken at night for 7 to 10 days will allow patients to sleep. A soft cervical collar may help relieve pain in those with severe muscle irritability, but the same cautions and questions regarding the efficacy of therapy in patients with cervical strain extend to patients with radiculopathy. A nonsteroidal antiinflammatory drug provides additional pain relief. Pt’s with sensorimotor involvement (with or without spinal cord compression) have a less predictable prognosis than those with pure sensory radiculopathy; they are more likely to have more dramatic degrees of disc herniation, are at higher risk for nerve damage, and are more likely to require neurosurgical intervention. Thus, acute therapy for these individuals is more aggressive, including early cervical traction, neurosurgical consultation, or both. Pt’s with sx’s that are not improving after 2-3 wks should have a reevaluation of neurologic function to rule out progression. If neurologic function is stable, recommend gentle stretching exercises in rotation and lateral bending in sets of 20, performed after application of heat. Most patients with cervical radiculopathy improve without the need for surgery, even those with disc herniation. Pt’s with predominant symptoms of myelopathy (bilateral long tract signs in the extremities) rather than radiculopathy seem to clearly benefit from surgery compared with conservative therapy.

If no improved: Check: C-spine series with including flexion & extension views (r/o vertebral destruction or instability). If normal continue X4wks, if it still not improved, Check: MRI. If dx unclear, Check: EMG.

If progressive deficit or disabling: Check: C-spine series (flex/extend) and MRI. If inconclusive, Check: CT-myelography, if negative, Check: neuro consult, MRI brain, EMG, spinal tap.

Vertical traction is also recommended at this stage to decrease direct pressure on the cervical roots and nerves. A physical therapist can initiate this therapy, but daily traction will have to be performed by the patient at home. A cervical water bag traction unit should be prescribed. Traction is begun at 5 pounds for 5 minutes; at intervals of 7 days the weight and timing are gradually increased to a maximum of 12 to 15 pounds for 10 minutes twice daily. The efficacy of traction in patients with cervical radiculopathy has not been well studied; a small retrospective study in patients with radiculopathy due to foraminal encroachment found that 90 percent reported symptom improvement.[16] In my experience, radiculopathy due to foraminal encroachment almost uniformly responds to traction (gradually over four to six weeks). Radiculopathy due to a herniated disc responds less predictably. A poor response to vertical traction suggests severe muscle spasm or herniated disc.

Cervical epidural corticosteroid injections: usually 80 to 120 mg of methylprednisolone may be helpful in alleviating persistent radicular pain and avoiding the need for surgery in patients who have not responded to the above measures. Epidural injections are most effective in patients with radicular pain in whom the clinical examination correlates with findings noted on the imaging study.

Inflammatory Arthritis: RA, can result from pannus formation. Check: flexion and extension films, if normal and still sx’s Check: MRI (c/contrast).

Spondyloarthropathy: dz at site of ligamental attachment to bone rather than at the synovial joint. AS may have isolated
cervical pain. AM stiffness, subluxation at C1-C2 on flexion & ext views.

**Diffuse Idiopathic Skeletal Hyperostosis (DISH syndrome):**
Extensive ossification of paraspinal ligaments anteriorly and laterally leading to bridging of the intervening disc spaces. Tends to occur in the lower cervical and thoracic spine. Irregular shaped, unlike the vertical syndesmophyte seen in ankylosing spondylitis seen in young males.

**Cervical Spondylosis (Cervical Spinal Stenosis):**
Typically begins by age 40-50; frequency men > women, most at C5-6 or C6-7. May lead to myelopathy (cord compression) +/- radiculopathy (root compression). Note: persons without “stenosis” may have cervical spondylosis (I think of canal stenosis).

S/s: Pain most common early sx.
3 main clinical sx’s:
1. Radicular complaints, can involve >1 nerve roots.
2. Myelopathy from spinal cord compression, characterized by weakness (upper >lower), ataxic broad-based shuffling gait, sensory changes such as neck, shoulder and arm pain, paresthesias & numbness. Possible urinary retention, UMN findings (hyperreflexia, clonus, Babinski). Lhermitte’s phenomenon: shock-like sensation radiating down back with neck flexion.
3. Pain/ paresthesias of head/ neck/ shoulders with no radiculopathy. May be congenital, or due to DJD of the disk.

Dx: X-ray: Check: AP, lateral & oblique, look for osteophytes, degenerative changes of apophyseal joints and disc space narrowing. The normal canal diameter (spinolaminar line to post vertebral body with 6ft tube to film distance is 17-55mm. Stenosis (and impingement) if <12mm in an adult. Osteophytic dz: facet osteophytes that cause foramen impingement. Commonly at C5-6.

Tx: NSAIDs, analgesics, rest, exercises, soft cervical collar, pain clinic referral for steroid injection: 60% response. Surgical decompression if progressive neurologic deficit (radicular sx’s) or if pain no longer tolerable. May also be from hypertrophies or lamina, dura, ligaments.

**Cervical Spondylotic Myelopathy (CMS):**
Most common cause of spinal cord dysfunction in elderly. Due to degenerative changes in the joints, intervertebral discs, ligaments and connective tissue from spinal cord compression, ischemia or repeated trauma. Usually insidious and progressive. Age >55, M:F.

S/s: Radicular arm pain (41%), neck stiffness (unilateral or bilateral), hyperreflexia (88%), Babinski (55%), spasticity (54%), various motor deficits, sensory dysfunctions in glove distribution, gait disturbances, LE weakness, sphincter disturbance (urgency, 50%), Inc jaw jerk (=UMN lesion above the pons), weakness/ wasting of hand muscles, slow/ stiff opening-closing the hand. May have crepitation with neck movement, brachialgia (stabbing pain in shoulders, arm, elbow, wrist or fingers).

Lhermitte’s sign = shock-like sensation down center of back after flexing neck.

Dx: characteristic s/s and MRI/ CT showing spinal stenosis, cord compression due to osteophyte overgrowth, disc herniation or ligamental hypertrophy.

Dx: ALS (tends to have fasciculations, atrophy of arms and legs with denervation), extrinsic/intrinsic neoplasia, hereditary spastic paraplegia, syringomyelia, B-12 def, NPH, MS- spinal cord infarction.

Tx: careful watching if mild. Cervical traction, immobilization (collar or neck brace), physical therapy. If myelopathy need surgical decompression of the spinal cord. Other: fx’s, fibromyalgia, CAD, TOS, Pancoast’s.

**Disc Space Infection (Discitis):** See ID section (osteomyelitis).


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**Low Back Pain (LBP):**

Links: Red Flags; Acute Strain; Chronic LBP; Disk Syndromes; Sciatica; Piriformis Syndrome; Pregnancy and LBP; Sacroiliac; Lumbar Sacral Root Compression Diagram; Spinal Stenosis; Spondylitis.

Back pain is extremely common, 60% will get better in 1w, 90% in 4-6 wks. The financial costs are staggering (1.7% of the GNP of industrial counties). Basic guidelines are to search for red flags and neuro dysfunction and perform frequent clinical reevaluations. The Focus should be on improving pt’s activity tolerance. In most cases one can delay imaging studies for 4-6 weeks if no “red flags” (see below).

**Kypnosis:** a dorsal round back.

**Lordosis:** a swayback.

**Schueermann’s dz (spinal osteochondrosis):** Due to a growth disturbance in the thoracic vertebral bodies.

S/s: kyphosis with structural changes such as anterior wedged vertebral body, Schmorl’s nodes (small disc herniation into the center of the bodies), +Fhx. Often have a mild backache, may need a brace or corset. 80% of Americans will experience low back pain. 8% have it chronically.

9 Questions: where is pain, onset/ duration, previous attacks, provoking factors, reliever, previous treatments, previous back surgery, occupation, functional limitations at this time.

**Red Flags:** (need X-ray and or other emergent treatments):
1. 1st onset in age >50 or <20yo, trauma induced (mapor or minor), fever, midline TTP, awaken at night , unrelenting, AIDS, h/o CA, IV Drug (IVD) use, DM, wt loss (unexplained >4.5kg in 5mo), corticosteroid use, new sx’s >3mo, saddle anesthesia/ anal sphincter laxity; r/o cauda equina syndrome, conus medullaris syndrome or spinal cord compression. Urinary retention, pt is seeking compensation for back pain, chronic drug/ ETOH abuse, suspect anklyosing spondylitis. Having associated abdominal pain (r/o AAA).

Other Relative Indications: AM stiffness, bilateral radiation, progressive deficits, Babinski clonus, pain inc with cough/ sneeze/ valsalva, worse with hyperextension/ improve to flex spine (spinal stenosis). Always start with plain films to r/o fx or degeneration

**Surgical referral if:** cauda equina syndrome, progressive/ severe neuro deficit, persistent (4-6wk) neuromotor deficit, persistent (4-6wk) sciatica, persistent, disabling back/ leg pain that improves with spinal flexion or severe back pain/ sciatica causing functional impairment >1yr.

**Basic PE:** Include inspection of the back, palpation of the spinal and paraspinas areas as well as abdomen, and costovertebral angle.

**Full lower extremity motor exam:** gait, heal and toe walking, strength of flexor hallucis longus knee extension and hip flexion. Check sensation to anterior lateral calf and dorsum of foot. Reflexes include knee jerk, ankle jerk and medial hamstrings (L5, comforting if present, meaningless if absent). Check: straight leg raise (SLR): see below.
Acute Lumbar (Myofascial) Strain:
70% resolve in 2wks, 90% in 4-6wks, occurs yearly in 50% of working adults, reassure nothing serious, put pt back in control.
If lasts >1yr have only 15% chance of resolution.

PE: Forward flexion ~90deg (see reversal of lumbar lordosis), Ext ~15deg 20deg, Side bend ~45deg, trunk rotation. Check:
- curvature, posture, ROM, SLR, femoral stretch test (lie prone, extend hip, + in pain in anterior thigh), reflexes, saddle sensation.
- If pt demands inappropriate X-rays, remind them that "we use X-rays/ MRI to tell the surgeon where to put the knife".

Tx: Acute pain: (<6wks) - pain free ROM, NSAIDs, narcotics, heat, lumbar sacral wrap (easy wrap)-elastic neoprene for support, then strengthen and rehab. Best to keep them at some modified work to minimize the time to healing. Keeping the pt in the work environment for both physical and psychological reasons is critical. Avoid staying home where they become deconditioned, psychologically isolated, and away from daytime TV and the attorney commercials. Those with workers compensation, work dissatisfaction, work dis-satisfaction pending have a much lower spontaneous healing rate. Even those with sciatica have a >50% chance of spontaneous recovery. No need imaging unless red flags or persists >6wks. If neuro deficits or not improved after 6wks, start with and ESR & plain films to r/o fx or degeneration. If severe neuro deficits or ESR >20 mm/hr get an MRI, if stable tx with PO steroids or epidural. If cauda equina or significant deformity get stat neuro surgery consult.
McKenzie exercises: Stretching exercises to “centralize the pain and reduce peripheral sx’s”. Press-up (prone, lift upper torso). Knee to chest, cat-stretches. Keep repeating theses and progressively modifying as sx’s centralize, then finally eliminated.

Explain to pt that: 99% of all back pain gets better (50% recover in 2wks, 90% 6wks), work is the best tx. Don’t always find exact cause, but OK to work through some of the pain. Deconditioning (sedentary) & kinesophobia are what leads to chronic pain. Only 5-10% of cases ever require surgery.

Muscle Relax: A commonly used drug for sedation. Flexeril 10mg TID, Robaxin (Methocarbamol) 500mg 1-2 PO q6hr at home only. Valium 5mg 1-2 PO q6hr. (Cyclobenzaprine and back pain. Arch Intern Med 2001;161:1613).

Chronic LBP: (>12wks)
Risk: previous episode of back pain, chronic pain, psychosocial stress, general pain, poor fitness, workplace (bend, twist, vibration, sedentary). Tightness in hams/ quads/ hip flexors-> flexed LE-> more force on back from biomechanics, need dynamic lumbar stabilization program to strengthen LE and abd muscles.
Lab: X-rays, CBC, SED, Chem 7, Ca, P, AP, RF, U/A, ANA, RPR, TSH, HLA B-27, SLEP/ UUEP.
Tx: An intensive multidisciplinary approach with biopsychosocial rehabilitation does reduce pain and improve function, but expensive (BJM USA 2001;1:445-51). Must shift focus from pain control to improving functioning/ activity tolerance. “Motion is lotion”, combo of aerobic, stretching and strengthening exercises. Exercises inc the muscle mass and thus inc stabilization, thus decreases pain.
- Age 15-20-most spondylothesis (not congenital), 20-25yo. Can try botulinum injections. Dr. Sarno’s tx: In his widely published book. Most back pain is “secondary to emotional stress”, not physical. It is all in your head. You need to tell your brain to “shut-up” and it goes away.

Nonpharmacologic tx for myofascial LBP: 90% resolve spontaneously in 8wks. Trigger point injections (see Rheum chapter), Capsaicin cream. US/Phonomousphic. Teach massage techniques to family members. Physical Therapy/ Training to restore fitness and prevent future sx’s. TENS units are not effective for chronic low-back pain (Cochrane Databases Syst Rev. 2001;2:CD003008).

Stretch the hamstrings: (hold for 45-60 sec, no bounce) While lying own, bring straight leg up to trunk as use the hands to pull the back of the thigh or a towel around the toes. Lying through a doorway, put one foot on the door frame as the opposite leg extends through the doorway.

Exercise to Strengthen support muscles: Back injuries 10X <frequent in the physically fit. Increases strength, flexibility and psych. Start with extension and isometric. Avoid flexion exercises as they apply a greater load onto the disc. Exercise motivation is a strong indicator of outcome in chronic LBP. Simple exercises will improve long-term outcomes. Improving aerobic fitness can increase blood flow and oxygenation to all tissue, this helps the body to break down scar tissue and heal.
Back extension: Nautilus-type machine or lay prone and lift arm (extended, palm down) with opposite leg 30X each side. Abdominal crunches: raise shoulders off floor, hands should support, not pull the head. If pain in back, do with feet & legs propped straight up against a wall. Back school: teach ergonomics, anatomy, exercises to promote positive pt attitude, encourage wt loss and smoking cessation.

Acupuncture: may help some, not proven (not effective, Arch Intern Med 2001;161:1081). Manipulation: inconsistent results, no improved outcome in acute LBP, may help chronic.

Myofascial Pain Syndrome: Aches in other parts of body, trigger points, in people who are tense and have multiple stressors. Historical dx, sleep disturbances common.
Tx: encourage exercise and stress reduction. See fibromyalgia.

Facet Joint Pain: facet (zygaphysial, apophysial, posterior intervertebral) joints are paired diarthrodial (synovial) articulations between the posterior elements of the adjacent vertebrae. They are innervated by medial branches of the dorsal rami of the spinal nerves from the L1-L4 levels. Facet pain can often radiate in patterns. L1-2 may cause central and lateral radiating band pain. L2-3 is usually lumbar pain, can cause gluteal or trochanteric and lateral thigh pain. L3-4 or L4-5 may cause gluteal, trochanteric, lateral thigh and groin pain. L5-S1 is also predominately lumbar pain, but may cause posterior and buttock pain.

Extrusion of the nucleus pulposus material through the annulus fibrosis. (Pain Physician 2002;5:1)

Chronic Simple Backache: Recurrent episodes, may be described as new onset by pt. Historical dx.
Tx: non-habit forming analgesics. Exercise, wt loss, nutrition, smoking cessation, physical therapy, address ergonomic issues. If pain is due to an occupational setting, a multidisciplinary team approach is needed.

If suspects a psychosocial overlay: carelessly ask the pt if there are any issues in their life that may be contributing to their back pain.
Ultimately if the pt is recalcitrant to treatment, thoroughly review all previous notes, X-rays, consults and tests. Consider a second opinion, if there are no discrepancies, consider discharging the pt to a primary care physician after maximal medical recovery has been obtained.

Clinical Disc Syndromes:

Degenerative Joint Disease (DJD): Osteoarthritids (OA), 30-40yo, lumbar pain from subchondral bone, annulus, post longitudinal lig, facet joint and capsules, muscles tendons.

Herniated Nucleus Propulsus (HNP): Extrusion of the nucleus pulposus material through the annulus fibrosis. Synonymous with slipped or ruptured disk. Leads to compression of the spinal nerve. Most common in age 30-40yo.
Often has leg pain-> back, in dermatomal pattern.
“Internal Disc Disruption”: identified by provocative discography that injects contrast material into the disc and simultaneously assesses pain. Unclear if truly significant as asymptomatic adults have pain with this procedure and disc disruption often improves spontaneously.

**Discogenic** → worse on flexion (Vs arthritis, facet pain (SI) and spinal stenosis worse with extension), worse with cough, valsala, sitting. 75% resolve in 6mo (refer if lasts >6wks or progressive neuro deficit/ flaccid paralysis), 5-10% require surgery.

**Lumbosacral Root Compression Diagram:**

**Straight Leg Raise (SLR):** + in 80% of L5-S1 HNP (also in spinal stenosis). Passively lifting leg to 70 deg reproduces sciatic-type pain, a radicular pain that radiates below the knee, worsened by ankle dorsiflexion (back or hamstring pain is not a +. Considered a nerve root tension sign).

**Increasing the Confidence:** confirm by stopping short on the initial level and precipitating the *sciatica* by dorsiflexion of the foot to stretch the nerve, conversely plantar flex should allow you to raise it higher, also a double SLR should ease the pain. The chin-to-chest motion will also exacerbate the pain. **Crossed SLR:** Radicular pain on affected side while lifting asymptomatic leg (less intense than affected side) also specific for L5/S1 HNP.

**Bowstring test:** the arc of the SLR is decreased a few degrees to a nontender point. The examiner then manually distracts the popliteal nerve with his thumb to increase tension on the sciatic nerve to re-create the sx’s.

**Femoral Stretch Test:** to evaluate reproducibility of the SLR. Pt prone or in lateral decubitus. Thigh is extended to the hip and knee is flexed to reproduce the pain.

<table>
<thead>
<tr>
<th>Disc Level: Pain / Motor Deficit:</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1-2-L1: Inguinal region, medial thigh / None.</td>
</tr>
<tr>
<td>L1-2: Ant-med upper thigh / Weak quads, Dec KJ.</td>
</tr>
<tr>
<td>L2-3: Ant-lat thigh / Weak quads, Dec KJ.</td>
</tr>
<tr>
<td>L3-4: Post-lat thigh &amp; Ant tibial / Weak quads, Dec KJ.</td>
</tr>
<tr>
<td>L4-5: Dorsum of foot / Extensor of great toe/foot.</td>
</tr>
<tr>
<td>L5-S1: Lateral foot / Dec Ankle reflex.</td>
</tr>
</tbody>
</table>

**Management:** Check: Plain films & ESR. If normal or no red flags: Conservative tx X 4-6wks (same as lumbar strain) unless neurologic deficits progressive.

**Exercises:** back extension on Nautilus machine or lie prone with arms/legs extended to counterbalance. Abdominal crunches to add support to spine. Stretches. Consider **epidural steroid** injections if not improved.

**If not improved in 6-8wks:** check an MRI, non-contrast CT or EMG.

**Surgery:** initially will have less pain, but at 1 & 5 yrs same, best to tough it out. Avoid surgery unless neuro deficits or leg pain. electric/jabbing. Most recover spontaneously with rest and NSAIDs.

**Sciatica:** Pain in the distribution of the sciatic nerve, usually sharp pain radiating down the post-lat aspect of the leg to foot/ankle. Often associated with numbness or paresthesias. The most common cause is a herniated intervertebral disc. Usually due to radiculopathy of a root contributing to the sciatic nerve (L4-S1). Only a minority of these discs are therapeutically important. Dec ankle jerk (AJ) and unable to tip toe (normal AJ in S1 radiculopathy).

**Check:** plain film and ESR.

**Ddx Sciatica:** HNP, spinal stenosis, discitis, arachnoiditis, neoplasm, pelvic lesions, peripheral nerve lesions, cauda equina, conus medullaris lesion, piriformis syndrome (causes a pseudo-sciatica).

**The common perineal nerve** passes behind the fibular head where it is superficial and fixed (vulnerable). It is often damaged with frequent leg crossing or mild trauma. Pt will complain of top of foot being numb, have foot drop and not be able to ever lift foot (L5 lesion will ot be able to invert or evert foot). The sciatic nerve is divided into the **Deep Peroneal (Anterior Tibial N):** motor to foot/ toe extensors, sensory to small area between 1st & 2nd toes. Trauma: **Foot Drop**→ weak ankle dorsiflexion, usually painless. Vs L4-5 radiculopathy.

**Superficial Peroneal (Musculocutaneous N):** motor to foot evertors (Peroneus longus, brevis), sensory to lateral leg and dorsum of foot. **Common causes of injury:** entrapment, DM, inflammatory neuropathy (Leprosy), trauma, masses (popliteal cyst, aneurysm), pressure (crossing legs, casts), neoplasia.

**Piriformis Syndrome:** Irritates the sciatic nerve as nerve courses near or through. Causes a pseudo-sciatica. The piriformis muscle originates from the anterior surface of the sacrum, passes through the greater sciatic foramen and attaches to the greater trochanter. It is a hip rotator and abductor (when hip is flexed).

**Injury:** mild trauma, prolonged sitting (wallet pressure), athlete.

**Hx:** dull ache in buttock region near sciatic notch. Inc pain walking upstairs. Paresthesias in sciatic nerve distribution (buttock, posterior thigh, lower leg). Pain with sitting, may have pain walking. S/s: piriformis TTP at the sciatic notch during passive IR (affected leg is flexed and crossed over the other leg), affected leg often held in external rotation due to spasm.

**+Freiberg’s sign**→ inc pain with passive (forced) IR or resisted ER of hip with pt in prone position. May have + Trendelenburg’s sign.

**+Pace’s sign**→ pain/weakness with resisted abduction and ER of thigh. Pain on SLR with internal rotation at less height than SLR.
Dx: Clinical, check MRI if unclear or failure to improve with conservative tx.

Tx: Step #1: Activity modification, NSAIDs. Stretch the gluteals: ankle to chin as lay supine or “eager beaver” groin stretch, or foot up on chair as seated.

Step #2: Strengthen abdominals/ hip abductors/ hip adductor muscles.

Step #3: Physical therapy modalities (U/S), Piriformis stretching-->adduction, internal rotation and flexion at the hip (pt flexes right knee and crosses over flexed left knee, then pulls left knee toward himself, stretching right hamstring and piriformis.)

Step #4: corticosteroid injection if not improving.

Ddx: tensor fascia lata syndrome, hamstring syndrome. True sciatica.

Gluteus medius/ maximus syndrome’s--> myofascial pain over the mid portion of the muscle, may refer to leg, worse with stretching/ contraction.

Gluteus Medius Strain: pain with resisted abduction with leg extended. Neg SLR / nerve root signs.

Pregnancy and LBP: 50% of women experience mod-severe LBP during pregnancy, related to hormonal and vascular changes that cause anatomic and biomechanical alterations as the fetus enlarges. 37% still have back pain after delivery, and 7% lasts >18mo.

Extension stretching is the most effective method of treating. This is done by leaning back with hands on hips, pushing upper body of the ground as lay prone, kneeling on the ground as elbows rest on a chair. Sleep with a small roll pillow tucked between ribs and iliac crest on the painful side as sleep.

Side gliding: against a wall (shoulders parallel to floor as bring hips up against the wall away from the painful side).

Sacroiliac Dysfunction:

Generalized term to describe pain from the sacroiliac joint. May be due to arthritis or hypermobility. The SI joint is an auricular-shaped, diarthrodial joint with a capsule, synovium, hyaline cartilage and fibrocartilage.

Pain referral: buttocok (94%), lower lumbar (72%), thigh (48%, 30% posterior, 20% lateral, 10% anterior), lower leg (28%, 18% posterior, 12% lateral, 10% anterior), groin (14%), ankle (14%), foot (12%, 8% lateral, 4% plantar, 4% dorsal), upper lumbar (8%), abdomen (2%).

Sacroiliac (SI) Sprain: Often due to direct blow, sudden torsion, sudden violent contraction of abd muscles or hamstrings. R/o Reiter’s, psoriatic arthritis, IBD, ankylosing spondylitis. Pt has pain walking or other activity, +Patrick’s sign.

S/s: +Patrick’s (Fabere) Test: (Flex-Abd-External Rotate- Extension): Pt lying supine, stabilize the contralateral iliac crest with downward pressure. Pt’s heel/foot of test leg rests on top of opposite knee (on opposite side of examiner, as is lies flat).

Slowly lower test leg into abduction. Normal if leg falls to table or at least parallel to opposite leg. Lack of symmetry more important than ROM or discomfort.

3. Trendelenburg gait
4. TTP @ pubic symphysis
5. Radiates to thigh

1. +SI compression test:
2. Pain with resisted abduction.

Pain indicates inflammation of pathology of the hip joint. It is one of the first signs of OA in the hip. Pt often has TTP over SI joint. +SI Compression Test (pt on side, push down on pelvic) or distraction of iliac crest illicit pain.

+Hip Flexor Tightness: knee to chest maneuver aggravates the pain.

+Single Leg Stand: pain as stand on symptomatic side and raise opposite knee. May have +Trendelenburg sign, some with pain on flexion and extension of back of while standing.

+Gaenslen’s Sign/ maneuver: pt is supine over edge of table, drop one leg over edge or table and pull opposite knee to chest. The pt has the ipsilateral leg hangs off the exam table. The contra leg & hip are flexed toward the abd as a hyperextension force is applied to the hip, positive if get pain.

Yeoman Test: pt lying prone; the ipsilateral leg is placed in 20 deg extension and is externally rotated while the examiner’s hand is placed over the sacral sulcus.

X-ray: SI view to r/o sclerosis/ erosions of spondyloarthopathy.
**Schaumann's dz, overuse, postural, HNP, tumor/infection, spinal dysraphism. (Spondylolysis in active adolescents. Phys**

**Ddx LBP In Children:**

**Age <10yo:**
- Jumping, running, collision sports and any hyperextension activities for a minimum of 4-6wks.
- TENS, acupuncture.

**Tx:**
- Before initiating significant activity restrictions and rehab, still should confirm with thin-slice CT.
- Single-photon emission CT defect. Next step is bone scan, not very specific, but highly sensitive to pick up inc metabolism, has a 15% false+ rate. Thus, classic "scottie dog" with the pars lesion at the neck (elongated or broken). Many asymptomatic individuals have a pars w/u:
- of spondylolysis.

**Stork Test:**
- Dull, nagging LBP, AM stiffness, worse with activity, Dec ROM.

A failure of the neural arch, manifesting as a defect in the pars interarticularis (neck of the "Scotty Dog" seen on oblique L movements restricted.

**Axbal:**
- Spondylolysis, spondylolisthesis, scoliosis, Reiter's syndrome, psoriatic arthritis, IBD.

**Neurogenic Claudication (Lumbar Spinal Stenosis):**
- Usually develops from narrowing of the spinal canal secondary to spondylolisthesis. Up to 20% of adults >60yo have imaging evidence of spinal stenosis. Neural foraminal narrowing often results from the osteophyte formation.

**Etiology:**
- Most due to DJD (OA with facet hypotrophy), also due to soft tissue (bulging disc or thickened ligamentum flavum), achondroplasia, Paget's dz, spinal dysraphism. Most in elderly (60-70yo) with severe DJD-osteophytes (usually at L4-5 or L3-4), bulging annuli decrease the cross-sectional area of spinal canal → spinal stenosis →

**S/s:**
- Leg pain, commonly bilateral sciatic, insidious onset neuro deficit (dermatomal weak/ numb). Worse with any activity that extends the spine, walking down-hills, variable amount of walking, prolonged stand, back extension, lift/bend, cough. Able to walk longer at grocery store Vs mall, can lean on cart and flex spine.
- No pain when the pt is seated with spine flexed.

**Relief slowly with resting:**
- Pain is relieved only by sitting down (flexes spine), not by just standing still (as with intermittent claudification).
- If not flexing spine often takes >30min sit/lying down and flexion/ squat.

**Central canal stenosis:**
- Age >55, back & buttock pain exacerbated by walking or standing and relieved by sitting or flexion;
- Radiating arm pain, numbness, weakness, to lower extremities.

**Foraminal stenosis:**
- Above Rx in a unilateral dermatal distribution.

**Bicycle test:**
- Bike riding (bending forward at hip relieves) is tolerable (unlike vascular claudication). Often with past h/o back pain. Neg SLR.

**Dx:**
- Confirmation by CT/MRI see hypertrophy of lamina, pedicles, apophyseal joints, thickened lig flavum all impinging on canal: "cloverleaf/ trefoil" appearance. Interpediculate distance (IPD) on AP of spine (normal in mm = (lumbar level + 12) X1.5)

**Tx:**
- Reassure that most do not progress.
- Lose weight (obese with large abdomen causes hyperlordosis). Lumbar bracing (semirigid or rigid corset), bed rest, PT (prolotherapy), pain management, surgical decompression if debilitating.
- Leg lifts if length discrepancy. NSAIDs. Short courses of Prednisone 20 mg TID tapered over 2-3 weeks help with acute exacerbations. Back stretching exercises such as pelvic tilt and knee-chest. Flexed position, bicycling helps. If neurogenic claudication occurs at <300 yards (100 meters) of walking and/or who must sit/squat to relieve the walking sx's usually respond best to surgery.

**Vs. Vascular (Intermittent) Claudication:**
- Due to ischemia in exercising muscles. Pain is sclerotomal (vascular supply distribution), occurs with a fixed amount of activity, may occur with standing alone→ resolves almost immediately with rest.
- Not improved with grocery shopping with cart Vs shopping mall (neurogenic claudication is). Atherosclerotic dz of iliofemoral vessels, often with impotence, dystrophic skin changes (nail atrophy, alopecia), foot pallor, decreased pulses, arterial bruits. Check: ABI and Doppler if suspect.

**Ddx:**
- Abscess, cauda equina syndrome, compression fx, sublux/ spondylolisthesis,

**Hip DJD:** +Patrick's sign—reproducing leg pain by lateral rotation of flexed knee.

**Spondylosis/ Spondylolisthesis/ Spondylolysis:**

**Spondylosis:**
- Non specific degenerative process of the spine, in cervical region it is synonymous with stenosis. Usually seen in age >50.

**S/s:**
- Presents as dull nagging LBP, morning stiffness, worse with activity, relief with gentle exercise, hydrotherapy. All movements restricted.

**Tx:**
- Analgesics, exercise. TENS? Tends to cause spinal stenosis with neurogenic claudication.

**Spondylolysis:**

**Fx pars interarticularis.**

**Spondylolysis:**

**Forward slide of vertebral.**

**Spondylolisthesis:**
- A failure of the neural arch, manifesting as a defect in the pars interarticularis (neck of the "Scotty Dog" seen on oblique L spine). May be congenital, degenerative, traumatic, pathologic. 6% men, 9% females, many asymptomatic. Presents with dull, nagging LBP, AM stiffness, worse with activity, Dec ROM.

**Sthor Test:**
- The pt balances on the ipsilateral leg, then hyperextends the lumbar spine. Positive test if pain localizes to the side of spondylolisthesis.

**W/u:**
- Plain radiographs. Look for scoliosis on AP. On lateral look for spondylolisthesis (see below). On oblique view see the classic "scottie dog" with the pars lesion at the neck (elongated or broken). Many asymptomatic individuals have a pars defect. Next step is bone scan, not very specific, but highly sensitive to pick up inc metabolism, has a 15% false+ rate. Thus, before initiating significant activity restrictions and rehab, still should confirm with thin-slice CT. Single-photon emission CT (SPECT) is even more sensitive.

**Tx:**
- Start with conservative: NSAIDs, exercise, hydrotherapy. If any significant pain, need to restrict rigorous activity such as jumping, running, collision sports and any hyperextension activities for a minimum of 4-6wks. TENS, acupuncture.

**Ddx LBP In Children:**

**Age <10yo:** infection, tumor, psychogenic. **Age >10yo:** spondylolysis, spondylolisthesis, Schaumann's dz, overuse, postural, HNP, tumor/infection, spinal dysraphism. (Spondylolysis in active adolescents. Phys
Spondylolisthesis: Anterior subluxation (slipping) of one vertebral body on another, usually L5 on S1. Grade 1-4 (<25-75%). 5% pop. Pain with extreme stretching of the interspinous ligaments. Risk for progression if early onset (10-15yo), female, recurrent sx’s, postural deformity.

Tx: strict flexion exercise program for at least 3 mo (avoid hyperextension). If have <25% slippage: counsel on avoiding heavy lifting or strenuous activity. If >50%; avoid contact sports.

Risk Factors for Pain or Progression in Children & Adolescents: (1) early age of onset (spondylolisthesis progresses during the adolescent growth spurt in ages 10-15 years). (2) female (greater risk of additional slippage and development of severe grades). (3) recurrent episodes of pain in the back. (4) presence of deformity (postural deformity, abnormal gait due to tight hamstring).  

Radiographic risk factors: (1) dysplastic (type I), (2) Grade III or IV degree of slip. (3) increasing angle of slip. (4) instability with a "teeter-totter" appearance (dome-shaped, vertical sacrum and trapezoidal fifth lumbar vertebral body, and lack of sclerotic change at L5-S1).

Cauda Equina Syndrome (CES) and Conus Medullaris Syndrome (CMS):

Conus Medullaris Syndrome: found between T11 & L1-2, the thoracolumbar junction is very hypermobile compared to adjacent areas. Presents with UMN & LMN findings, most commonly paralysis of the lower extremities with flaccid rectal tone and urinary retention. Common to have bladder dysfunction and impaired erection/ ejaculation. Pain is uncommon.

Cauda Equina Syndrome: a peripheral nerve injury due to lesion below the conus (L1-L2), presents with asymmetric and incomplete paralysis, areflexia, loss of bowel/bladder control. Pain is often unilateral, worse with valsalva. The most consistent sx is urinary retention. Reduced sphincter tone in 75%. Usually have a good recovery, higher risk if due to a central disk herniation as only have rectal/ urinary incontinence (w/o weakness) as risk permanent damage if not recognized.

Immediate Surgical Referral. = saddle anesthesia, bladder dysfunction such as retention/ frequency/ incontinence, progressive deficit, laxity of anal sphincter, perianal sensory loss, major motor weakness. 1st S/s is loss of temperature sensation of rectal area (ask if the KY gel is cold). Gradual, unilateral deficit, progressive/ severe neuro deficit, neumromotor deficit persisting after 4-6wks conservative tx, persistent sciatica, sensory deficit, reflex loss after 4-6wks in pt with +SLR.

Other Immediate referrals: if bilateral sciatica, severe disabling sciatica and those not responding to standard conservative treatment or suspect infection (diskitis) or other life threatening condition.

Ankylosing Spondylitis:

HLA-B27 + in 93%. HLA-B27 found in 50% of Haida Indians of British Columbia, <1% Asians/Africans, 3-15% of Europeans.

Natural history: insidious onset, exacerbations and remissions, morning stiffness a dominant sx, limited spina movement, recurrent initis, mild in women. May occasional have constitutional sx’s, extra-articular bony tenderness, apical lung fibrosis.

S/s: Insidious onset of dull back pain lasting >3mo in age <40. Morning stiffness, alleviated with exercise, may interfere with sleep, located in deep gluteal region. May have stooping posture due to flexion contracture of hip with flattening of the L-spine.

Extra-articular: amyloid, uveitis, aortic insufficiency, cardiac conduction abnormality, cauda equina syndrome, IgA nephropathy, apical pulmonary fibrosis.

Schober test for mobility:
1. Draw line at L5 between post-sup iliac crests.
2. Mark 10cm above and 5cm below.
3. Pt flex spine, if interval >20 cm, then normal

Chest expansion: decreased = <3cm expansion at nipple line.

X-ray: periostitis at pubic symphysis, postame stamp changes @ SI joint, bridging syndesmophyte @L5-S1. (=vertebral bridging due to outer annulus fibrosus calcification. Vs osteophytes in DJD due to endochondral ossification causing a bony spur). Wide sclerotic SI joint on CT. Bamboo spine, sacroiliitis, spondylitis.

Tx: Sulfasalazine 500 BID, titrate to 1g BID, NSAIDs. Physical Therapy: exercise, stretching, to maintain posture, ROM and conditioning. Avoid waterbeds, pillows. Avoid falls (loose rugs, lights, handrails).

Related Disorders: Reactive Arthritis (Reiter’s), Juvenile Spondyloarthropathy, Psoriatic Arthropathy, Enteropathic Arthropathy.

Ref: (Rheum Dis Clin NA 1998;24) (Curr Opin Rheum 1998;10)

Lower Extremity (Lumbar) Neuropathy:

Lumbosacral Plexopathy: a neuropathy that resembles brachial plexus neuropathy. Typically affects middle-aged and elderly men. Pt’s often have diabetes (in which case the terms diabetic amyotrophy, diabetic femoral neuropathy, proximal diabetic neuropathy, or diabetic lumbosacral radiculoplexus neuropathy are sometimes used), although an identical syndrome can occur in nondiabetic patients

S/s: begins with pain in the anterior thigh, usually severe and continuous, lasting for several weeks. As the pain subsides, weakness appears, most often involving the quadriceps and hip flexors. Often, the weakness causes no symptoms until the patient fails, giving the misleading impression of an acute event. Significant wasting of the quadriceps may occur, and the knee jerk is absent. Sensory signs are minimal. Sometimes, the initial symptoms and signs involve only the lumbar or sacral parts of the plexus, but there is a tendency for the process to spread to the whole plexus and to involve the contralateral side. Very gradual recovery is the rule. Electrodiagnostic testing is helpful in supporting the diagnosis. Imaging studies of the pelvis to exclude malignant invasion of the lumbar plexus, retroperitoneal hematoma, and psoas abscess are often needed.

Tx: symptomatic, pain that lasts more than a few weeks may be helped by drugs such as amitriptyline.


Etiology: DM, femoral nerve entrapment (rare, pelvic surgery, inguinal hernia), intraabdominal surgery, retroperitoneal hematoma (hemophiliac, anticogulants).

Ddx: L4 radiculopathy (no iliopsoas weakness), diabetic plexus neuropathy, idiopathic lumbosacral neuropathy.

**Peroneal Neuropathy:** most often the result of injury to the peroneal nerve at the point where the nerve winds around the head of the fibula, passing from the popliteal fossa to the anterior compartment of the leg. Distal peroneal branches are superficial at the ankle, where they are sometimes compressed by tight-fitting shoes.

S/s: unilateral footdrop caused by weakness of ankle dorsiflexors. However, footdrop may be caused by an L5 radiculopathy, a lumbosacral plexopathy, a proximal sciatic neuropathy, or a lesion in the contralateral cerebral motor cortex. L5 radiculopathy, the most common differential diagnosis, is suggested by the presence of back pain radiating to the leg and weakness of ankle invertors, hip abductors, ankle dorsiflexors, and toe extensors. Electrodiagnostic testing may be particularly helpful in localizing the lesion in patients with footdrop. A history of obvious trauma (fx of the fibula) is often seen in patients with peroneal neuropathy at the knee. Compression during states of altered consciousness (during anesthesia and coma) is another common cause. Herniation of a Baker cyst may compromise the nerve. In patients without such precipitants, peroneal neuropathy at the knee is often attributed to habitually sitting with legs crossed: a plausible explanation, although difficult to prove.

**Tx:** usually conservative. In most pt’s who have suffered trauma to the nerve, improvement will occur with time, particularly when there is some residual function in the distal peroneal nerve. In severe trauma, the nerve is sometimes completely transected, in which case the outcome is usually poor and surgical anastomosis offers the best hope of recovery. When no other cause of the peroneal neuropathy is apparent, patients can be advised to avoid sitting with legs crossed; slow improvement may result. Regardless of the cause, an ankle-foot orthosis should be tried to compensate for the footdrop; most pt’s find that this simple device greatly improves their walking.

**Isolated Foot Drop:**

With sensory deficit: L5 radiculopathy, lumbar plexopathy, sciatic nerve palsy, peroneal neuropathy (injury at fibular head, DM), early GBS, Charcot-Marie-Tooth dz.

W/o sensory deficit:ALS, scapulopernoneal variety of fascioscapulohumeral muscular dystrophy.

**Obtrurator Nerve Entrapment:** L2-4 roots. Sensation to inner thigh, motor to thigh adductors (gracilis, adductors magnus/ longus/ brevis). Often compressed by pelvic tumors, fetal head, forceps trauma.

**Sciatic Nerve:** Sciatica.

**Medial Knee numbness:** damage to the infrapatellar branch of the saphenous nerve (gonyalgia paresthetica). Often due to blunt trauma (straddling a surfboard) or knee surgery. Sensory loss to medial knee, no weakness. Treat conservatively, oral agents for neuropathic pain.

**Sensory loss of sole of foot:**

**Tarsal Tunnel Syndrome:** due to ill-fitting footwear, ankle pain that worsens with walking. Weakness of abductor hallucis. Proximal Tibial Neuropathy: due to Baker’s cyst or trauma. Often have knee pain with sensory loss to sole and lateral foot. Weakness in the gastroc and tibialis posterior. Dec knee jerk.

**S1 radiculopathy:** back pain, positive SLR, sensory loss of sole & lateral foot that spares the great toe. Weakness of gastroc & gluteus maximus with dec ankle jerk.

**Meralgia paresthetica (MP):** Compression neuropathy of the lateral femoral cutaneous nerve (LFCN). The most common pure sensory mononeuropathy.

**Etiology:** joggers, obese (panniculus), tight clothing, belt, prolonged sitting/ hip flexion, repetitive small trauma often where it exits at ASIS, scar tissue near inguinal ligament, DM, pregnancy, rarely caused by abdominal/pelvic tumor. Worse with prolonged standing/ walking.

**PE:** Syndrome of dysthesia, hypoesthesia of lat thigh. +Sensory deficit (pinprick and light touch), TTP at inguinal ligament, +Tinel’s sign over the nerve at the anterolateral thigh.

**Dx:** Nerve block: Cutaneous infiltration 2cm below and medial to ASIS, then laterally and superiorly in fan wise fashion to relieve sx’s. AP pelvis to r/o abn (AP/lat Hip if groin pain or restricted internal rot).

**Ddx:** OA, neuropathy, HNP at L2-3, burstitis, femoral neuropathy (sensory changes more ant-medial), pelvic tumor.

**Tx:** Conservative is 90% effective; avoid cause such as tight garments, belts. If sit a lot, get up and walk frequently. Lose wt, strengthen abd muscles. Avilid, Ice to area of constriction TID X 20min. NSAIDs X 7-14d. Steroid + local anesthetic inj beneath inguinal lig at ASIS or point of max TTP. Most cases self limited. Consider Carbamazepine or Phenytoin to reduce the dysthetic pain.


**Detecting the Inconsistent/ Exaggerating Pt’s:**

**Waddell’s Signs:** To identify pain of psychologic or socioeconomic basis. (Spine 1998;23:21)

Widespread pain: pain on superficial touch of skin/ scrotum, pain “everywhere” (whole extremity is numb/ pain/ weak), nonanatomic, non-dermatomal altered sensation not explained on localized neurological basis.

Hip rotation: (Simulated rotation) pain with passive trunk rotation. Pt stand with hands at side, Doc passively twists the torso (hip & shoulders in unison). No pain should be felt at 1st 30 deg or torso rotation does not rotate the back.

**Gluteus maximus sign:** Check’s for pt cooperation. Ask them to squeeze them together. Check for tone. If one does not tense, may have a nerve deficit.

Axial loading: +LBP with compression of top of head of standing pt. Should not cause LBP. (will exacerbate neck pain).

**Distracted SLR:** Pt supine, if had +SLR, next raise both legs (should be able to raise higher now as spine flexes). Also test with pt seated, which should give same result as supine.

**Give Away Weakness:** see on ankle dorsiflexion testing as get cog-wheeling/ giving away/ breakaway/ dithering/ sudden letting go type weakness. True weakness gives smooth giving away.

**Other signs:** multiple doctor/ surgery, pt complains about previous Dr. then says “I have heard so many nice things about you”, high ratio of complaints to findings sign. No sign to tx, allergic to tx. Regional weakness or sensory changes.

**Overreaction:** exaggerated, noreproducible response to a stimulus.

**Observational findings:** if pt is limping, Check: shoes, as should have asymmetry of wear if the limp is of a true physical cause. Examine the hands, calluses disappear in 3 wks of inactivity, periangual dirt, abrasions. Upper body muscle tone
maintenance. A pt who puts on a show of collapsing but takes care not to injure themselves. 

**Johnson’s sign:** psychogenic involvement of pain, pt attempts to appear weaker or have problems worse than indicated clinical findings, either conscious (malingering) where pt animated, often demanding procedures, diagnosis and compensation.

**Unconscious** (conversion reaction/ hysteria) pt often calm or indifferent.

**Libmans sign:** to eval pt’s response to pain, press mastoid processes (control) with thumbs and ask if hurts, then slide to styloid process (most pt’s feel pain here), can gauge if hyposensitive vs hypersensitive (exaggerate) pain reports.

**Mannkops Test:** palpation of a painful area should raise the pulse rate >5%.

**O’Donoghue’s Maneuver:** Pt who has passive ROM < active ROM.

**Burn’s Test:** ask pt to kneel on a chair and touch the floor. This will relieve true LBP and sciatica, but not nonorganic LBP.

**Pseudo neurological Syndromes:**

**Links:** 

**Pseudocoma:** Conversion D/o:

**Pseudoparalysis:** Psychiatric disorders may cause paraplegia. True weakness can be differentiated as it has decreases resistance over the entire tested range of motion. Psych pt’s tend to grimace with a mix of a smile & anger with periodic vasaiva maneuvers or sighing during muscle testing.

**Drop test:** “paralyzed” arm will not strike pt’s face. Unexpected painful stimuli may cause purposeful withdrawal.

**Hoover sign of Hysteria:** Pt supine, raise legs at ankles, as lift affected limb, the unaffected heel presses down if dz is real.

**Hoover test:** place on hand under heel of “weak” leg and other hand on good leg. Ask pt to lift good leg (against resistance) + if feel counterpressure from “weak” leg.

**Hysterical gait** has no leg circumduction (tend to just drag it) hyperreflexia of Babinski sign.

**Heal Drag:** pt is supine, quickly lift their knee. If their heal does not drag, suspect inc muscle tone.

**Pseudo sensory Syndrome:** True hemianesthesia does not split the genitalia because of overlapping innervation.

**Check:** Painful stimuli to “numb” area : pulse rate increase of 20-30. **Check:** Tuning fork applied to a bony structure, vibratory loss of 1/2 of skull, sternum, pelvis impossible because of bone conduction. **Check:** Yes-no test with eyes closed if continue to say “no” when touching a supposedly numb limb.

**Pseudo-blindness:** Pt follows reflection in mirror or newspaper print (optokinetic reflex).

**Malingering:** Feigning illness of disability to derive benefit or secondary gain. Repeated fabrication of an illness, usually dramatic, convincing, acute. Often from a person who wanders from hospital to hospital. Hx of emotional/ physical abuse. Often to elicit sympathy, gain compensation, obtain meds, avoid prosecution, get better jail conditions, avoid military service.

**Tx Approach to Nonorganic Syndromes:** Avoid directly confronting pt. Do not dismiss their complaints. Give them a ladder to climb out by 1st explaining that they do not have a serious physical problem. Reassure them that no significant deterioration in their condition is expected, let them know that although exercise may hurt, it will not negatively affect their condition. Work with them to improve their daily activities to overcome and replace their illness behaviors. If they overtly exhibit malingering sx’s, tell them that you cannot help them. Refer to psychiatry if needed.


**Various Other Neurological:**

**Phacomatoses (phakomatosis):** a generic term for a group of hereditary d/o’s characterized by hamartomas. Includes Von Hippel, neurofibromatosis, Sturge-Weber, and tuberous sclerosis.

**Tuberous Sclerosis:** 1/3 AD, 2/3 sporadic, Triad of MR, sz, adenoma seb aceum (by age 4yo, in butterfly pattern). Most have scattered leaf-shaped depigmented areas, subungual fibromas, shagreen patches (leathery areas of skin on back), retinal phakomas, calcified tubers on head films.

**Alterations seen in Neurologic Lesions:**

**Frontal lobe Lesions:** Broca’s area: inferior part of dominant frontal lobe causes dysphasia.

Precentral gyrus: monoplegia or hemiplegia.

Supplemental motor area: paralysis of head and eye movements to the opposite side. Head turns toward the diseased hemisphere and eyes look in the same direction.

**Orbitofrontal syndrome:** disinhibition, poor judgment, emotional lability.

**Frontal Convexity syndrome:** aprathy, indifference, poor abstract thought.

**Medial Frontal syndrome:** akinetic, incontinent, sparse verbal output.

**Left Hemisphere:** Usually dominant. Receives info from and controls the right side of the body.

**Frontal lobe:** personality, attention, planning, judgment.

**Parietal lobe:** somatosensory, reading, writing, calculations, naming body parts, R-L distinction, vision, taste.

**Temporal lobe:** language, comprehension of verbal, visual and smell.

**Right Hemisphere:** usually nondominant. Receives info from and controls the left side of the body. More in tune to emotional, music and melodies.

**Parietal:** somatosensory, spatial relationships, attention to L side of face/body.

**Temporal:** nonverbal visual, comprehension of prosody, affect and gestures.

**Cognitive Domain & Localization:**

**Memory:** mesial temporal lobes.

**Executive function:** frontal lobes.

**Calculations:** dominant hemisphere (usually L) parietal. Can also be impaired if poor attention due to frontal lobe dysfunction.

**Reading:** parieto-occipital. Need to r/o ocular causes.

**Speed of thought:** frontosubcortical circuits.

**Limb praxis:** dominant hemisphere (usually L) parietal or mesial frontal.

**Dressing praxis:** nondominant hemisphere (usually right) parietal.

**Language d/o:**
The language domain is usually the dominant hemisphere (usually left) frontotemporalparietal.

**Aphasia:** injury to speech cortex or to subcortical association fibers or transitory following a sz.

**Four tests to eval/locate the aphasia:**

#1: Repeat after me: ‘I am here’. If unable to repeat will tell if have a lesion at the sylvian fissure (Broca, Wernicke or conduction aphasia). If able to repeat then a transcortical aphasia (cortex dz).

#2: Follow these instructions: point to the floor, ceiling, chair. Next, “point to the door, then window’ (to add complexity).

Language disorders have problems with multiple tasking. If can’t repeat but can comprehend then Broca. If can repeat but can’t comprehend then transcortical sensory aphasia.

#3: Fluency: they understand, but cannot say so. If can’t repeat, but fluent, then Broca. If fluent but can’t understand then Wernicke or transcortical. If problem with intact fluency and comprehension then conduction aphasia (para-sylvian arcuate fasciculus located between Broca & Wernicke’s areas).

#4: Object Naming: most aphasic types have this problem.

**Anomic aphasia** only have problems naming (lesion of Brodmann’s area 37 in the temporal lobe or a lesion in the inferior parietal lobe). **Broca aphasia:** nonfluent verbal output, good comprehension, poor repetition/ naming.

**Other nonfluent aphasia:** global, transcortical motor, mixed transcortical.

**Wernicke:** fluent, poor comprehension/ repetition/ naming. Word salad-like babbling.

Other fluent aphasia: conduction, transcortical sensory, anomia, thalamic.

**Akinetic mutism:** seen in bilateral frontal lobe dysfunction.

**Dysarthria:**

Congenital: cerebral palsy, muscular dystrophy, agenesia of lower cranial nerves, hearing d/o, inborn error of metab, hereditary ataxia.

Acquired: drugs, toxin, trauma, encephalitis, mass lesion, MS, dementia, ALS, basal ganglia or cerebellar degeneration..

**Flaccid:** LMN dz such as bulbar palsy, have hypervasality, audible inspirations.

**Spastic:** (pyramidal tracts): UMN dz, pseudobulbar palsy, slow and imprecise articulation, low pitch, strained voice, mumbling, breathy. **Ataxic:** cerebellar dz, excess stress and mono stress, dysrhythmia of speech, slow, loudness variation.

**Hypokinetic:** extrapyramidal dz such as Parkinsonism, monotone, variable rate.

**Hyperkinetic:** chorea, monocular, Tourette’s, athetosis.

**Mixed:** ALS, MS, Wilson’s.

**Parkinsonian:** indistinct rapid stammering, quiet.

**Dysarthria:** basal ganglia dz, strained, slow, with associated dystonia and athetosis.

**Bulbar:** brain stem dz, indistinct, slurred, often nasal voice with dysphagia, diplopia and ataxia.

**Scanning:** cerebellar dz. Slurring, impaired timing and cadence, sing-song quality. With ataxia of limbs, gait tremor of head/limbs.

**Myasthenic:** indistinct voice with fatigue, dysphonia, fluctuating severity.

Myopathic: indistinct, poor articulation. Weakness of face, tongue and neck.

**Personality Changes:**

Apathy: lesions of medial frontal, basal ganglia, thalamic.

Disinhibition or Irritability: orbitofrontal, caudate lesions.

Explosive: posttraumatic encephalopathy.

**Placidity:** Klüver-Bucy syndrome (bilateral temporal lobe).

**Suspiciousness:** epilepsy, Huntington.

**Alexithymia:** R hemisphere lesion.

**Schizoid:** child onset R brain lesion.

**Coprophilia:** cursing or Copropraxia (obscene gesturing), seen in Tourette’s, acanthocytosis, basal ganglia d/o.

**Palilalia:** repetition of one’s own words, seen in developmental delay, Tourette’s, advanced dementia, basal ganglia d/o.

**Echopraxia:** imitation others actions, seen in Tourette’s, hyperekplexia.

**Stereotypy:** repetitive, non-goal directed movements, seen in psychosis, autism, Rett’s syndrome.

**Mannerisms:** repetitive directed movements, seen in psychosis, autism.

**Preservation:** repetition of the last or recently performed motor act, seen in frontal lobe d/o and dementia.

**Primary Intracranial (Brain Tumors) Neoplasia:**

If suspect a brain neoplasm, obtain an MRI without and with contrast. CT is more sensitive and specific with respect to calcification. This can be important in distinguishing certain lesions such as craniopharyngioma, retinoblastoma, chondrosarcoma, Sturge-Weber syndrome, toxoplasmosis, and tuberous sclerosis whose lesions have a strong tendency to calcify. In cases where the detection of calcium is important, non contrast CT is necessary.

**Brain Mets:** lung > breast > unknown (10%), > melanoma > colon. Also with GU, sarcoma, thyroid. **Dural** Mets with breast & prostate. Parenchymal mets with lung, renal, breast, melanoma and lymphoma. **Link:** Brain Mets Tx:

Epidural mets at the spinal cord cause LBP worse with lying down with bladder/bowel dysfunction.

6 main histological types: meningial, primary CNS lymphoma, metastatic, sellar (craniopharyngioma), germ-cell (choriocarcinoma, embryonal carcinoma, teratoma) and Neuroepithelial (astrocytic, oligodendroglial, ependymal, choroid, pineal, embryonal). There are ~17,000 new tumors/yr, but >100,000 metastases/yr in USA. Ionizing radiation is a significant risk factor.

**Presentation:** either focal or generalized sx’s. Hemorrhages, aphasia, H-A upon awakening that dissipates in 2-3hr. sz, mental status change. May have a focal neuro deficit (arm or leg weakness), papilledema, asymmetric pupils, asymmetric DTR. If inc ICP give Decadron 10mg, the 4mg IV q4hr.

**Gliomas:** Gliomas are the most common primary brain tumor (60%). Most brain tumors affect people during the productive years of their lives.

**Types:** astrocytoma, oligodendroglioma, ependymoma and primitive neuroectodermal tumors. Markers for proliferation include proliferating cell nuclear antigen (PCNA) and Ki-67 Ag. High grade may arise alone (primary) or arise from a low-grade (secondary) tumor.

**Astrocytoma:** Commonly found in young adulthood, with a peak incidence in 3rd-4th decade. Presentation is usually a sz. Variable prognosis, median survival with a low-grade (age 20-40y) is 5yrs, most die progression of their dz in 1-2yrs if high-grade (age 40-60y). Cerebellar lesions are more benign.

**Glioblastoma multiforme (GBM):** Malignant astrocytoma presents with nonspecific complaints due to increased ICP.

Focal deficits appear as it grows larger. Poor prognosis, total resection is difficult, resistant to radiation. Primary has mean age of 55y, secondary at 45y. Tx with surgery, then radiotherapy with up to a total dose of 60 Gy. Chemo with carbustine
can be tried. Survival is usually 1-3yrs.

**Ependymoma:** glioma from the ependyma of a ventricle or central canal of the cord. Tx surgery.

**Oligodendrogloma:** Seem in adults, slow growing, see calcifications. Tx is excision.

**Brainstem glioma:** Children, get CN palsies and long tract sign in the limbs. Tx is radiation and shunt.

**Primary Cerebral Lymphoma:** <1% of all primary CNS brain tumors. Most seen with immunodeficiency states. Tx with whole brain irradiation and adjunctive chemo. High dose MTX.

**Medulloblastoma:** Often arising in the 4th ventricle, more common in child. Tx with surgery, chemo and radiation.

**Meningioma:** A “benign” neoplasm. Compresses rather than invades. 20% of intracranial neoplasms. F:M is 3:2. 30% incidental incidence at autopsy. Originates from the dura or arachnoid. Usually benign, often incidental on a CT or skull film (calcification). Lights up with IV contrast. Tx: depends on the site and sx’s. Not all require excision, some can use radiosurgery, may recur in 20%.

**Acoustic neuroma:** see ENT. H-A, tinnitus, vertigo. Check: MRI and brainstem auditory evoked potentials. Excise. Good prognosis.

**Cerebellar Hemangioblastoma:** Can be familial. Have ataxia, inc ICP, dysequilibrium. Tx with surgery.

**Pineal tumor:** Sx’s of inc ICP, some with impaired upward gaze or other midbrain lesions. Tx is shunt and excision.

**Variable prognosis.**

**Craniopharyngioma:** due to remnants of Rathke’s pouch that compresses the optic chiasm. Usually in child, have bitemporal field defects. Surgery.


### Bulbar & Pseudobulbar Palsy:

**Bulbar Palsy:** LMN lesions at either fascicular or nuclear level in the medulla or bilateral CN’s outside brainstem. The tongue is wasted and fasciculating, the palate moves minimally.

**Etiology:** X-linked genetic dz, medullary infarction, degenerative motor neuron dz, syringomyelia, myasthenia, GB-syndrome, polio, Lyme dz, vasculitis, brainstem glioma, malignant meningitis.

**Pseudobulbar Palsy:** UMN lesion at the corticobulbar or pyramidal tracts. The tongue is small and bunched, it moves slowly. Brisk jaw jerk.

**Etiology:** bilateral hemorrhagic (lacunar) infarction, degenerative motor neuron dz, MS, cerebral vasculitis or high brainstem neoplasia.

**Ref:** (Acute bulbar weakness: thyrotoxicosis or myasthenia gravis. Ann Neurol. 1999:46:434-5)

### Neurofibromatosis (NF):

Common neurocutaneous d/o. 97% are NF-1 (peripheral)= von Recklinghausen’s dz, 1:3,000 people. Vs NF-2 (central, no prominent external lesions), 3%. Autosomal dominant, due to deletion from Chromo 22 (50% risk that their offspring will also be affected).

Sx’s: almost any organ can be involved. The dz is progressive and is associated with a predisposition to a malignant state. Sarcomatous degeneration of skin lesions is rare but may occur in extra cutaneous tumors. Cafe au lait spots of NF-1 may be present at birth and may be best visualized under a Wood’s light. Neurofibromas begin to appear at puberty as soft, globoid, and pedunculated tumors that are skin colored or violaceous. Lesions may be large and numerous, causing complications resulting from impingement on surrounding structures.

**Malignant risk:** 3-15% in lifetime, often neurofibrosarcoma (Schwannoma).

**Criteria NR-2:** either bilateral CN 8 masses or a 1st degree relative with NF-1.

**Dx Criteria NF-1:** 2 of the following:

1) ≥6 café au lait macules >5mm in prepubertal, >15mm in postpubertal. Can occur anywhere except scalp/ palms/ soles. They inc in number & size over time.

2) ≥2 neurofibroma.

3) axillary or inguinal freckling.

4) Optic nerve glioma.

5) ≥2 Lisch nodules (iris hamartoma)

6) sphenoid wing dysplasia or cortical thinning of long bones, with or w/o pseudo hemarthrosis.

7) a 1st degree relative with NF-1.

**Tx:** Primarily symptomatic, annual PE and eye exam throughout school years. Check BP 2X/yr, audiology exam before enters preschool, monitor for scoliosis. (Mayo Clin 1998;73:1071-76)

#### von Hippel-Lindau Disease (VHL):

An autosomal dominant disorder causing a tumor predisposition syndrome. Rare, but seen in all ethnic groups, M=F. Like other hereditary cancer syndromes it is due to a germline mutation affecting a tumor suppressor gene. Have benign and malignant tumors in multiple organ systems. Retinal angiomas, hemangioblastomas of the cerebellum and spinal cord, and renal cell carcinomas. Mutations in the VHL gene on chromosome 3p25, the normal VHL protein blocks elongin, a translational control factor.


**Tx:** close surveillance. At risk family members can be offered the option of presymptomatic gene testing.


#### POEMS Syndrome:

S/s: Polynuropathy - combined sensory and motor, osteosclerotic bone lesions (82%), skin abnormalities (58%, hyperpigmentation, hypertrichosis, angiomas), lymphadenopathy (42%), papilledema (37%), hepatomegaly and/or splenomegaly (~25%), ascites 11%, abnormal serum and/or urine M protein (IgA or IgG), scleroderma like changes can occur, thrombocytopenia.

Tx: Plasmapheresis, Corticosteroids, Cyclophosphamide, Methotrexate, Busulfan, Chlorambucil. Tx similar to that for multiple myeloma

(NEJM 1998;338:1601)

Normal Pressure Hydrocephalus (NPH):  

| Link: Pseudotumor Cerebri |

“Symptomatic hydrocephalus”. There diagnosis and treatment are difficult as there are no pathognomonic sx’s and shunt surgery is risky

**Step #3:**

**W/u:** Myelitis, Infectious Myopathy, Drug and Toxin Myopathy, Critical Illness Myopathy (loss of myosin filaments). 

**Ddx: NPH:**

Progressive Multifocal Leukoencephalopathy (PML), diffuse Lewy body dz, multiple sensory deprivation syndrome (neuropathy and visual impairment in diabetes), Alzheimer’s with extrapyramidal features, cognitive impairment and Parkinson’s.

**Classification:**

Dermatomyositis, Inclusion-body myositis (viral?), Granulomatous, Toxin Induced.

**Musculoskeletal Pain:**

S/s: polyneuropathy - combined sensory and motor, osteosclerotic bone lesions (82%), skin abnormalities (58%, hyperpigmentation, hypertrichosis, angiomas), lymphadenopathy (42%), papilledema (37%), hepatomegaly and/or splenomegaly (~25%), ascites 11%, abnormal serum and/or urine M protein (IgA or IgG), scleroderma like changes can occur, thrombocytopenia.

**Laboratory:***

Aldolase (most specific enzyme available for muscle tissue), Lactate dehydrogenase (LDH is the least specific enzyme), Creatine kinase (CPK) (most specific and available for muscle tissue).

**Meds to avoid if ICP:**

Hydralazine, Na-nitroprusside, ketamine, CCB (nicardipine, nimodipine), halogenated anesthetics (halothane, isoflurane).

**Ref:**

Diagnosis and management of normal-pressure hydrocephalus. J Neurol 2000;247:5-14)

**Diagrams:**

Upper-front Dermatomes & Cutaneous nerves: Upper-back; Lower-front; Lower-back Sensory Patterns: Pyramidal Tract Dzt: Brachial Plexus; Carpal Tunnel Injection: Cerebral Circulation Diagram: Migraine: Cervical radicular pain diagram: Lumbosacral Root Compression Diagram: Piriformis Syndrome: Sacroiliac Dysfunction: 

**Myositis:**

**Myopathies:**

Inflammatory Muscle Disease: Rare overall, marked by a lymphocytic infiltration of the muscles. Commonly present with pain and proximal muscle weakness, difficulty climbing stairs or combing hair. Main types include: Polymyositis, Dermatomyositis, Inclusion-body myositis (viral?), Granulomatous, Toxin Induced.

Classification: inflammatory (dermatomyositis), infective (trichinosis, viral, toxo), Muscular Dystrophies (Duchenne, Becker, Limb Girdle), metabolic (carnitine def, glycogen storage dz), Endocrine (thyroid, adrenal), Spinal muscular atrophies.

The first step is to determine if the weakness is true muscular weakness or from the perception of "weakness" due to other problems such as anemia, arthritis, CHF, neuropathy or deconditioning. Once weakness is confirmed via manual resistive testing consider and inflammatory myopathy. Next consider if it is due to a viral illness, trauma, IM injection, ischemia (compartment syndrome). If true weakness get a neurology eval. There are many causes of inflammatory muscle diseases:


W/u: Step #1: ESR, LFT and CPK (quickest and most sensitive for muscle disease).

Step #2: ANA (+uncommon except in overlap syndromes), consider obtaining anti-U1-RNP if ANA is positive. Anti-Jo1 and other anti-RNA synthetase Ab’s. Anti-GAD Ab’s associated with stiff man syndrome.

Step #3: Aldolase (most specific enzyme available for muscle tissue). Lactate dehydrogenase (LDH is the least specific enzyme).
enzyme available). Myoglobinuria (+ urine dipstick hemoglobin with no or few RBC’s on microscopic).

**Step #4:** Electromyographic (EMG), may see small amplitude, short duration, polyphasic motor potentials or spontaneous fibrillations with positive spike waves at rest or increased spontaneous spike waves and irritability. Nerve Conduction Studies and MRI may be useful (see inc T2 signal in inflamed areas with true inflammatory disease, may distinguish between inclusion body myositis and others). Muscle biopsy - Gold Standard for Diagnosis.

**Ddx:** Hypokalemia (also with periodic paralysis), Hypo/hypercalcemia, Hypophosphatemia, Hypomagnesemia, Drugs and Toxins, Alcohol, Cocaine, Viral (coxsackievirus, EBV, influenza, HIV, echorovirus), Bacterial (staphylococci, streptococci, clostridia), Parasitic (toxoplasmosis, trichinosis, schistosomiasis, cysicercosis) Rheumatologic (Polymyalgia rheumatica, Mixed Connective Tissue Disease, Scleroderma, Undifferentiated CTD, Vasculitis, SLE, RA), Neuromuscular (Muscular Dystrophy) Peripheral Neuropathy (Guillain-Barre, Diabetes mellitus, porphyria, B12 Deficiency), Neuromuscular Junction Disease (Myasthenia Gravis and Eaton-Lambert Syndrome), Amyotrophic Lateral Sclerosis, Endocrinopathy (Cushing’s, Addison’s, Hyper/hypoparathyroidism, Metabolic Myopathy).

**Ddx of Dermatomyositis:** HIV (at onset of immunodeficiency), lichen planus, polymorphous light reaction, psoriasis, SLE, seb derm, alcohol, contact dermatitis, trichinosis, drug SE (Penicillamine, Nifuric Acid, Phenylbutazone, Hydroxyurea, Pravastatin, Clofibrate, ipecac).

**Myopathies by Lab Values:** to reach a tentative diagnosis without need for muscle bx. Patients who should not be analyzed by algorithm include pt’s with h/o active heart dz, pt’s with a h/o of recent surgery or trauma, pt’s with a h/o concurrent malignancy, pt’s with a h/o receiving immunosuppressive therapy. These pt’s need a muscle bx to reach a dx.

**Serum enzymes studied:** CK in U/L, CK-MB, as per cent of total CK activity (by agarose gel electrophoresis), aldolase in U/L. AST in U/L, ratio of CK-to-AST = (CK in U/L) / (AST in U/L), ratio of CK-to-aldolase = (CK in U/L) / (aldolase in U/L).

**Normal or neurogenic atrophy:** CK, AST and aldolase normal.

Duchenne’s muscular dystrophy: CK > 14,100 U/L and AST > 38 U/L.

Atrophic: CK <= 14,100 U/L or AST < 38 U/L (not Duchenne’s), aldolase <= 3.9, or ratio of CK-to-AST <= 0.7 (not myopathic).

Polymyositis: CK <= 14,100 U/L or AST < 38 U/L (not Duchenne’s), aldolase > 3.9 and ratio of CK-to-AST > 0.7 (myopathic), AST > 50, and CK-to-AST ratio < 40, and CK-MB > 2%.

Myopathy, not otherwise specified (NOS): CK <= 14,100 U/L or AST < 38 U/L (not Duchenne’s), aldolase > 3.9 and ratio of CK-to-AST > 0.7 (myopathic), AST <= 50, or CK-to-AST ratio >= 40, or CK-MB <= 2% (not polymyositis), CK-to-AST ratio <= 44, or CK-to-aldolase ratio <= 124.


**Metabolic Myopathies:**

**Link:** Mitochondrial Myopathy: See: Forearm ischemic exercise test.

Most pt’s with a metabolic myopathy (glycogen storage dz, carnitine palmityltransferase def) have dynamic rather than static symptoms, and therefore usually complain of exercise intolerance, muscle pain, and cramps upon exercise rather than fixed weakness. Nevertheless, some pt’s may develop progressive muscular weakness which is usually proximal, mimicking inflammatory myopathy or limb girdle muscular dystrophy, but is sometimes distal. In a smaller group of patients, both dynamic and static symptoms predominate.

**Muscle phosphorylase deficiency (McArdle disease):** the prototypical glycogenosis: glycogen breakdown is inhibited, which leads to pyruvate shortage and impaired energy output. This autosomal recessive disease presents as exercise intolerance and myoglobinuria in patients older than 15 years. If patients rest briefly after exercise-induced myalgia and stiffness, they can resume activity with better endurance (second-wind phenomenon), owing to increased mobilization and utilization of FFAs and glucose. Fixed muscle weakness may develop later in life. The resting serum CK level is often elevated. The ischemic forearm exercise test shows no increase of venous lactate. Muscle biopsy shows an absence of phosphorylase, the presence of subsarcolemmal vacuoles, and increased glycogen accumulation. The defect is caused by mutations in the muscle isoform of phosphorylase on chromosome 11q13.

**Phosphofructokinase (PFK) Deficiency:** an enzyme with three genetically distinct structural subunits: M, expressed in muscle, heart, and brain; L, expressed in liver and erythrocytes; and P, expressed in platelets. PFK deficiency is an autosomal recessive disease. Distinct mutations in the M subunit, localized to chromosome 1,40 cause myophathic symptoms and chronic hemolysis and an increased serum bilirubin level and reticulocyte count. Because PFK deficiency is a glycolytic defect, the functional consequences of PFK deficiency are similar to those observed in McArdle disease. PFK deficiency should be suspected in patients who experience exercise intolerance, nausea, and myoglobinuria. Fixed muscle weakness may develop later in life. A long history of mild, compensated hemolysis, a high reticulocyte count, and hyperuricemia also indicate PFK deficiency, especially in certain ethnic groups, such as Japanese and Ashkenazi Jews. There is no specific treatment for PFK deficiency. Recently, a ketogenic diet has been advocated.

**Acid maltase deficiency (AMD):** an autosomal recessive glycogen storage disease that is caused by deficiency of alpha-glycosidase, an enzyme encoded in a gene localized to chromosome 17q23. Mutations or small deletions that cause abnormal splicing affect alpha-glycosidase expression. There are three clinical forms of AMD: infantile, childhood, and adult.

The infantile form (Pompe disease) presents within the first few months of life as hypotonia, weakness, and enlargement of the heart, tongue, and liver; respiratory and cardiovascular changes lead to death before 2 years of age. In the childhood form, patients present with a myopathy characterized by delayed motor milestones, proximal muscle weakness, respiratory muscle involvement, and calf enlargement. The disease leads to death by the second decade of life. The adult form of AMD manifests in persons older than 20 years as a proximal muscular weakness that resembles polymyositis or limb-girdle dystrophy. Respiratory muscle weakness may be the presenting symptom in one third of AMD cases in adults.

**Primary and Secondary Carnitine Deficiency:** carnitine is mostly derived from the diet, but 25% is synthesized in the liver from lysine and methionine. Carnitine is crucial for the oxidation of LCFA’s. The burden of carnitine deficiency is dysfunction of the liver, heart, and muscle tissues, which are highly dependent on LCFA oxidation. Primary carnitine deficiency (PCD) results from the absence of functional high-affinity carnitine receptors and the resulting defects in carnitine transport across cell membranes. It is believed that the defects in lipid transport to the mitochondria associated with PCD cause a shift toward the glycolytic pathway. This results in accumulation in the mitochondria of acyl-CoAs that esterify free carnitine to form acyl carnitines. The acyl-CoAs, in turn, are easily released from the mitochondria and excreted in the urine. Pt’s with PCD experience progressive cardiomyopathy, episodes of hypoketotic hypoglycemia (because of hepatic dysfunction), and proximal...
myopathic weakness. Lipids accumulate and form small lipid droplets.

Other: Na channel d/o's: hyperkalemic and normokalemic periodic paralysis (hyperKPP), paramyotonia congenita, and sodium channel or potassium-aggravated myotonia (previously called acetazolamide-responsive myotonia or myotonia fluctuans).

Ca channel d/o's: present as hypokalemic periodic paralysis (hypokPP), an autosomal dominant disease localized to chromosome 1q31-q32 near the gene that encodes the muscle dihydropyridine receptor.

Cl channel d/o's: include the autosomal dominant myotonia congenita (Thomsen disease), which occurs in the first decade of life and is often associated with muscle hypertrophy, and the autosomal recessive myotonia congenita (BMD), which comes later in life and can be more severe. Typical percussion myotonia and generalized myotonia, experienced by the patient as stiffness and hyperreflexia of the legs and buttocks and hyperlordosis, are characteristic findings. Myotonia improves with exercise.

**Inclusion Body Myositis (IBM):**

Chronic idiopathic myositis with similar characteristics as dermatomyositis. M>F (3:1), seen in elderly (>50yo), 15% have an autoimmune dz.


W/u: ESR, aldolase, anti-Jo-1, AST/ALT, LDH, AP, TSH, C, Mg, EMG, muscle Bx. CPK may be normal to 10X. May have neuropathy.

Tx: therapeutic trial of Prednisone 1-2mg/kg/d X6mo, usually poor response. Physical and occupational therapy. Refer to neurology and rheumatology.


**Drug induced Myopathy:**

Clofibrate, Suxamethonium, heroin, amphethamine, Vincristine, alcohol, Guanochlor, Li, Emetine, Cimeditone, Isothearine, PCP, Zidovudine (zidovudine myopathy are proximal muscle weakness, myalgia (predominantly in the thighs and calves), fatigue, myopathic changes on EMG, and elevated serum CK levels, which often increase with exercise), Colchicine, Glucocorticoids, Hydroxychloroquine, Niacin, HMG CoA Reductase Inhibitor ("statin"), Lipoic Acid, Penicillamine, Tripppotyn, Valproate, Zidovudine (AZT). Statins may even cause exertional myalgias with normal CPK levels that is relieved with the cessation of the drug. Most are able to switch to another brand. Prudent to hold the statin if the pt requires a limited course of another drug that is a strong inhibitor of P450 3A4 for a short time.

**Asymptomatic Creatine Kinase (CK) Elevation:**

An enzyme released into the serum when skeletal or cardiac muscle is injured. Mature muscle is mostly MM, heart is mostly MB (CPK-MB).

W/u: Repeat the CK after the pt has not exerted himself for 3-5 days. If still elevated, screen for hypothyroidism (check TSH), hypoparathyroidism (check PTH), electrolyte disturbance (check Chem 17), mild structural (check EMG), and muscle Bx or metabolic myopathies (check ischemic lactate test) and the carrier state of malignant hyperthermia (DNA test). Familial myopathy (check Bx with a “vital” stain).

Ddx: CPK Elevation: metabolic and bone dz. Includes: Tips:

- Heart: AMI, cardiac contusion, post thoracic surgery, PCTA, myocarditis, prolonged SVT, cardiomyopathy (hypothyroid, ETOH), necrosis/infarction of skeletal muscle, DKA, acromegaly, hypoparathyroid, hypothyroid, EBV, flu, echovirus, RMSF, fungal, parasite, peripartum, acute cholecystitis, acute exacerbation of COPD, drugs (ASA, tranquilizer), neoplasia (prostate, breast).

- CK-MB not inc with:
  - angina, PCTA, IM injection, sz, brain injury, pacemaker implantation, pericarditis.

**Pyomysitis:**


S/s: pain and fever. Often have metastatic abscess formation and septicemia.

Ddx: diabetic myonecrosis, sarcoma, contusion.

Tx: surgical debridement and Abx.

**Polymyositis/ Dermatomyositis and Myositis:**

Links: S/s: W/u: Tx: Ddx: CPK Elevation: Metabolic and Bone Dz: Approach to Myositis:

Polyomysitis & dermatomyositis are rare inflammatory myopathy. DR3 predisposes. F>M. May be associated with ILD, malignancy (paraneoplastic, rare), vasculitis, CTD (25% of cases). Ave age is 40yo, associated with malignancy if age >55yo. Juvenile form peaks age 5-8 & 10-14yo.

- There are 7 basic types of myositis: Adult polymyositis, Adult dermatomyositis, juvenile polymyositis/dermatomyositis, myositis associated with cancer, myositis associated with other connective tissue disease ("overlap syndrome"), inclusion body myositis and amyopathic dermatomyositis (affects only the skin).

- S/s: variable presentation. Often (55%) with an insidious onset of myalgias, proximal > distal muscle weakness, usually occurs first in the legs/hips (difficulty arising from a chair). Skin manifestations in 35% adults & 95% of children → violent macular erythema symmetrically distributed. 30% (usually child/young adult) have subacute onset (over 2-6wks) with pain and constitutional sx's. 10% just have insidious proximal muscle weakness over 1-10yrs. 5% have proximal myalgias alone. 1% have rash alone.

- Helioprote rash: red-purple edematous erythema (macular) on the upper palpebra purplish, with periocular edema.

- Gottron papules: flat-topped raised nonpruritic keratotic papules (or macules) found over dorsal (extensor surface) of IP & MCP, elbow or knee joints (virtually pathognomonic).

- Shawl sign: erythematous rash in a V-distribution on the chest and across posterior shoulders.

- Other skin: periangual telangiectasias, occasionally get calcinosis cutis, poikidermia atrophicans vasculare. Rare to get erythoderma, lichen planus, vasculitis, panniculitis, hypertrichosis, vulvar/scarotal involvement. No rash in polymyositis, which is more common in childhood. Arthralgias in 60%, but usually mild. May get muscle calcification with chronic dz. Calcification cutis is more commonly seen in children, develop dystrophic calcification in the soft tissue & muscles leading to skin ulceration, secondary infection and joint contractures. Conduction defects and tachyarrhythmias are common.

Restrictive lung dz from respiratory muscle weakness in 8%.

W/u: ECG to r/o AVB. CPK (often 3-5X normal, up to 50X), ANA (70%), ALT, AST, LDH, aldolase (all these enzymes inc).
Consider muscle Bx on the affected muscle, can use MRI to localize affected regions. Aldolase is less specific for myositis than CPK as it is in hepatocytes and erythrocytes as well. ESR (inc in 50%, but no correlation with activity), RF inc in 20%.


**Musculoskeletal Pain:**

Psychogenic rheumatism refers to several conditions that may produce pain (Myalgias) without objective findings. It is a diagnosis of exclusion. Soft tissue rheumatic pain (STRP) conditions are common in pain clinics. One must first r/o reflex sympathetic dystrophy (RSD, see neuro section). Commonly seen are myofascial pain syndromes (MPS), fibromyalgia syndrome (FMS), closely related is chronic fatigue syndrome (CFS). The basic clue to any somatofacial condition is the overwhelming disability that is out of proportion to physical findings.

**Ddx of Diffuse Musculoskeletal Pain:** RA, spondyloarthopathy, Lyme dz, SLE, vasculitis, polymyositis/dermatomyositis, polymyalgia rheumatica, eosinophilia-myalgia), hyper/hypothyroidism, osteomalacia (DEXA scan), chronic fatigue syndrome, psychogenic rheumatism, silicone implants, SLE, enthesopathy syndrome, drugs (alcoholic-cocaine-heroine myopathy, statins, Penicillamine, corticosteroids), electrolyte disturbances. Must r/o metastatic cancer, pre-leukemia, syphilis, Paget's, osteoporosis and neuropathy.

**W/u:** ECMP, CPK, TSH, CBC, U/A, ESR. Consider muscle Bx, lactate level, EMG, MRI, works better for dermatomyositis. U/S. See chronic fatigue syndrome w/u.

**Active:** causes pain at rest and it TTP with referred pain.

**Latent:** no spontaneous pain, but may restrict movement or cause muscle weakness. If there is no zone of referred pain then called a tender spot (point).

**PP:** faulty microanatomy caused by acute or chronic overload of a muscle, with a variety of stress inducing stimuli (emotional or physical) implicated in the onset. The power of the stressors is modulated by genetics, personality, conditioning and physiologic state. It may act as a translator of stress (emotional or physical) implicated in the onset. The power of the stressors is modulated by genetics, personality, conditioning and physiologic state. It may act as a translator of stress (emotional or physical)

**PE:** palpable, firm, tense rope-like band in the muscle. There may be a local zone of tenderness surrounding. May have a local twitch response to tapping the muscle, dec ROM, weakness w/o atrophy, no sensory deficits. Locate by searching painful area with the tip of the finger. Mark the point with a pen, and restart the search. (Variability in the site of max tenderness speaks against a true TP. )

**Tx:** tx the most sensitive points first. Some require more than one injection, avoid >3 injections to one area as need to reassess contributing factors such as posture, ergonomics or overuse injury. Must r/o above pathology 1st and only treat if sx's are localized to the muscle.

**Code:** 20550, complete documentation is critical to need as established a medical necessity, such as the fact that the pt's condition is marked by substantial pain & functional disability or conservative therapy has failed and there is a strong likelihood injections will help. Record the degree of relief the pt gets.

**Risks of injections:** PTX, skin infection, bleeding, nerve injury.

**Injection Procedure:**

**Equipment:** gloves, gauze pads, alcohol pad, 3-5ml syringe. Lidocaine 1% w/o epinephrine 1:200,000 1%

Adhesive bandage. Consider PO Diazepam 5mg 30-60 min prior if marked pain or mild-moderate anxiety.

**Contra:** systemic illness (especially if febrile), bleeding diathesis or anticoagulation tx, cellulitis overlying the area, high
anxiety, Hx of syncopal reaction to injections, suspicion of a nerve root lesion, malingering is suspected, allergy to anesthetic, acute muscle trauma.

**Complication:** vasovagal syncope, skin infection, PTX (never aim at an intercostal space), needle breakage (never insert to hub), hematoma (avoid by direct pressure after inj for 2min).

**Step #1:** Have pt laying down to minimize vasovagal reaction. Consider a cold pack to injection site for 5min.

**Step #2:** Use 5ml syringe, 22-25g, 1.5-2 inch needle, antiseptic prep. + skin wheel of local anesthesia. 1ml of 40mg triamcinolone/ 0.5ml Marcaine/ 1ml 1% Lidocaine

**Step #3:** Stabilize the area with your second and third fingers of your nondominant hand. Warn the pt they may feel a sharp pain. Point of entry should be at point of maximal tenderness. Lightly rub area as give injection. Consider using a vapo-coolant (ethyl chloride or fluoromethane) that is sprayed until the skin is slightly frosted, then the needle is inserted. An alternative is to pinch the skin in the area to be injected (to distract the sensory pathways) followed immediately by needle insertion. Once the needle reaches the taut band, a fibrotic type of resistance (gritty, sandpaper-like) is felt. Aspirate (withdraw plunger) to confirm a nonvascular site. If severe cramping or paresthesia occurs, reposition as may have nerve penetration.

**Step #4:** Once in position inject 0.2ml, then re-position as inject a total of 0.5-2ml using a fanning technique (Repeatedly withdrawing part of the way and redirecting.) No more than 1ml for areas per day.  Apply pressure over site for 2min. Once done have pt stretch the area immediately, then active ROM exercises TID.

**Max injection:** 3ml to head, neck, hand, feet. 4ml for trunk muscle. 5ml shoulder. 10ml lumbar paraspinal or gluteal. Most effective when pt feels an intense pain at time of injection, leading to >80% persistent relief for months or permanent in 50%. Can use 0.25% Bupivacaine and Eridocaine or NS or dry injection. Can repeat 2-5 times at weekly intervals. Apply moist heat after injection 20min, instruct pt to perform active ROM TID, avoid heavy use of the site for 3 days. Stretching and relaxation breathing exercises.

**Needing:** repetitive insertion & withdrawal of 22-25-g 1.5 inch needle to mechanically break up fibrotic pockets. Can be done "dry" or using a local anesthetic.

**Home Trigger Point Tx:** Pt lay supine on top of a golf ball on a carpeted floor for 20-30 sec per pressure point. Can use a tennis ball against a wall all standing if it place it in a long sock to control the location as it hangs over the shoulder. Best to use a soft (old) ball. Expect an initial increase in sx’s then an easing of the pain.


**Acute Spinal Cord Injury:**

**Links:** Incomplete Cord Injury: C-Spine: Neck Pain: Vertebral Body Frx's: Whiplash: Low Back: Sensory Patterns:

Assume that every pt with multiple trauma or head injury has a spina cord injury. Control the airway, give O2. Nasotracheal intubation is preferred. Treat neurogenic shock with fluids & Dopamine. Immobilize the unstable C-spine.

**Neuro assessment:**

- **Saclral sparing** → preservation of sensation in perianal region (2nd-4th sacral vertebrae)
- **Tx:** If obvious neurologic spinal cord deficit give Methylprednisolone IV bolus @ 30mg/kg, then 5.4 mg/kg infusion X 23 hours if able to initiate within 3hr or X48hr if initiate within 3-8hrs of injury. This enhances blood flow to the cord and suppresses lipid peroxidation/ hydrolysis and vasoactive by products from damaging membranes. Transfer to spinal cord injury unit ASAP. DVT prophylaxis with pneumatics or heparin. Prevent pressure sores, Foley, Baclofen for spasticity.

**Thoraco-lumbar Injury:** most stable fx’s are managed conservatively with bed rest and a brace for 8-12 wks. Operative fusion if unstable injury with incomplete cord lesion.

**Complete Cord Transection:** all sensory modalities and reflexes impaired below the level of severance (pinprick loss most valuable), Flaccid (paraplegia, tetraplegia), fasciculations, urinary/ rectal sphincter dysfunction. Sweating, piloerection diminished below the lesion. Genital reflexes lost, priapism common.

**Common Incomplete Cord Injuries:** May have combination of all types. Look for sacral sparing (light touch with cold sensation at anus) as a sign of incomplete damage. All have a better prognosis than complete cord transection.

**Brown-Sequard Syndrome:** Hemisection from penetrating (knife wound), leads to ipsilateral loss of motor (weakness/ vib/ position sense 2 segments below the lesions and contralateral loss of light touch/ pain/ temp (uninjured side).

**Rare recovery.**

**Central Cervical Spinal Cord Syndrome:** hyperextension injury → weakness and flaccid paralysis of UE (face and arms), often with sparing the LE secondary to concentric-lamellar pathways. Prognosis is good (recovery in hours). Vest-like loss of pain & temp. Sacral sparing (implies an intramedullary central cord lesion).

**Anterior Cord/ Spinal Artery Syndrome:** Neck flexion injury/ vertebral burst fx → paralysis, but retain position/vib/pain/temp/touch. May recover.

**Anterior Horn:** pain & temp loss below the lesion, proprioception spared. Flaccid areflexia, fasciculations, urinary/ rectal sphincter dysfunction. No dysautonomias.

**Posterior Cord Syndrome:** loss of proprioception, preservation of power and pain/temp sensation.

**Gait Evaluation:**

**Links:** Evaluation: Common Gait Disturbance: Trendelenburg Test: Crutches: Cerebellar Dz:

**Eval:** Observations to be made: Look at standing balance, head position, arm swing, shoulders, pelvic tilt, thighs, knees, ankle motion, heel position, foot position, swing phase, metatarsals, and overall muscle activity. Does the pt lurch or look uncoordinated (ataxia or cerebellar problem)?

**Static Posture** → While standing, observe the pt’s balance, curvature of the spine, head position, pelvic tilt, flexion of knees and hips, stance base (shoulder width).

**Postural Control & Balance** → Any postural problems. Check Romberg’s test, nudge to the chest or back, bending over, reaching while standing.

**Walking** → sitting & rising from a chair (should not need arms), initiation of gait, coordination of upper & lower limb movements, step length (should be at least the length of the foot), step width/rhythm/density/ symmetry/ velocity, foot-floor clearance and contact, walking path, turning 180 deg, walking on heels/ toes, tandem walking.
Gait cycle→ rate, symmetry, fluidity and consistency. Stride width, length, stance/ swing phase.

Clues to Etiology:
- Difficulty getting up/ down→ myopathy, arthropathy, Parkinson’s, orthostatic, deconditioning.
- Difficulty with neck turn and reaching→ cervical dz; vertebrobasilar insufficiency.
- Unsteady after external nudge→ Parkinson’s, NPH, CNS/ back problems.
- Dec Step height→ CNS dz, sensory deficits, fear.
- Unsteady turning→ Parkinson’s, cerebellar, hemiparesis, visual field deficits.
- Path Deviation→ cerebella, sensory deficits, sensory or motor ataxia.

Common Gait Disturbances:

Ataxia: Wide-based unsteady gait. May be due to cerebellar ataxia, sensory ataxia or other such as frontal lobe lesion (tumor, thrombosis of ant cerebral artery), labyrinth destruction (neoplasm, inflammation, compression), parainfection (GBS, acute ataxia), ataxia, coordinated ataxia, sensory ataxia, sensory or motor ataxia.

Antalgic Gait:
Common with many lower extremity/ spine/ pelvic injuries. Pain in the legs results in the pt “hurrying” to take weight off the painful limb in order to take more weight on the good leg. Limping gait. Pt’s face may show signs of pain or anxiety.

Cerebellar Ataxic Gait:
Feet are separated widely when standing or walking. Steps are jerky and unsure, varying in size, the trunk sways forward. Mild cases may have Tandem Gait: heel-toe walking is impaired, pt falls to one or both sides. Seen in alcoholism, degenerative brain processes (spino-cerebellar atrophy, progressive supranuclear palsy, MS, cerebellar tumors), high doses of 5-FU or cytarabine, paraneoplastic syndrome. Tabes dorsalis, Wernicke’s encephalopathy, vertebral-basilar insufficiency, neoplasm, abscess, infarct, hyperthermia, hypoxic encephalopathy, hypoparathyroidism, ataxic telangiectasia.

Sensory Ataxic Gait:
Disturbed proprioception due to interruption of afferents in the peripheral nerves or spinal cord (posterior columns, spino-cerebellar tracts). The gait appears normal when pt’s eyes are open and looking at feet to walk, although the feet often “stump” on the ground. Romberg’s test and impaired joint position sense. Seen in d/o affecting posterior columns such as B12 def, cervical spondylosis, spino-cerebellar degeneration, cisplatin, paclitaxel, paraneoplastic syndrome, polyneuropathy, tabes dorsalis, MS, Friedreich’s ataxia.

Hemiplegic (Circumduction/ Spastic) Gait:
The leg is extended and the toes forced downward. Triple extension of the hip/ knee/ ankle with the foot inverted. Walk with abduction and circumduction of the hip to prevent the toes from catching on the ground. Some may push the inverted foot along the floor. In paraplegia, strong adduction of the hips can produce a scissor-like posture of the lower limbs. Mild cases may have normal gait with excessive wear at the outer front aspect of the sole of the shoe. Seen in stroke and other focal brain lesions (neoplasia), high spinal cord lesion, abscess, trauma, demyelination.

Parkinsonian (Festinating) Gait:
Flexed stooping posture of trunk and neck. To initiate walking, the pt leans forward, then hurries (festinates) to “catch up” on himself and avoid falling. Symmetric short and shuffling steps (poor ground clearance). Associated movements of swinging the arms are lost.

Steppage (Foot Drop) Gait:
Pt lifts the affected advancing leg high so that the toes clear the ground. When bilateral, it resembles a high-stepping horse. The dorsiflexors of the foot are paralyzed. Seen in LMN weakness of pretilabial and peroneal muscles (CMT dz), nerve palsy, peripheral neuropathy (leg crossing, intermittent pneumatic compression devices, neurotoxins, post radiation), lumbar stenosis, HNP.

Frontal Lobe Gait:
Due to dz in connection between frontal cortex, basal ganglia and cerebellum. Wide based (feet wide apart). Similar to Parkinson’s. Difficulty in initiation, the feet seem to be stuck/ glued to the floor. There is a tendency to fall backwards. Strength and sensation are normal. Seen in normal pressure hydrocephalus, Alzheimer’s and multi-infarct dementia.

Myopathic (Waddling) Gait:
Characteristic of muscle dz. Trunk and pelvic muscle (hip girdle) weakness result in a sway-back, pot-bellied appearance with difficulty in pelvic fixation when walking. Seen in Muscular Dystrophy, severe DJD of the hips, severe proximal muscle weakness (myositis, polymyalgia rheumatica), cerebral palsy.

Hysterical (Bizarre) Gait:
Numerous variations. Inconsistency, lack of neurological signs. Need to observe closely. Grotesque movements are employed. Must exclude other dz’s. Seen in somatiform d/o, affective d/o with conversion reaction, factitious d/o, malingering.

Spastic (Scissors) Gait:
Paraplegia with adductor spasm. The knees are pulled together so the body must sway laterally away from the stepping limb to clear the floor. Bilateral circumduction gait. Seen in bilateral UMN lesions.

Clownish (Choreiform) Gait:
Walking is attended by grotesque movements caused by interruption of purposeless involuntary acts. Basal ganglia dz such as Huntington’s, Sydenham chorea, cerebral palsy.

Senile (Cautious) Gait:
18% of elderly with slow/ abnormal gait. Men→ Flexed posture with wide based, short, shuffling steps that are especially prominent when the pt turns. Women→ narrow-based, waddling. No specific etiology, often a collection of multiple minor defects seen with aging such as visual disturbances, vestibulopathy, knee extension weakness→ muscle resection, hematoma, lumbar plexopathy, femoral neuropathy.

Toe Walking:
tight heel cords, ankle contractures, bilateral pyramidal tract dz. Seen in cerebral palsy, Duchenne’s MD, idiopathic.

Trendelenburg Gait:
Dipping gait, due to weakness of the gluteus medius muscle. (It normally pulls the iliac crest and greater trochanter together when standing to elevate the pelvis on the opposite side) Seen in d/o of the hip such as congenital dislocation, DJD, failed...
arthroplasty. Weak gluteals result in the pelvis dropping below the horizon when standing on the normal leg giving a characteristic waddling gait.

**Trendelenburg Test:**
to test hip stability. Normally the pelvis tilts upward away from the side of weight bearing on standing so that the center of gravity with center over the weight bearing hip. Both iliac crests are felt as the pt stands on each leg in turn w/o support.

**Negative test**— Normal, pt has good strength and hip stability. The iliac crest on the non-weight bearing side tilts up and the body lifts to the side of weight bearing.

**Positive test**— if pelvis sags downwards to the opposite side of weight bearing.

**Causes:** Weak Hip Abductors—paralysis or wasting.

**Damaged hip**— damage between greater trochanter and acetabulum. Seen in fx of the femoral neck, damage to the acetabulum, pain form arthritis.

**Dislocated or absent hip**— no fulcrum for the abductors to work across. Congenital dislocation, absent head or neck of femur (infection, excision), failed total hip replacement due to infection.

**Crutches:**
Adjust ht to one hand breadth below axilla, hand grips so elbow slightly flexed. Partial wt bearing-move bad leg with ipsi crutch, vs non wt bear-alt crutch and bad leg as walk. (Am Fam Phys 1991;43-2)

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**Nausea & Vomiting (N/V):**

**Links:** Tx/ Meds; Ddx:

**Characteristics:** Undigested food —> esophageal lesions or above cardia.

**Non-bilious** —> lesion proximal to pylorus.

**Bilious** —> obstruction beyond ampulla of Vater (2nd portion of duodenum) or adynamic ileus.

**Fecal odor** —> peritonitis or lower obstruction. **Bloody** —> lesion proximal to ligament of Treitz.

**Bright red** —> vomitus has little or no contact with gastric juices. Active bleeding at sight or above cardia.

**Coffee Grounds** —> bloody vomitus altered by gastric juices.

**Chemotherapy Induced Emesis:**
See Hemo-Onc.

**Anti-Emetics:**

See below for Ddx.

**Droperidol (Inapsine):** 2.5mg IV/IM q3-8h PRN (0.625mg IV, may repeat in 30min). Associated with fatal cardiac arrhythmias at high doses (over 25 mg) due to QT prolongation.

**Ondansetron (Zofran):** 4mg IV q8hr PRN. 8mg PO TID if age >12yo. 4mg TID if 4-12yo. For chemo use 0.15mg/kg or 32mg IV over 15min q4-8h PRN.

**Anzemet (Dolasetron):** 100mg PO or 12.5 mg IV qd-q12hr. 5HT antagonist.

**Metoclopramide (Reglan):** 10mg IV/IM q2-3h PRN. 10-30mg PO 30 min qAC and HS.

**Phosphorated Carbohydrates (Emetrol):** OTC. 15-30ml PRN. 5-10ml in Peds.

**Prochlorperazine (Compazine):** [5,10,25; 5mg/5ml elixir. Supp @ 2.5, 5, 25 mg. Inj @ 5mg/ml]. Adults @ 5-10mg IV over 2-5min. 5-10mg PO/IM TID-QID. Peds age >12yo @ 0.13mg/kg/dose. **Contra:** CNS depression, neuroleptic malignant syndrome, poorly controlled seizure disorder. **SE:** Sedation, extrapyramidal syndromes (muscle stiffness, dystonia, tardive dyskinesia, akathisia), neuroleptic malignant syndrome, anticholinergic effects, orthostatic hypotension, seizures, blood dyscrasia, sexual dysfunction, p毒ikitherma, decreased gag reflex, tachycardia, confusion, dizziness, amenorrhea, lens opacities, wt. gain. May cause severe sedation & hypotension when given with Demerol.

**Promethazine (Phenergan):** 25-50mg PO/IM/PR. Peds @0.25-0.5mg/kg/dose (max 50mg) PO/IM/IV over 20min or PR q4-6h. (tabs/supp in 12.5, 25, 50mg).

**Trimethobenzamide (Tigan):** 250mg TID-QID PO. 200mg IM/PR q6-8h. Peds @15mg/kg/d or IM/PO/PR q6-8h, 100&250mg caps, 100&250mg supp.

**Granisetron (Kytril):** 10ug/kg IV over 5min, 30 min prior to chemo. 1mg PO BID or 2mg 1h before radiation tx. 5HT3 antagonist —> only work if nausea is due to 5HT release as in chemo.

**Dronabinol (Marinol):** 2.5-5 mg BID-TID. Cannabinoids are effective for pain and nausea, particular if palliative care is needed. Pts express a preference for cannabinoids over other antiemetics despite inc psychotropic effects, similar pain relief as codeine (BJM 2001;323:16-21). Cannabinoid receptor CB1 mediates analgesia via indirect antagonism of NMDA receptors. Antinausea due to it antikinetic effect on the bowel, which may be beneficial for pt's with bowel obstruction or bowel mets.

**Other:** Lorazepam, Metoclopramide.

**Sea sick:** Try 30mg Nifedipine XL qd start 2 days prior.

**Impalnts:** an abdominal implant by Enterra has been approved for chronic drug-refractory N/V secondary to gastroparesis of diabetic or idiopathic etiology. It has intramuscular stomach leads and an implantable pulse generator (IPG) giving an average improvement of 66%

**Ddx N/V:** CNS —> abscess, epilepsy, head injury, labyrinthitis, malignany, Ménière’s dz, meningitis, migraine, motion sickness, pseudotumor, vestibular d/o, tabes, degenerative/ vascular dz.

**Endocrine** —> adrenal insufficiency, diabetic acidosis, inc Ca, hyperparathyroid, pregnancy, thyrotoxicosis.

**GI** —> adhesions, appendicitis, biliary tract dz, carcinoid tumor, cholecystitis, constipation, food poisoning, gallstone ileus, gastroparesis, hepatitis, hernias, infectious gastroenteritis, IBD, intussusception, malignany, Meckel’s diverticulum, motility d/o, pancreatitis, parasitosis, peritonitis, pseudo-obstruction, PUD, superior mesenteric artery syndrome, visceral pain, ZE syndrome, esophageal d/o, parasites.

**iatrogenic** —> chemo, radiation, surgery, meds (narcotics, amniphylline, analgesics, Abx, cardiac glycosides, copper, mercury, ammonium chloride, dig).
**Psychogenic**: anorexia nervosa, anticipatory, anxiety, bulimia, cyclical vomiting, depression, other eating d/o (self induced), schizophrenia, acute psychosis, neurosis.

**GU**: renal colic, UTI, renal malignancy.

**Other**: ETOH, asthma, Graft Vs Host dz, pregnancy, erotic vomiting, CVD.

**Cardiac**: AMI, CHF, pericarditis.

**Heme**: lympoma, pernicious anemia.

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**Step #2:**

Antecubital vein of the arm to be exercised. A single blood sample of CK and sequential samples of lactate, pyruvate, and specific metabolic markers are obtained. This is used to assess aerobic mitochondrial function.

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**Step #1:**

Myopathies

- Selenium, lipoic acid (200mg TID). Prednisone 5-60 mg may give symptomatic improvement in some. (Clev Clin J Med 1988, 50th ed., Rakel, pp5-9, Saunders)

**Feverfew (Tanacetum parthenium):** For prevention migraines @ 0.25-0.75 mg (2-3 leaves/d) BID of 0.2% parthenolide or 125mg/d of Tanacetum. As the quality varies, some manufacturers recommend 100-300mg capsule 1-6X/d. Abrupt discontinuation can exacerbate, chewing leaves can cause oral lesions. Inhibits PGE production, a SHT agonist that inhibits platelet and leukocyte SHT release. May need 2-4mo to take effect. Bitter tasting, should be taken with food. SE: mouth ulcers in 15% with chronic use, rebound H-A, 10% GI upset, cross reacts with Ragweed pollen. Avoid in pregnancy/ lactation, Warfarin use and child <2yo.

**Mitochondria Cytopathies and Mitochondrial DNA D/o's:**

The main function of mitochondria is to provide energy for the cell. Mitochondria contain their own extrachromosomal DNA (mtDNA), which is distinct from nuclear DNA. MtDNA is a circular molecule of ~16 kilobases. Mutations in mtDNA are typically inherited maternally. Classical syndromes have skeletal muscle and neurological dysfunction. 1.5 billion years ago the aerobic mitochondria took up residence in the anaerobic ancestor of the modern eukaryotic cell. 37 mitochondrial genes still encode vital functions.

**D/o's:**


**S/s:**

- Neurological (sensorineural hearing loss, sz, basal ganglia calcification, stroke, ataxia, dementia, peripheral neuropathy, valveular headache), cardiac (conduction disease, dilated cardiomyopathy, myopathy (proximal weakness usually occurs first: myoclonus), ocular (ophthalmoplegias, pigmentary retinopathy, cataracts), endocrine (gynecomastia, diabetes mellitus, short stature), gastrointestinal (liver dysfunction, pancreatic exocrine insufficiency, pseudo-obstruction), other (lactic acidosis, pancytopenia, renal dysfunction, depression).

**Ad:****

May present with weakness and fatigue due to myopathy. Cramping of large and small muscles. May have mild inc CK MM fraction. “Second wind” phenomena where pt experiences pain & muscle cramps at the beginning of exercise, when they slow down or “push through it”, their sx’s diminish, this is pathognomonic for defects in glycogenolysis or glycolysis and should prompt further testing. Myalgias with endurance sports seen with carnitine palmitoyltransferase type 2 (CPT-2) def, fatty acid oxidation defects (FAOD), mitochondrial mtDNA defects and myoadenylate deaminase deficiency (AMPD). Myalgias with power or sprint sports seen with glycogen storage dz (GSDs), and AMPD def. N/V with exercise seen with GSD type 7 and mtDNA defects. Gouty arthritis seen with GSDs.

**Leber hereditary optic neuropathy (LHON):** is an increasingly recognized disease of young adults (the prevalence is higher in men than in women). Patients present with painless, subacute, bilateral vision loss.

- MELAS Syndrome: Syndrome of Mitochondrial Encephalopathy, Lactic Acidosis and Seizures and/or Strokes. It usually develops during childhood, with relapsing remitting course (age always <40 years). 80% of cases have point mutations in tRNA-Leu gene at position 3243. Maternal inheritance is always observed.

**S/s:** stroke-like episodes: hemiparesis, hemianopia and/or cortical blindness may occur. Focal or generalized sz, recurrent migraine-like headaches. N/V, short-stature, hearing loss, muscle weakness.

**Myoclonic Epilepsy (MERRF):** Myoclonic epilepsy with ragged-red fibers. Usually presents in late adolescence or early adulthood.

**S/s:** myoclonus, ptosis, sz, cerebellar ataxia, myopathy, deafness.

**Dx:** Hx, mitochondrial DNA sequencing, presence of "ragged red fibers" on muscle biopsy.

**Leigh Syndrome:** Infancy with hypotonia, seizures, developmental delay, lactic acidosis.

**Leber’s Hereditary Optic Neuropathy:** The most common form of blindness in otherwise healthy young men. Average onset at 23 years of age; 90% affected by age 40.

**S/s:** painless, subacute, bilateral visual loss, central scotomas and abnormal color vision, visual recovery can occur.

**Gluconeogenesis:**

- The process of converting pyruvate or lactate to glucose in the liver in times of fasting or low carbohydrate intake. It requires the availability of amino acids and keto acids as substrates.

**Warfarin use and child <2yo.**

- Warfarin use and child <2yo.

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**Forearm ischemic Test:**

This test may be useful in assessing all patients with exercise intolerance. Demonstration of an absent lactate response and an exaggerated ammonia response to exercise points to glycogen storage disease (GSD) or myoadenylate deaminase deficiency (AMPD). Best performed at a tertiary care center. Metabolic & Mitochondrial Myopathies:

**Step #1:**

Get baseline ammonia & lactate from arm at rest w/o tourniquet. Place and stabilization a needle in a superficial antecubital vein of the arm to be exercised. A single blood sample of CK and sequential samples of lactate, pyruvate, and ammonia are obtained at intervals of 1, 2, 3, 5, and 10 minutes after removal of the blood pressure cuff.

**Step #2:**

Inflate cuff to 200 mmHg (or 20-30 above SBP, some say inflate to an intermediate between the systolic and DBP), and...
then have pt do handgrip exercise with a ball (one hand grip/ second at least 75% of the maximum voluntary hand grip) to fatigue the forearm, most only last ~90sec. If an acute cramp develops, the cuff should be immediately deflated.

**Step #3:** deflate cuff then draw labs again, then repeat draw in 2-5min. A normal response is a 3-fold rise in both lactate and ammonia. In individuals with GSD (McArdles or other carb metab d/o), then ammonia levels rise, but lactate remains at baseline. In myoadenylate deaminase def, the lactate rises, but ammonia does not. Any abnormal result should be confirmed by enzyme analysis. If both normal, consider lipid metab d/o. In normal individuals after a good effort, a three- to fivefold rise in lactate is noted within the first one to three minutes. The rise in serum ammonia is similar, but somewhat slower and more gradual; ammonia reaches a peak at three to four minutes. The rise in lactate is less than twofold among patients with inborn errors of glycolysis/glycogenolysis; however, the increase in ammonia is normal in patients who have made sufficient effort during the test. Lactate production may be absent or diminished in phosphorylase, phosphofructokinase, debrancher, phosphoglycerate mutase, phosphoglycerate kinase, and LDH enzyme deficiencies. In the last condition, there is no rise in lactate levels, but pyruvate levels rise normally. The lactate curve is normal in acid maltase and in most cases of phosphorylase b kinase deficiencies. In patients with mitochondrial myopathies, there may be excessive production of lactate at submaximal levels of effort. With myoadenylate deaminase deficiency, there is absence of ammonia production with normal responses of venous lactate and pyruvate. The level of CK may rise in both glycolenolitic/glycolytic and fatty acid oxidation defects. The forearm ischemic exercise test is normal in defects of fatty acid metabolism as far as the lactate and ammonia curves are concerned.

Nuclear magnetic resonance (NMR) spectroscopy: a noninvasive method for the study of muscle metabolism, limited use since it is unavailable in most institutions. If used, the absence of intracellular acidification during exercise suggests a glycolytic defect. In mitochondrial defects, the ratio of inorganic phosphate to phosphocreatine at rest is elevated, with subsequent years.

**Diagnosing Brain Death:**

Brain death is the lack of brainstem function. With the widespread use of mechanical ventilators, vital functions can now be maintained artificially after the brain has ceased to function. Need to exclude/correct of medical conditions (acid-base d/o, electrolyte imbalance, endocrinopathy).

**S/s:** Does not respond to noxious stimuli (no grimacing). Core body temp >34C. Negligible serum levels of ETOH, CNS depressant drugs. Absence of posturing, shivering, spontaneous movements.

**Reflexes absent:** pain (no motor response to nail bed compression with a pen or supraorbital nerve pinch), corneal blink absent, pupillary (round, mid position @4-6mm, no response to light), oculovestibular (calorics, absence of provoked eye movements), no nococephalic (Doll's eyes) movement, gag. EEG is isoelectric at maximal gain.

**Apnea testing** --- to show that there is no ventilatory movement in the setting of maximal CO2 stimulation (PaCO2 of 60 mmHg) of the respiratory centers in the medulla. This test demonstrates persistent apnea despite hypercapnic stimulation. Pt should be at least 32.2 C and off sedatives.

**Step #1:** Preoxygenate with 100% O2 for 10 min. Separate the pt from ventilator as give O2 into ET at 6-10 L/min (O2 catheter should be at the level of the carina).

**Step #2:** allow PCO2 to rise to at least 60mmHg above baseline as observe for any chest/abd wall respirations (if see respiratory attempts stop the test as no apnea). Check an ABG in ~10-15 min, expect the PCO2 to rise ~2-3 mmHg/ min off the ventilator. 

**Apnea confirmed if:** no spontaneous respirations in 3-8 min and PaCO2 >60 ) (or 20mmHg higher than normal base-line value), +PaO2<55. This documents the irreversibility of the coma if the mechanisms is know (massive stroke/ trauma).

Usually get a neurologist or second physician to concur the dx.

**Confrmatory tests:** optional but recommended if age <1yo. EEG (lack or reactivity to intense stimulation) or caloric, cerebral angiography, transcranial Doppler U/S (lack of diastolic or reverberating flow or absence of flow), cerebral spectroscopy. Absence of intracellular acidification during exercise suggests a glycolytic defect.

**Diagnosing Brain Death:**

**Clinical observations not incompatible with brain death** --- certain spontaneous movements of the limbs, respiratory-like movements w/o significant tidal volumes. Sweating, flushing, tachycardia. Normal BP w/o pharmacologic support. Reflexes commonly intact: DTR, superficial abdominal, triple flexion, Babinski.

**Ddx:** locked-in syndrome (destruction of the pons, should have voluntary blinking and intact eye movement), hypothemia, drug intoxication, Glaulin-Barré syndrome (dx by history of progression over days). (The diagnosis of brain death. NEJM 2001;344:16)

**Conversion D/o:**

Occurrence of sign/sx inconsistent with known anatomy /pathophysiology. Sx’s most commonly are sensory (blindness, numbness) and motor deficits (paralysis, mutism), and pseudo-seizures, the abnormality usually does not have an anatomical distribution and the neurological exam is normal. Pt often has a characteristic lack of concern has been termed “la belle indifference.” Can coexist with depression, anxiety disorders, and schizophrenia and sx’s often will temporarily remit after the disorder has been suggested by the physician. More common in lower socioeconomic groups. See Pseudo neurological disorders in Neuro section.

**S/s:** abrupt onset at any time/ age, often after major stress, not intentionally feigning, they experience sx as genuine.

**Common:** blindness, deafness, anesthesia, paralysis, ataxia, tremor, sz, globus hystericus, syncpe, coma, anosmia, nystagmus, facial weakness. **Course:** episodic or chronic (rare), with spontaneous remission in weeks to months, recurring in subsequent years.

**DSM IV Criteria:**

A. The patient complains of sx’s or deficits affecting voluntary muscles, or deficits of sensory function that suggest a neurological or medical condition.

B. The temporal relation of sx’s a stressful event suggests association of psychological factors.

C. Sx’s are not intentionally produced.

D. Sx’s are not explained by an organic etiology.

E. Sx’s result in significant functional impairment.

F. Sx’s are not limited to pain or sexual dysfunction, and are not produced by another mental disorder.

**Tx:** inform pt gently and nonjudgmental, yet quietly and authoritatively. Confess that although medicine doesn’t know the cause, they tend to recover in a few weeks, sx’s typically last for days to weeks and typically remit spontaneously. Must be supportive with insight oriented or behavioral therapy can facilitate recovery. A knowledgeable physical therapist may provide a “face saving” device. Hypnosis may help, consider anxiolytics and relaxation therapy. Consult psychiatrist.

**Ddx:** true medical conditions, somatization disorder (begins in early life and involves multi-organ, tend to be very concerned).
facultitious disorder (sx’s are under conscious voluntary control, assume a sick role), malingering (presence of external motivations), MS, SLE, PAN, sarcoid, sz, schizophrenia.

Preamble and List of Abbreviations:

Written by Carl G. Weber MD, board certified, Internal Medicine. Any feedback is appreciated:

CGWEBER@POL.NET, http://cgweberMD.tripod.com/Clinical-med/

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Lab Values and Tests:

Common Laboratory Values:

***Most laboratories set their own “normal” ranges, thus check with your own lab. This list is for your convenience to give you a general range, thus use at your risk! No warranty to accuracy or correctness implied or otherwise.

Chem 7 = basic metabolic panel, 17 = comprehensive, which includes electrolytes, renal and liver function tests.

New Medicare Labs:

Electrolyte Panel (4#): Na, K, Cl, CO2.
BMP: #8: Chem 7 (SMA-7) with Ca.
Renal Panel: #10 BMP + Alb & PO4.
CMP #14: BMP + Alb, AP, AST, ALT, Tb, Dbili.
ECMP #17: BMP + Mg, P, LDH.
Hepatic: Alb, Tbili, Dbili, AP, Tp, ALT, AST.

Acetocetate: 0.3-2.0 mg/dl.

Acid phosphatase: 0-0.8 U/ml (0-5.5 U/L).

Acid phosphatase, prostatic: 2.5-12.0 IU/L.

Delta-aminolevulinic acid (ALA): <200 µg/dl.

Alpha-Fetoprotein, serum: <25-40 µg/dl.

Albumin (Alb): 3.0-5.5 g/dl.

Aldolase: 1-6 IU/L.

Alkaline phosphatase (AP): 15-20 years @ 40-200 IU/L (U/L), 20-101 years @ 35-125 IU/L.

Alpha-1 antitrypsin: 200-500 mg/dl.
Aminotransferases: AST (SGOT): 0-35 U/L (IU/L), ALT (SGPT): 0-40 U/L.
Ammonia: 11-45 µmol/L = 80-110 mcg/dL.
Amylase: 0-4.15 mg/dl.
AST: 5-40 IU/L.
Bilirubin: Total @ 0.2-1.2 mg/dl, Direct @ 0-0.4 mg/dl, Indirect @ 0.2-0.7 mg/dl.
Calcium: 8.7-10.6 mg/dl.
Carbon dioxide: 18-20 mEq/L (mmol/L).
Carcinembryonic antigen, serum (CEA): <25. µg/dl.
Carotene (carotenoids): 50-300 µg/dl.
Complement, serum
C3 complement: 55-120 mg/dl. C4 @ 14-51 mg/dl.
Creatinine (Cr): Female adult @ 0.5-1.3 mg/dl, Male adult @ 0.7-1.5 mg/dl.
Creatinine kinase, total (CPK): 20-200 IU/L (25-145 U/L).
C-reactive protein (CRP): 0-3.5 mg/L.
C-peptide: nl = 0.8-4 ng/mL.
CysC: 0.7-1.5 mg/L.
C-peptide: 0.8-4 ng/mL.
Decapeptide: <0.1 mg/dl.
Dehydroepiandrosterone
Males 0.2–2.0 mg/24 h = 0.7–6.9 µmol/d.
Females 0.2–1.8 mg/24 h = 0.7–6.2 µmol/d.
Delta-4-androstenedione: <250 µg/dl.
Delta-5-androstenedione: <250 µg/dl.
Delta-5-androstenediol: <0.25 mg/dl.
DHEA: 1.2-2.0 mg/dl.
DHEA-S: 30-40 µg/dl.
Dehydroepiandrosterone sulphate: <10 µg/dl.
Ferritin: 15-200 ng/mL.
Gamma glutamyl transpeptidase (GGT or GGTP): Male @ 12-38 IU/L, Female @ 9-31 IU/L.
Glucose, serum (fasting, blood sugar = FBS): 70-115 mg/dl. Subtract 15-20% if a plasma value.
Gluco-amylase: 0-440 IU/L.
Histamine: 10-100 ng/ml.
IgG: 700-1500 mg/dl = 6.4–13.5 g/L,
IgA: 70-400 mg/dl = 0.70–3.1 g/L,
IgM: Male = 30-350 mg/dl = 0.90–3.5 g/L,
Iron: 80-150 µg/dl (80-180 mcg/dL).
LDL: 20-220 IU/L.
LDL: 20-220 IU/L.
Leucine aminopeptidase (LAP): 30-55 IU/L.
Lipase: 4-24 IU/dl (49-220 U/L).
Magnesium (Mg): 1.6-2.6 mg/dL.
Manganese: 0.05-0.5 mg/dl.
NAD: 1.5-3.0 mg/dl.
NADH: 0.5-1.5 mg/dl.
Potassium, plasma: 3.1-4.3 mEq/L.
Platelet count: 150-450 x 10^9/L.
Procalcitonin (PCT): <0.5 ng/ml.
Proinsulin: 10-200 ng/ml.
PSA: < 4.0 ng/mL (see Urology section).
Prolactin: 2-20 ng/ml.
Sodium (Na): 136-145 mEq/L.
Sulfate: 0.5-15 mg/dl.
T3 uptake: 25%-45%.
T4 uptake: 40%-50%.
Uric acid: 3.5-8.0 mg/dl.
Vitamin B12: 200-1500 pg/ml.
Vitamin D: 20-60 ng/ml.
Vitamin E: 10-40 mg/L.
White blood cells: 4000-10000 /µl.
Zinc: 0.5-2.0 mg/dl.
T4: 4.11 µg/dl.
Triglycerides (Trig): <60 mg/dL. 2-29 yo @ 10-140 mg/dl, 30-39 yo @ 20-150 mg/dl, 40-49 yo @ 20-160 mg/dl, 50-59 yo @ 20-190 mg/dl, 60-101 yo @ 20-200 mg/dl.
Trop-I: NL <0.4. 0.4-2.0 possible early MI. >2.0 MI likely.
Urea nitrogen, serum (BUN): 2-65 yo @ 5-22 mg/dl.
Vitamin A: 0.15-0.60 µg/ml.
Vitamin B12: 200-850 pg/ml.
Lead, blood
Adults <25 µg / dL <1.2 µmol / L
Children <15 µg / dL <0.7 µmol / L
Lead, urine <80 µg / 24 h <0.4 µmol / d
Mercury, urine <30 µg / 24 h <150 nmol / d
Hematology Labs:
Complete blood count: Male / Female.
Hemoglobin (g/dl): 13.5-18.0 / 12.0-16.0.
Reticulocyte count (%): 0.6-2.6 / 0.4-2.4.
MCV (fl): 82-98 / 82-98.
WBC (x 10^9 cells/L): 4.5-11.0 / 4.5-11.0.
Segmented neutrophils: 1.8-7.7 / 1.8-7.7. Ave %: 40-60 / 40-60.
Bands (cells): 0.0-0.3 / 0.0-0.3. Ave (%): 0-3 / 0-3.
Eosinophils (cells x 10^9/L): 0.0-0.5 / 0.0-0.5. Ave %: 0-5 / 0-5.
Basophils (cells x 10^9/L): 0.0 / 0-0.2. Ave %: 0-1 / 0-1.
Subsets, Whole Blood, Heparinized Antigen(s) Expressed Cell Type// Percentage Absolute Cell Count
CD3 Total T cells 56%–77% //860–1880.
CD19 Total B cells 7%–17% //140–370.
CD3 and CD4 Helper-inducer cells 32%–54% //550–1190.
CD3 and CD8 Suppressor-cytotoxic cells 24%–37% //430–1060.
CD3 and DR Activated T cells 5%–14% //430–1060.
CD2 E rosette T cells 73%–87% //1040–2160.
CD16 and CD56 Natural killer (NK) cells 8%–22% //130–500.
Helper / suppressor ratio: 0.9–1.8.
Monocytes (cells x 10^9/L): 0-0.8 / 0-0.8. Ave %: 2-6 / 2-6.
Coagulation Normal Values:
Template bleeding time: 3.5-7.5 min.
Clot retraction, qualitative: Apparent in 30-60 min; complete in 24 hr, usually in 6 hr.
Coagulation time (Lee-White), in glass tubes: 5-15 min, in siliconized tubes: 20-60 min.
Euglobulin lysis time: 120-240 min.
Factors II, V, VII, VIII, IX, X, XI, or XII: 100% or 1.0 unit/ml.
Fibrin degradation products: <10 µg/ml or titer 1.4.
Fibrinogen: 200-400 mg/ml.
Partial thromboplastin time, activated (aPTT): 20-40 sec.
Prothrombin time (PT): 11-14 sec.
Thrombin time: 10-15 sec.
Whole blood clot lysis time: >24 hr.
Acid hemolysis test (Ham): No hemolysis.
Carboxyhemoglobin: Nonsmoker @ <1%, Smoker @ 2.1%-4.2%.
Cold hemolysis test: No hemolysis.
Erythrocyte life span: Normal @120 days, 51Cr-labeled half-life @ 28 days.
Erythropoietin by radioimmunoassay: 9-33 mU/dl.
Ferritin (serum): Male @ 15-200 µg/L, Female @ 12-150 µg/L.
Folate (serum): Male @ 120-670 ng/ml.
Folate: 5-12 ng/mL.
Fragility, osmotic: Hemolysis begins @ 0.45%-0.38g% NaCl, completed @ 0.33%-0.30% NaCl.
Hemoglobin: 135-150 mg/dl.
Hemoglobin A1C @ 0%-5% of total, A2 by column @ 2%-3% of total, fetal @ <1% of total, plasma @ 0%-5% of total, serum @ 2-3 mg/ml.
Iron: Male @ 75-175 µg/dl, Female @ 65-165 µg/dl.
Iron-binding capacity, total (TIBC): 250-450 µg/dl.
Iron turnover rate (plasma): 20-42 mg/24 hr.
Leukocyte alkaline phosphatase (LAP) score: 30-150. Elevated in polycythemia vera, myeloid metaplasia and some inflammatory diseases. Dec in CML, PNH, Wilson’s dz and occasionally in Hodgkin’s.
Methemoglobin: <1.8%.
Schilling test: urinary excretion of radiolabeled vitamin B12 after “flushing” IM injection of B12 @ 6%-30% of oral dose within 24 hr.
Sedimentation rate: Male / Female. Wintrobe: 0-5 mm/hr / 0-15 mm/hr. Westergren: 0-15 mm/hr / 0-20 mm/hr.
Volume: Male / Female.
Blood: 52.83 ml/kg / 50-75 ml/kg.
Plasma: 25.43 ml/kg / 28-45 ml/kg.
Red cell: 20-36 ml/kg / 19-31 ml/kg.

Differential cell counts of bone marrow:
Myeloid cells: Neutrophilic series: Myeloblasts: 0.3%-5.0%, Promyelocytes: 1%-8%, Myelocytes: 5%-19%.
Metamyelocytes: 9%-24%, Bands: 9%-15%, Segmented cells: 7%-30%, Eosinophil precursors: 0.5%-3.0%.
Eosinophils: 0.5%-4.0%, Basophilic series: 0.2%-0.7%.
Erythrocyte cells: Pronormoblasts: 1%-8%, Polychromatophilic normoblasts 7%-32%, Megakaryocytes: 0.1%.
Lymphoreticular cells: Lymphocytes: 3%-17%, Plasma cells: 0%-2%, Reticulum cells: 0.1%-2.0%, Monocytes: 0.5%-5.0%, Myeloid/erythroid ratio: 0.6-2.7.

Endocrine Labs:

Adrenocorticotropic (ACTH): 15-100 pg/ml
B-HCG levels: 0.2 wks @ 0 - 250 mIU/ml.
4-8 wks @ 100-5000.
8-2 wks @ 8000-100,000.
Calcitonin: Basal @ 0.15-0.35 ng/ml, stimulated @ <0.6 ng/ml.
Catecholamines, urinary:
Epinephrine <10 µg / 24 hr <55 nmol / d
Norepinephrine <100 µg / 24 hr <590 nmol / d
Total free catecholamines = 4-126 µg / 24 h = 24-745 nmol / d
Total metanephrine = 0.1-1.6 mg / 24 h 0.5-8.1 µmol / d
Chorionic gonadotropin (hCG): Pregnancy 1st mo @ 10-10,000 mIU/ml, 2nd,3rd @ 10,000-100,000 mIU/ml. 2nd trimester @ 10,000-30,000 mIU/ml, 3rd trimester @ 5000-15,000 mIU/ml. Nonpregnant @ <3 mIU/ml.
Cortisol: 8 AM @ 5-25 µg/dl, 8 PM @<10 µg/dl.  Cosyntropin stimulation @ >10 µg/dl rise over baseline (30-90 min after 0.25 mg cosyntropin IM/IV). Overnight suppression (8 AM after 1 mg dexamethasone PO at 11 PM) @ 5 µg/dl. Urine @ 20-70 µg/hr.

C-peptide: 0.28-0.63 pmol/ml. Inc in insulinoma, DM 2. Dec in exogenous insulin administration (high insulin levels), DM 1. Formed during the conversion of proinsulin to insulin.

11-Deoxycortisol: Basal @ 0-1.4 µg/dl. Metyrapone stimulation (30 mg/kg PO 8 hr prior to level) @ >7.5 µg/dl.
Epinephrine, plasma: <35 pg/ml.
Estradiol: Estradiol-17-beta, adult females: 30-100 pg/ml, Follicular phase @ <0.9 ng/ml, Luteal phase @ 6-30 ng/ml.  Male @ <2 ng/ml.

17-Oxydrolactone acid (5'-HIAA), urine: 2-9 mg/24 hr.
Insulin, plasma: Fasting @ 6-20 µU/ml. Hypoglycemia (serum glucose <50 mg/dl) @ <5 µU/ml.
17-Ketosteroids, urine: <0.2 pg/ml. 5% during pregnancy, dec after menopause.  Male / Female. Total @ 4-25 µg/hr / 1-500 ng/ml.
Estradiol @ 0-6 µg/24 hr / 0-14 µg/24 hr. Estrone @ 3-8 µg/24 hr / 4-31 µg/24 hr.
Etiocanololone, serum: <1.2 µg/ml.

Follicle-stimulating hormone (FSH): Male @ 2-18 mIU/ml. Female Follicular phase @ 5-20 mIU/ml. Peak midcycle @ 30-50 mIU/ml. Luteal phase @ 5-15 mIU/ml. Postmenopausal @ >50 mIU/ml.
Free thyroxine index: 1-4 ng/dl.

Gastrin, serum (fasting): 30-200 pg/ml.
Growth hormone: Adult, fasting @ <5 ng/ml. Glucose load (100 g orally) @ <5 ng/ml.
Levodopa stimulation test: serum growth hormone after 0.5 g (500mg) levodopa PO while fasting @ >5 ng/ml rise over baseline within 2hr.
17-Hydroxycorticosteroids, urine: Male @ 2-12 mg/24 hr. Female @ 2-8 mg/24 hr.
5'-Hydroxyindoleacetic acid (5'-HIAA), urine: 2.9 mg/24 hr.

Insulin, plasma: Fasting @ 6-20 µU/ml. Hypoglycemia (serum glucose <50 mg/dl) @ <5 µU/ml.
17-Ketosteroids, urine: <8 yo @ 0-2 mg/24 hr. Adolescent @ 0-18 mg/24 hr. Adult Male @ 8-18 mg/24 hr. Female @ 5-15 mg/24 hr.

Luteinizing hormone (LH): Male adult @ 2-18 mIU/ml. Female adult Basal @ 5-22 mIU/ml. Ovulation @ 30-250 mIU/ml. Postmenopausal @ >30 mIU/ml.
Metanephrine, urine: <1.3 mg/24 hr.
Norepinephrine, Plasma @ 150-450 pg/ml. Urine @ <100 µg/24 hr.
Parathyroid hormone: C-terminal @ 150-350 pg/ml. N-terminal @ 230-630 pg/ml.
Pregnadniol, urine: Female Follicular phase @ <1.5 mg/24 hr. Luteal phase @ 2.0-4.2 mg/24 hr, Postmenopausal @ 0.2-1.0 mg/24 hr. Male @ <1.5 mg/24 hr.
Progestosterone: Female Follicular phase @ 0.02-0.9 ng/ml. Luteal phase @ 6-30 ng/ml. Male @ <2 ng/ml.
Prolactin: Nonpregnant day @ 5-25 ng/ml, night @ 20-40 ng/ml. Pregnant @ 150-200 ng/ml.
Radioactive iodine (131I) uptake (RAIU): 5%-25% at 24 hr (varies with iodine intake).
Testosterone, total plasma: Bound in adolescent male @ <100 ng/dl. Adult male @ 300-1100 ng/dl. Female @ 25-90 ng/dl. Unbound adult male @ 3-24 ng/dl. Female @ 0.09-1.30 ng/dl.

Thyroid-stimulating hormone: <10 µU/ml.
Thyroxine (T4): Total @ 4-11 µg/dl. Free @ 0.8-2.4 ng/dl.
Thyroxine-binding globulin capacity: 15-25 µg T4/dl.
Thyroxine index, free: 1-4 ng/dl.
Triiodothyronine (T3): 70-190 ng/dl.
T3 resin uptake: 25%-45%.
Vanillylmandelic acid (VMA), urine: 1-8 mg/24 hr.
Glucocorticoid suppression: overnight dexamethasone suppression test (8 AM serum cortisol after 1 mg dexamethasone orally at 11 PM) @ 5 µg/dl.
Glucocorticoid stimulation: cosyntropin stimulation test (serum cortisol 30-90 min after 0.25 mg cosyntropin IM or IV) @ >10 µg/ml more than or equal to baseline serum cortisol.
Metyrapone test: 8 AM serum deoxycorticisol after 30 mg/kg metyrapone (oral dose) @ >7.5 µg/dl.
Aldosterone suppression: sodium depletion test (urine aldosterone collected on day 3 of 200 mEq day/sodium diet) @ <20 µg/24 hr.
Glucose tolerance test: serum glucose after 100 g glucose PO. 60 min after ingestion @ <180 mg/dl. 90 min @ <160 mg/dl. 120 min @ <125 mg/dl. Add 10 mg/dl for each decade over 50 years of age.

Growth hormone suppression: glucose tolerance test (serum growth hormone after 100g glucose orally after 8 hr fast) @ <5 ng/ml within 2 hr.

Luteinizing hormone (LH) stimulation: gonadotropin releasing hormone (GnRH) test (serum LH after 100 µg GnRH IM/IV) @ 4- to 6-fold rise over baseline.

Thyroid-stimulating hormone (TSH) stimulation: thyrotropin-releasing hormone (TRH) stimulation test (serum TSH after 400 µg TRH IV) @ >2-fold rise over baseline within 2hr.

Radioactive iodine uptake (RAIU): suppression test (RAIU on day 7 after 25 μg tri-iodothyronine PO 4 times daily) @ <10% to <50% baseline.

Commonly Used Abbreviations:

Links: E: J: N: S:

1/2 NS = 0.45% saline solution
5-HIAA = 5-hydroxyindoleacetic acid
5-HT = serotonin
17-OHCS = 17-hydroxcorticosteroids
AAA = apply to affected area, abd aortic aneurysm
ac = ante cibum (before meals)
ABG = arterial blood gas
Ab = antibody
ABI = ankle brachial index (in PVD)
Abx = antibiotics
ac = before meals
ACD = anemia of chronic dz
ACT = activated clotting time
ACTH = adrenocorticotropic hormone
Ad = R ear (aurio dextra)
ad lib = as needed or desired
AD = autosomal dominant
ADH = antidiuretic hormone
ADL = activities of daily living
AF = atrial fibrillation
AFB = acid fast bacillus
AK = actinic keratosis
AP = alkaline phosphatase
AR – autosomal recessive
ALL = acute lymphocytic leukemia
ALT = alanine amino-transferase
am = morning
AMA = against medical advice
AMI = acute myocardial infarction
AML = acute myelogenous leukemia
amp = ampule
AMV = assisted mandatory (mode) ventilation
ANA = antinuclear antibody
ante = before
AP = anteroposterior, alk phos
AR = autosomal recessive
ARB = angiotensin receptor blocker
ARDS = adult respiratory distress syndrome
ARF = acute renal failure
ASA = acetylsalicylic acid, aspirin
ASO = antistreptolysin
AST = aspartate amino-transferase
AVB = atriovenous block
AVM = atrial venous malformation
AVN = avascular necrosis
BAL = blood alcohol level
BBB = bundle branch block
BCC = basal cell carcinoma
BID = bis in die (twice a day)
B12 = vitamin B-12
BM = bowel movement, bone marrow
BMD = bone mineral density
BMR = basal metabolic rate
BMT = bone marrow transplant
BP = blood pressure
BPH = benign prostatic hypertrophy
BS = bowel sounds
BUN = blood urea nitrogen
BSA = body surface area
Bx = biopsy
CA = cancer
Cal = calorie (kilocalorie)
c/o = complaint of
c cum (with)
C/ S or C & S = culture and sensitivity
C = centigrade
Ca = calcium
CAD = coronary artery disease
cap = capsule
CBC = complete blood count
CBT: cognitive behavioral therapy.
CBZ = carbamazepine
cc = cubic centimeter, creatinine clearance
CCB = calcium channel blocker
CCU = coronary care unit
CF = cystic fibrosis
CFU = colony forming units
Chem 7 = basic metabolic panel, 17 = comprehensive, which includes electrolytes, renal and liver function tests.
New Medicare Labs:
BMP = Basic metabolic panel: #8: Chem 7 with Ca.
Renal Panel: #10 BMP + Alb & PO4.
CMP (comprehensive panel): #14: BMP + Alb, AP, AST, ALT, Tb, Dbili.
ECMP (extended) #17: CMP + Mg, P, LDH.
Hepatic: Alb, Tbili, Dbili, AP, Tp, ALT, AST.
cm = centimeter
CMV = cytomegalovirus
CNS = central nervous system
CO2 = carbon dioxide
COPD = chronic obstructive pulmonary disease
CP = chest pain
CPK-MB = myocardial-specific CPK
Cr = creatinine
CrCl = creatinine clearance
CRI = Chronic renal insufficiency = CRI = ESRD
CRF = chronic renal failure = CRI
CSF = cerebrospinal fluid
CT = computerized tomography
CTA = cotton tip applicator
CTD = connective tissue disease
CTX = contraction
CV = cardiovascular
CVA = cerebrovascular accident, costovertebral angle
CVD = cardiovascular disease
CVP = central venous pressure
Cx = culture
CXR = chest x-ray
DA = dopamine
d/c = discharge or discontinue
DSW = 5% dextrose water solution
DBP = diastolic blood pressure
DIC = disseminated intravascular coagulation
Diff = differential cell count
DHPS = dihydropyridine, a CCB
DJD = degenerative joint disease
DKA = diabetic ketoacidosis
dl = deciliter
DM = diabetes mellitus
DNR = do not resuscitate
DOC = drug of choice
DOE = dyspnea on exertion
DOT = directly observed therapy
Doxy = doxycycline
DT's = delirium tremens
DTR = deep tendon reflex
DVT = deep vein thrombosis
Dx = diagnosis
Ddx = differential diagnosis
DUB = dysfunctional uterine bleeding
Dz = disease
EBV = Epstein Barr virus
ECG = electrocardiogram = EKG
ECT = electroconvulsive therapy
EDC = estimated date of confinement (due date)
EE = ethinyl estradiol
EEG = electroencephalogram
EGA = estimated gestational age
ELISA = enzyme-linked immunoabsorbent assay
EM = erythema multiforme
EMB = endometrial biopsy
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emcy</td>
<td>erythromycin</td>
</tr>
<tr>
<td>EPO</td>
<td>erythropoietin</td>
</tr>
<tr>
<td>EPS</td>
<td>extra pyramidal symptoms</td>
</tr>
<tr>
<td>ERCP</td>
<td>endoscopic retrograde cholangiopancreatography</td>
</tr>
<tr>
<td>ERT</td>
<td>estrogen replacement therapy</td>
</tr>
<tr>
<td>ESR</td>
<td>erythrocyte sedimentation rate</td>
</tr>
<tr>
<td>ESRD</td>
<td>End-stage renal dz</td>
</tr>
<tr>
<td>ESLD</td>
<td>End-stage liver dz</td>
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<tr>
<td>ETT</td>
<td>endotracheal tube</td>
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<tr>
<td>ETD</td>
<td>eustachian tube dysfunction</td>
</tr>
<tr>
<td>ETOH</td>
<td>alcohol</td>
</tr>
<tr>
<td>Fb</td>
<td>foreign body</td>
</tr>
<tr>
<td>FBS</td>
<td>fasting blood sugar</td>
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<tr>
<td>F/C</td>
<td>fever and chills</td>
</tr>
<tr>
<td>FEV1</td>
<td>forced expiratory volume (1 sec)</td>
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<tr>
<td>FHT/ FHR</td>
<td>fetal heart tones/ rate</td>
</tr>
<tr>
<td>FiO2</td>
<td>fractional inspired oxygen</td>
</tr>
<tr>
<td>FOB</td>
<td>fecal occult blood</td>
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<tr>
<td>FSP</td>
<td>fibrin split product</td>
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<tr>
<td>FVC</td>
<td>functional vital capacity</td>
</tr>
<tr>
<td>Fx</td>
<td>fracture</td>
</tr>
<tr>
<td>G</td>
<td>gram(s)</td>
</tr>
<tr>
<td>GC</td>
<td>gonococcal; gonococcus</td>
</tr>
<tr>
<td>GBS</td>
<td>Group B Beta Hem Strep</td>
</tr>
<tr>
<td>GFR</td>
<td>glomerular filtration rate</td>
</tr>
<tr>
<td>GH</td>
<td>growth hormone</td>
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<tr>
<td>GI</td>
<td>gastrointestinal</td>
</tr>
<tr>
<td>gm</td>
<td>gram</td>
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<tr>
<td>GN</td>
<td>glomerular nephritis</td>
</tr>
<tr>
<td>gt</td>
<td>drop</td>
</tr>
<tr>
<td>gtt</td>
<td>drops</td>
</tr>
<tr>
<td>GU</td>
<td>genitourinary</td>
</tr>
<tr>
<td>h or hr</td>
<td>hour</td>
</tr>
<tr>
<td>H2O</td>
<td>water</td>
</tr>
<tr>
<td>HA</td>
<td>headache</td>
</tr>
<tr>
<td>Hb</td>
<td>hemoglobin concentration</td>
</tr>
<tr>
<td>HCO3</td>
<td>bicarbonate</td>
</tr>
<tr>
<td>HCG</td>
<td>human chorionic gonadotropin</td>
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<tr>
<td>HCT</td>
<td>hematocrit</td>
</tr>
<tr>
<td>HCTZ</td>
<td>hydrochlorothiazide or hydrocortisone</td>
</tr>
<tr>
<td>HCW</td>
<td>Health Care Worker</td>
</tr>
<tr>
<td>HDL</td>
<td>high-density lipoprotein</td>
</tr>
<tr>
<td>HF</td>
<td>heart failure</td>
</tr>
<tr>
<td>Hg</td>
<td>mercury</td>
</tr>
<tr>
<td>HI</td>
<td>homicidal ideation</td>
</tr>
<tr>
<td>HIV</td>
<td>human immunodeficiency virus</td>
</tr>
<tr>
<td>hr</td>
<td>hour</td>
</tr>
<tr>
<td>HOCM</td>
<td>HCM</td>
</tr>
<tr>
<td>HPF</td>
<td>high power field</td>
</tr>
<tr>
<td>HR</td>
<td>heart rate</td>
</tr>
<tr>
<td>HRT</td>
<td>hormone replacement therapy</td>
</tr>
<tr>
<td>HS</td>
<td>hora somni (bedtime)</td>
</tr>
<tr>
<td>HSM</td>
<td>hepato-splenomegaly</td>
</tr>
<tr>
<td>HSP</td>
<td>Henoch-Schönlein purpura</td>
</tr>
<tr>
<td>HTN</td>
<td>hypertension</td>
</tr>
<tr>
<td>HUS</td>
<td>hemolytic uremic syndrome</td>
</tr>
<tr>
<td>Hx</td>
<td>history</td>
</tr>
<tr>
<td>ICP</td>
<td>intracranial pressure</td>
</tr>
<tr>
<td>IBD</td>
<td>inflammatory bowel disease</td>
</tr>
<tr>
<td>IBS</td>
<td>irritable bowel syndrome</td>
</tr>
<tr>
<td>ICP</td>
<td>intracranial pressure</td>
</tr>
<tr>
<td>IDA</td>
<td>iron deficiency anemia</td>
</tr>
<tr>
<td>ILD</td>
<td>interstitial lung disease</td>
</tr>
<tr>
<td>IM</td>
<td>intramuscular</td>
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<tr>
<td>I &amp; D</td>
<td>incision and drainage</td>
</tr>
<tr>
<td>I &amp; O</td>
<td>intake and output</td>
</tr>
<tr>
<td>IOP</td>
<td>intraocular pressure</td>
</tr>
<tr>
<td>IU</td>
<td>international units</td>
</tr>
<tr>
<td>ICU</td>
<td>intensive care unit</td>
</tr>
<tr>
<td>IgM</td>
<td>immunoglobulin M</td>
</tr>
<tr>
<td>IMV</td>
<td>intermittent mandatory ventilation</td>
</tr>
<tr>
<td>INH</td>
<td>isoniazid</td>
</tr>
<tr>
<td>INI</td>
<td>if not improved, RTC.</td>
</tr>
<tr>
<td>INR</td>
<td>International normalized ratio</td>
</tr>
<tr>
<td>IV</td>
<td>intravenous or intravenously</td>
</tr>
<tr>
<td>IVD</td>
<td>intravenous drug</td>
</tr>
<tr>
<td>IVF</td>
<td>intravenous fluids, in-vitro fertilization</td>
</tr>
</tbody>
</table>
SSC = squamous cell carcinoma
STAT = statim (immediately)
STD = sexually transmitted disease
susp = suspension
T-½ = half life (of a drug)
TCN = tetracycline
TID = ter in die (three times a day)
T4 = Thyroxine level
tab = tablet
TB = tuberculosis
Tbsp = tablespoon
TCA = tricyclic antidepressant
Temp = temperature
TIA = transient ischemic attack
TKO = to keep open, an infusion rate (~500 mL/24h) just enough to keep the IV from clotting, not the same as saline lock or Heplock.
TL = toxic level
TMJ = temporomandibular joint
TMP = trimethoprim
TMP-SMX = trimethoprim-sulfa-methoxazole
TPA = tissue plasminogen activator
TS/ TR = tricuspid stenosis/ regurge
TSH thyroid-stimulating hormone
tsp = teaspoon
TPN = total parenteral nutrition
TSS = toxic shock syndrome
TT = thrombin time
TTP = tender to palpation
Tx = treatment
U = units
UA = uric acid
U/A or Ua = urinalysis
UG = ulcerae collitis
UD = as directed
UDS = urine drug screen (tox)
ug = microgram
UFH = unfractionated heparin
ULN = upper limits of normal
um = micrometer
UO = urine output
URI = upper respiratory infection
UPEP = urine protein electrophoresis
U/S = ultrasound
UTI = urinary tract infection
UV = ultraviolet light
V = vitamin, V-C, V-E, V-B6 etc.
VAC vincristine, adriamycin, and cyclophosphamide
vag = vaginal
VC = vital capacity
VDRL = Venereal Disease Research Laboratory
V fib = ventricular fibrillation
VGE = viral gastroenteritis
VLDL = very low-density lipoprotein
Vol. = volume
VS = vital signs
VSD = ventricular septal defect
VT = ventricular tachycardia
VTE = venous thromboembolism (PE, DVT)
WBC = white blood count
X = times
Yo = years old = years of age.
Zn = zinc