Section B

Leg Weakness Case #2
Leg Weakness Case #3
Coma Case #2
Blurry Vision Case #1
Ataxia Case #1
Neurological Case Review

Leg Weakness Case #2
Neurological Case Review
Leg Weakness Case #2

HPI: A 72 y.o. male with a history of cardiovascular disease presents to clinic with a 6 week history of back pain along with right leg discomfort affecting his thigh and calf muscles. The pain has a burning and cramping quality and occasionally also affects the dorsum of his right foot. It is fairly constant but increases in intensity when he is walking or lying prone. The pain is improved when he is bending forward, such as when pushing a grocery cart or walking up stairs. It has significantly limited his walking distance and he now walks with a limp. He denies any urine or fecal incontinence but is having some hesitancy with initiating his urine stream and is no longer able to sustain an erection.

ROS: No history of back trauma, rashes, weight loss, or night sweats. He c/o some arthritis in his hands elbows and knees.
Neurological Case Review
Leg Weakness Case #2

General Examination:
PE:  T = 98.7, P = 86, BP = 162/87, R = 18, Os sat = 96% on RA
HEENT:  No carotid bruits.  Some slight painful limitation with forward flexion of the neck.  Oropharynx is clear and neck is supple.
Lungs:  CTA, no respiratory distress with good air movement.
CV:  RRR without murmurs, rubs or gallop.  No signs of CHF.  Extremities are well perfused with 2+ distal pulses.
Abdomen:  Soft, non-tender.
Musculoskeletal:  No joint swelling or tenderness.  Moderate percussion tenderness noted over lumbar-sacral spine.  He is bent forward slightly at the waist and has discomfort with extension of his spine.
G/U:  Normal rectal tone and mildly enlarged prostate on digital exam.
Neuro Exam:

**MS:** Patient is alert and fully oriented. Speech is fluent and articulate

**CN:** VA = 20/20 OU. PEERLA. EOMI. Face symmetric. SCM and trapezius strength full. Palate and tongue are midline.

**Motor:** UE’s have normal bulk, tone, and strength.

**Left leg** has slightly diminished tone. Strength is as follows:

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**Right leg** has moderately diminished tone. Strength is as follows:

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**DTR’s:** 2+ at Biceps and Triceps. **Patella:** L = 1, R = 0.

**Ankle:** L = 2, R = 1.

**Plantar Responses:** Flexor bilaterally
Sensory exam:
**Left leg**: Subjective diminished sensation to light touch and sharp over the medial and lateral anterior shin with sparing over the lateral and dorsal foot.

**Right Leg**: Loss of sharp sensation and diminished light touch over the entire leg with sparing of the middle posterior portion of the thigh. Patchy saddle anesthesia to pinprick. Vibration sense is mildly diminished bilaterally at the level of the toes.

Coordination Exam:
No dysmetria or tremor in the arms. Legs have weakness so mild dysmetria on heel-knee-shin may be non-specific.

Gait: Crouched posture with hyperextension of right knee with foot drop worse on the right than the left.
Neurological Case Review
Leg Weakness Case #2
Summarize the Case
Neurological Case Review
Leg Weakness Case #2
Summarize the Case

A 72 y.o. man with a six week history of back pain, along with leg weakness and pain who, on exam, shows weakness affecting several leg muscles bilaterally as well as objective sensory deficits in the right leg and patchy saddle anesthesia.
Neurological Case Review

Localization

- Central vs. Peripheral Nervous System?

Differential Diagnosis
Diagnostic Evaluation and Management
Neurological Case Review

Localization
- Central vs. **Peripheral Nervous System?**
- Muscle, NMJ, Nerve, Anterior Horn cell?

Differential Diagnosis
Diagnostic Evaluation and Management
Neurological Case Review

Localization
- Central vs. Peripheral Nervous System?
- Muscle, NMJ, Nerve, Anterior Horn cell?

“Which Nerves are Involved?”

Differential Diagnosis
Diagnostic Evaluation and Management
His Weak Muscles, Associated Nerves, Roots

**Hip Adduction:** (Hip Adductors), **Obturator N., L2, L3**

**Hip Abduction:** (Gluteus Medius and Minimus, TFL), **Superior Gluteal N., L4, L5 (S1)**

**Hip Flexion:** (Iliopsoas), Femoral N., L1, L2

**Hip Extensors:** (Glut. Maximus), Sciatic N. - > **Inferior Gluteal N., L5, S1**

**Knee Flexion:** (Hamstrings), Sciatic N., S1

**Knee Extension:** (Quadriceps), **Femoral N., L3, L4**

**Dorsiflexion:** (Tibialis Anterior), Sciatic N. - > **Deep Peroneal N., L4**

**Plantar Flexion:** (Gastrocnemius, Soleus), Sciatic N. - > Tibial N., S1, S2

**Foot Inversion:** (Tibialis Posterior), Sciatic N. - > **Tibial N., L4, L5**

**Foot Eversion:** (Superficial and Deep Peroneals), Sciatic N. - > Superficial Peroneal N., L5, S1

**Toe Extension:** (Ext Dig Longus and Brevis, EHL), Sciatic N., - > Deep Peroneal N., L5, S1

**Toe Flexion:** (Intrinsic Foot Muscles), Sciatic N., - > Tibial N., - > Lat. and Med. Plantar N., S1, S2

**DTR’s:** Patellar (Quadriceps), **Femoral N. L3, L4.**

Ankle Jerk (Gastrocs, Soleus), Sciatic N.- > Tibial N S1, S2
Neurological Case Review

Localization

- Central vs. **Peripheral Nervous System**?
  - Muscle, NMJ, **Nerve**, Nerve Root, Anterior Horn cell?

  "Which Nerves are Involved?"

From the Motor Exam:

- **Multiple different nerves** (Superior and Inferior Gluteal nerves, the Obturator nerve, Femoral nerve, Sciatic nerve, Deep Peroneal nerve, and Tibial nerve)
- **Multiple Nerve Roots** involved (mostly L3, L4, L5 with some involvement of S1 with sparing of L1, L2, S2)
- **Bilateral** leg involvement

From the Sensory Exam:

- Subjective and objective **loss of** pin prick and light touch **sensation** over L3, L4, L5 dermatomes
- **Patchy saddle anesthesia** (S1)
Localization???
Localization???
Cauda Equina Syndrome
(Lumbosacral Plexopathy)
Cauda Equina Syndrome Differential Diagnosis

**Toxic/Metabolic:** Diabetes Mellitus, Mucopolysaccharidoses

**Infectious/Post-Infectious/Autoimmune:** CIDP, Inflammatory arachnoiditis, sarcoidosis, TB, VZV, HSV, mycoplasma

**Neoplastic/Paraneoplastic:** *Epidural metastases*, lipoma, teratoma, meningioma, astrocytoma of the cord, carcinomatous meningitis

**Structural:** Occult spinal dysraphism, Paget’s disease, Achondroplasia

**Trauma:** *Spondylolisthesis of the L/S spine, Epidural hematoma*, Fracture of L/S spine

**Vascular:** AVM, Infarction of the L/S nerve roots or conus medullaris, aneurysm of the iliac artery, vascular claudication

**Degenerative/Neurogenetic:** *Spondylosis of the L/S spine, Central disc protrusion, thickening of the ligamentum flavum*
Neurological Case Review

What is your first step in diagnosis?

- **Blood Work**
- **Neuroimaging:**
  - **MRI of the L/S Spine** (for imaging of the ligaments, conus medullaris, cauda equina and soft tissues).
  - **CT of the Spine** (for imaging the boney structures, foramina, vertebral bodies)
  - **CT Myelogram** (if MRI contraindicated)
- **Lumbar Puncture**
- **Neurophysiology:** EMG and Nerve Conduction Studies
  - **Nerve Root Disease:** Abnormal paraspinal innervation. Normal NCV of sural nerve (since lesion is proximal to DRG)
  - **Plexopathies:** Normal paraspinal innervation with abnormal NCV’s of the motor nerves and of the sural nerve
Lumbar spinal stenosis is caused by narrowing of the spinal canal or neural foramina producing root ischaemia and neurogenic claudication. Stenosis of the spinal canal is most often caused by a combination of loss of disc space, osteophytes and a hypertrophic ligamentum flavum.

Not all patients with narrowing develop symptoms.

Lumbar spinal stenosis, therefore, refers to a clinical syndrome of lower extremity pain caused by mechanical compression on the neural elements or their blood supply.

Radiographic diagnosis of spinal stenosis includes an intraspinal canal area of less than 76 mm2 and 100 mm2 to identify severe and moderate stenosis, respectively. However this degree of stenosis may be asymptomatic in up to a third of adults over 60 years.
Many patients with Lumbar spinal stenosis have a normal EMG/NCS evaluation. Patients with fixed clinical symptoms and signs of nerve root injury are more likely to have abnormal EMG/NCS.

Spondylosis is the Greek word for vertebra, and it is a general term for nonspecific, degenerative changes of the spine. Often, spondylosis is a cause of cervical or L/S canal stenosis.
Neurological Case Review

Leg Weakness Case #3
A 54 year old man was referred for progressive weakness over the past 8 months. Weakness began as a foot drop in the left lower extremity, and similar symptoms developed 2 months later in the right leg. The was no history of trauma, pain, paresthesia, or sensory loss. There were no complaints in the upper extremities. Family history is negative for others with muscle or nerve disorders.

General Examination shows normal vitals and is otherwise unremarkable.
Neurological examination:

Mental status:  Awake and oriented.  Speech is fluent and articulate.

Cranial nerves:  VA = 20/20 OU, PEERLA, EOMI without ptosis.  Facial strength is full.  Palate elevates midline.  No tongue weakness or fasiculations.

Motor:  In the upper extremities:  Tone is normal.  There is slight atrophy in the intrinsic hand muscles bilaterally, but strength is normal.

In the lower extremities:  There is spasticity with prominent wasting and fasiculations in all muscles below the knees.  There is mild weakness in hip flexion, extension, abduction and adduction.  Exam of the more distal muscles shows marked bilateral foot drop as well as weakness of plantar flexion, ankle inversion and eversion.

Reflexes:  normal in upper extremities.  Pathologically brisk in the lower extremities with clonus at the ankles and extensor plantar responses bilaterally.

Sensory exam:  normal to light touch, temperature and vibration.

Coordination:  No tremor, or dysmetria in UE’s.  No ataxia.

Gait:  slow, spastic, and slapping (high stepping).
54 year old man with slowly progressive leg weakness, in the absence of sensory symptoms, who on neurological exam shows marked bilateral foot drop with distal atrophy, fasciculations, hyperreflexia, and spasticity in the legs along with extensor plantar responses.
Neurological Case Review

Localization

Central vs. Peripheral Nervous System?

Differential Diagnosis
Diagnostic Evaluation and Management
Neurological Case Review

Localization

Central and Peripheral Nervous System

Differential Diagnosis
Diagnostic Evaluation and Management
Neurological Case Review

Localization
- **Central and Peripheral** Nervous System
  - **Central Nervous System**
    - Spinal Cord, Brainstem, Cerebellum, Basal Ganglia, Subcortical Structures, Cortex?
  - **Peripheral Nervous System**
    - Anterior horn cell, peripheral nerves, NMJ, muscle?

Differential Diagnosis
Diagnostic Evaluation and Management
Neurological Case Review

Localization
- **Central and Peripheral Nervous System**
  - **Central Nervous System**
    - Spinal Cord, Brainstem, Cerebellum, Basal Ganglia, Subcortical Structures, Cortex?
  - **Spinal Cord**
- **Peripheral Nervous System**
  - Anterior horn cell, peripheral nerves, NMJ, muscle?
  - Anterior Horn Cell (and motor neurons)

**Upper versus Lower motor neuron findings**
- **LMN findings**: Atrophy in the intrinsic hand muscles, weakness in proximal and more in distal leg muscles, fasciculations in the lower extremities.
- **UMN findings**: brisk deep tendon reflexes, extensor plantar reflexes.
Neurological Case Review

Differential Diagnosis
Toxic/Metabolic:
Infectious/Post-Infectious/Autoimmune:
Neoplastic/Paraneoplastic:
Structural:
Trauma:
Vascular:
Paroxysmal:
Degenerative/Neurogenetic:
Psychiatric:
Differential Diagnosis Top Considerations

Toxic/Metabolic: Copper deficiency, B12 deficiency, Radiation

Infectious/Post-Infectious/Autoimmune: HTLV1, HIV, Tabes Dorsales, Lyme disease, Transverse Myelitis (CIS, MS, NMO)

Neoplastic/Paraneoplastic: Tumor (Astrocytoma, Ependymoma, Teratoma, Spinal or Epidural Mets), Paraneoplastic Myelopathy

Structural: Spinal Stenosis

Vascular: AVM

Paroxysmal: N/A

Degenerative/Neurogenetic: Hereditary spastic paraparesis (HSP), Progressive Bulbar Palsy, Amyotrophic Lateral Sclerosis, Primary Lateral Sclerosis)
Neurological Case Review

Diagnostic Evaluation

**Blood Work:**  B-12, Homocysteine, and MMA levels, HIV

**Neuroimaging:** MRI Brain, Cervical and Thoracic Spine

- MRI Brain: May demonstrate atrophy in a frontotemporal lobar pattern. MRI cervical and thoracic spine done to rule out myelopathy.

**Neurophysiology:** EMG and NCS

- Confirm the presence of active denervation, chronic denervation and fasciculations in multiple muscles innervated by multiple segments of the spinal cord- pattern consistent with ALS.
- Rule out abnormal sensory potentials-suggestive of Kennedy syndrome.
- Rule out large decremental responses-consistent with Myasthenia Gravis (in cases of bulbar involvement).
- Provide insight to the rate of progression of the disease.
- Rule out demyelinating polyneuropathy with conduction block.
Neurological Case Review

Results of evaluation in our patient:

- **MRI of the Brain and Spine:** Normal

- **NCS:** Shows normal sensory potentials. Motor potentials shows reduced amplitudes secondary to axonal loss.

- **Electromyography:** Shows evidence of active denervation in all muscles of the lower extremities manifesting as fibrillations and fasciculations. There is also evidence of chronic denervation with reinnervation manifesting as large amplitude, long duration, polyphasic motor unit potentials with decreased recruitment.
Amyotrophic Lateral Sclerosis.

- Uniform worldwide distribution
- Annual incidence is 1-2 per 100,000
- Most common age of onset 40-60 years of age
- Men more often affected than women
- Patients die on average 3-5 years from time of diagnosis. 10% of patients survive 10 years or more
  - In at least 90% of cases ALS is a sporadic disease (10% of cases are inherited). Motor neurons control voluntary muscles
ALS

- Earliest symptoms of twitching, cramping, or stiffness may be overlooked.
- The part of body affected first depends on which muscles are denervated first.
- Subsequent contiguous spread from site of onset.
- Rate of progression varies in different individuals, however eventually all patients develop severe weakness of limb muscles causing quadriplegia, pharyngeal muscles causing impaired ability to eat, and respiratory muscles causing inability to breath unassisted.
Neurological Case Review
Treatment

- **Riluzole**
  - Prolongs survival for several months and extends time before need for ventilatory support

- **Symptomatic and supportive treatment**
  - Best delivered by multidisciplinary team (physicians-neurologists & pulmonologists, occupational, physical, and speech therapists, nutritionists, social works, home care and hospice nurses)
  - Medications can be prescribed to treat fatigue, muscle cramp and stiffness, excessive saliva, pain, depression, sleep disturbance.
  - Appropriate devices such as ramps, braces, and wheelchair
  - Respiratory assistance (BiPAP or IPPV)
ALS Pearls and Pitfalls

- There is no test that definitely diagnoses ALS.
- ALS is a clinical diagnosis.
- 40% of cases start in limbs. 20% of cases start in bulbar region.
- If the legs are affected first the patient may complain of tripping. If the arms are affected first patient may complain of difficulty turning a key. If bulbar muscles are affected first patient may complain of slurred speech or difficulty swallowing.
- Other causes of progressive muscle weakness must be excluded.
- Full medical history with attention to rate of progression and family history.
- Neurological examination.
  - UMN signs (spasticity, increased reflexes, Babinski signs) and LMN signs (weakness, atrophy, fasciculations) in same muscle regions
  - No sensory abnormalities
Neurological Case Review

Coma Case #2
63 year old male suddenly collapses while jogging in Audubon Park. A bystander finds him unconscious and without a pulse. He initiates CPR and summons an ambulance. When EMS arrives he is found to be in ventricular fibrillation. Return of spontaneous circulation (ROSC) is re-established. He is intubated on the scene. On arrival to the ED he remains comatose with absent pupillary reflexes. Hypothermia protocol is initiated, achieving a core temperature of 34°C in 4 hours, which is maintained for 24 hours. The patient was then rewarmed, weaned off sedation and paralytics. After 36 hours of normothermia, he remains unresponsive.
Physical Exam: T = 97.8, BP = 160/73, P = 64, R = 21

HEENT: No signs of external head trauma. Eyes closed. Neck supple. Endotracheal tube is in place.

Neurological Exam:

MS: Patient is unarousable to deep noxious stimulation. GCS 3T (Eyes: 1 = won’t open to pain, Motor: 1 = no response to pain, Verbal = ETT = T, Total GCS = 3T)

CN: Pupils 3mm, sluggishly reactive to light. EOMI to doll’s eye maneuver, corneal reflex is intact, gag reflex is intact to deep suction. Breaths over ventilator setting.

Motor: No response to painful stimuli. DTR’s are present but diminished, plantar responses are extensor.

Sensory: No response to painful stimuli.
Neurological Case Review

Summarize the Case

63 year old male status post cardiac arrest and hypothermia protocol who remains comatose with preserved brainstem reflexes and a non-lateralizing neurological examination.
Neurological Case Review

Localization
- Central vs. Peripheral Nervous System?
Neurological Case Review

Localization

- **Central** vs. **Peripheral Nervous System**

Differential Diagnosis
Diagnostic Evaluation and Management
Neurological Case Review

Localization

- **Central** vs. Peripheral Nervous System
  - Spinal Cord, Brainstem, Cerebellum, Basal Ganglia, Subcortical Structures, Cortex

Differential Diagnosis
Diagnostic Evaluation and Management
Neurological Case Review

Localization

- Central vs. Peripheral Nervous System
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Differential Diagnosis
Diagnostic Evaluation and Management
Neurological Case Review

Localization
- Central vs. Peripheral Nervous System
  - Spinal Cord, Brainstem, Cerebellum, Basal Ganglia, Subcortical Structures, Cortex

Differential Diagnosis Top Considerations

Toxic/Metabolic:  sedative medications and drugs, hypoxia, hypoglycemia, hyperglycemia, hyperosmolar states, hyponatremia, heavy metals, renal failure, liver failure, hypercapnea, porphyria,

Structural:  Herniation syndromes, hydrocephalus, cerebral edema

Paroxysmal:  Seizures, non-convulsive status epilepticus, post-ictal state

Vascular:  Ischemic or hemorrhagic stroke, SAH, venous thrombosis, hypoxic-ischemia, cerebral hypoperfusion
Neurological Case Review

Diagnostic Evaluation

- Blood Work
  - CMP, CBC, ABG, Toxicology (urine and serum), INR, PT, PTT, CBC

- Neuroimaging
  - CT Brain without contrast (rule out hemorrhage, or hydrocephalus)
  - MRI Brain without contrast

- Neurophysiology
  - EEG for non-convulsive status epilepticus

- Lumbar Puncture
  - CNS Infection, CNS Inflammation

- Other
Neurological Case Review
Diagnostic Evaluation

Blood Work

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<td>Cr = 1.8</td>
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AST = 170, ALT = 120, PT = 15, PTT = 42, INR = 1.57
Albumin = 4.5, Alk P04 = 220, T Bili = 1.6, Ca = 9

ABG: 7.27/28/200/17/-6

Serum and Urine Tox screens: Negative

WBC = 18 (90%PMN, 8%L, 2%M), H/H = 14/36, Plt = 450
Head CT: Interpretation?
Diffuse cerebral edema with hypodensities (infarctions) of the basal ganglia
The Diving Reflex and Watershed Infarctions

Normal cerebral blood flow (CBF) ranges from 50 – 60 ml/100mg/min depending on what part of the brain is being perfused. When CBF drops below 20 ml/100mg/min there is not enough oxygen to maintain voltage gradients and neurons cannot produce action potentials. When CBF drops below 10 ml/100mg/min, irreversible neuronal injury occurs.

When the drop in CBF is slower and more gradual, the diving reflex kicks in and shunts blood to the most metabolically dependent part of the brain (the Basal Ganglia). This process leaves susceptible areas of the cortex lying at the distal ends of perfusion between the ACA and MCA and between the MCA and PCA subject to ischemic injury. This process leads to the watershed zone of infarction.

If, on the other hand, cerebral hypoperfusion is rapid in onset and profound or purely anoxic, the diving reflex does not have time to kick in and the basal ganglia become severely infarcted (as in our patient).
Neurological Case Review
Diagnostic Evaluation

- Blood Work
  - CMP, CBC, ABG, Toxicology (urine and serum), INR, PT, PTT, CBC

- Neuroimaging
  - CT Brain without contrast (rule out hemorrhage, or hydrocephalus)
  - MRI Brain without contrast

- Lumbar Puncture
  - CNS Infection, CNS Inflammation

- Neurophysiology
  - EEG for non-convulsive status epilepticus

- Other
Lumbar Puncture: Yes? No?
Lumbar Puncture: Yes? **No !!!**

Diffuse cerebral **edema** with hypodensities (infarctions) of the basal ganglia.

Why

not?
Neurological Case Review
Diagnostic Evaluation

- **Blood Work**
  - CMP, CBC, ABG, Toxicology (urine and serum), INR, PT, PTT, CBC

- **Neuroimaging**
  - CT Brain without contrast (rule out hemorrhage, or hydrocephalus)
  - MRI Brain without contrast

- **Lumbar Puncture (contraindicated)**
  - CNS Infection, CNS Inflammation

- **Neurophysiology**
  - EEG for non-convulsive status epilepticus

- **Other**
EEG

Showing 1-2 Hz generalized synchronous spike and wave discharges.
Management of **Non-convulsive Status Epilepticus**

**Acute Medical Therapy**

- **ABC’s**
  - Management of **airway**
    - Maintain airway patency, administer O2
    - Intubate if airway/gas exchange compromised, elevated ICP suspected or GCS < 9
  - **Breathing**
    - Give O2 if hypoxic
  - **Circulation**
    - O2 saturation, Blood Pressure, Heart Rate
    - Vasopressor support of BP if SBP < 90 mmHg or MAP < 70
    - Finger stick blood glucose (**Dextrose**)
  - Peripheral IV access
  - Continuous EEG monitoring
Management of Non-Convulsivse Status Epilepticus

**Acute Seizure Treatment**

**Emergent Initial Therapy** (first 10 minutes)

**First line Therapy:** Benzodiazepines (can give second dose after 5 minutes)
- Lorazepam (preferred IV agent)
- Midazolam (preferred IM agent)
- Diazepam (preferred suppository agent)

**Second Line Therapy** (next 40 minutes)
- Fosphenytoin
  - Cardiac monitoring during infusion
  - More neutral pH than Phenytoin (less extravasation injury)
  - Takes time to be converted into active metabolite (phenytoin)
- Phenytoin
- Phenobarbital
Management of Non-Convulsive Status Epilepticus

**Refractory Treatment**

- Move patient to intensive care unit
- Secure airway
- Place two peripheral IV lines or a central line
- Continuous EEG monitoring (to evaluate the response to therapy)

**Medication Options**

- Valproate sodium
- Levetiracetam
- Lacosamide

- **Refractory treatment**
  - Midazolam
  - Propofol
  - Pentobarbital
  - Phenobarbital
  - Ketamine
  - Lidocaine
Most clinical and electrographically seizures last less than 5-10 minutes in duration and seizures that last longer often do not stop spontaneously.

Status epilepticus is defined a seizure lasting 5 minutes or longer (revised working definition). Neuronal damage may occur before the traditional definition 30 minutes of seizing have elapsed.

There is a time-dependent decrease in the effectiveness of AEDs as the seizure continues (pharmaco-resistance).
Convulsive Status Epilepticus
- Defined as convulsions associated with rhythmic jerking of the extremities
- Mortality: at hospital discharge (9-21%), at 30 days (19-27%).

Non-Convulsive Status Epilepticus
- Defined as seizure activity seen on EEG without clinical findings associated with generalized convulsions.
- Mortality: at hospital discharge (18-52%), at 30 days (65%).

Anoxic Brain Injury
- Prognosis of SE after anoxic or hypoxic insult is poor, especially for patients who develop myoclonic SE.
- Seizure activity is common in patients with anoxic-ischemic encephalopathy and may contribute to brain damage and prolonged coma.
Neurological Case Review

Blurry Vision Case #1
HPI: A 34 year-old male presents to the emergency room with a 3 day history of blurred vision in his left eye. He reports seeing a “dark area” of blurry vision that he can still see across in the center of his vision. He also complains of pain with eye movements. He denies any diplopia or any previous visual disturbances in the past.

PMHx: The patient has been healthy and active

Soc Hx: Denies tobacco or drug use. Drinks occasionally. No HIV risk factors.

Medications: None. NKDA

Family Hx: Negative for any neurological disorders.
Neurological Case Review

General Examination

T= 98.7, P= 72, BP= 132/74, R= 18

HEENT: Neck supple, oropharynx clear, no chemosis, proptosis, or external signs of irritation of either eye.

Lungs: CTA

C/V: RRR no murmurs

Abd: Soft, non-tender.

Skin: No rashes

Ext: No arthritis or tenderness
Neurological Case Review

Neurological Examination

MS: Patient is fully alert and cooperative. He follows commands. His speech is fluent and articulate. Concentration and STM intact.

CN: II: VA = 20/20 OD and 20/200 OS.
   Pupils OD: 3mm - 1mm direct. Fixed at 3mm indirectly
   OS: 3mm-> sluggish to 2mm direct. 3mm-> 1mm brisk indirect.

Visual fields normal in right eye. Loss of visual field in left eye with some sparing of the peripheral temporal area. Fundus benign without elevation or erythema of either optic disc.

III, IV, VI: EOMI without nystagmus. + mild pain in the left eye with movement.

V/VII: Sensation and motor strength intact

VIII: Hearing grossly intact AU

IX/X/XII: Gag intact, palate elevates symmetrically, tongue midline

XI: SCM and trapezius strength full
Neurological Examination (cont’d)
Motor: Normal bulk, tone, and strength all 4 extremities. DTR’s symmetric and non-pathological. Plantar responses flexor.
Sensory: Normal light touch vibration and pinprick all 4 ext’s. Romberg negative.
Coordination: No dysmetria or tremor. No truncal titubation.
Gait: Narrow-based and steady.
Neurological Case Review

Summarize the Case
Previously healthy 34 y.o man with subacute visual loss and pain with movement of the left eye over 3 days who on exam shows decreased visual acuity and a relevant afferent pupillary defect of the left eye.
Neurological Case Review
Afferent Pupillary Defect

Light shown into eye with arrow. Shown is a left eye afferent pupillary defect. This suggests that there is reduced input from light reaching the Edinger-Westphal nucleus when light is shined into the left eye and a normal response when light is shined into the right eye.
Neurological Case Review

Localization?

- Central vs. Peripheral nervous System?
Neurological Case Review

Localization?

- **Central** vs. Peripheral Nervous System
Neurological Case Review

Localization?

- **Central** vs. Peripheral Nervous System?
- Spinal Cord, Brainstem, Cerebellum, Basal Ganglia, Subcortical Structures, Optic Nerve?
Neurological Case Review

Localization?

- **Central** vs. Peripheral Nervous System
  - Spinal Cord, Brainstem, Cerebellum, Basal Ganglia, Subcortical Structures, **Optic Nerve**
Neurological Case Review

Differential Diagnosis
Toxic/Metabolic:
Infectious/Post-Infectious/Autoimmune:
Neoplastic/Paraneoplastic:
Structural:
Trauma:
Vascular:
Paroxysmal:
Degenerative/Neurogenetic:
Psychiatric:
Differential Diagnosis Top Considerations

Toxic/Metabolic: Methanol intoxication

Infectious/Post-Infectious/Autoimmune: Iritis, Retinitis, Optic Neuritis

Neoplastic/Paraneoplastic: Retinoblastoma

Structural: Glaucoma, Cataract

Trauma: Retinal Detachment, Traumatic Globe Injury

Vascular: Anterior Ischemic Optic Neuropathy, Amaurosis Fugax

Paroxysmal: Ophthalmic Migraine

Degenerative/Neurogenetic: Leber’s Hereditary Optic Neuropathy

Psychiatric: Conversion Disorder

Amaurosis fugax and retinal detachment = sudden curtain dropping.

Leber’s – maternally inherited (mitochondrial), children to teenage, blurry vision, loss of central vision, over a few months severe deterioration of visual acuity.
Describe what you see
Describe what you see
Neurological Case Review

Diagnostic Evaluation

- **Blood Work:** ESR, CRP, ANA, ENA Panel, NMO antibodies
- **Neuroimaging:** MRI of Brain and Spine with and without contrast with thin cuts through the orbits
- **Lumbar Puncture:** Cell Count, Protein, Glucose, MS Panel (IgG index and synthesis rate, Oligoclonal Bands, Myelin Basic protein)
- **Neurophysiology:** Evoked Potentials
Brain MRI

T2 FLAIR

T2 FLAIR

T1 with Gad
Additional work-up

**Spinal fluid**

**IgG Index:** $\frac{\text{IgG}_{\text{CSF}}}{\text{IgG}_{\text{serum}}}$

$\frac{\text{Albumin}_{\text{CSF}}}{\text{Albumin}_{\text{serum}}}$

**Oligoclonal Bands:** IgG found in CSF and not found in serum
Additional work-up

- Sed-rate normal
- CRP normal
- ANA negative
- ENA panel normal
- Antiphospholipid antibodies negative
- NMO antibodies Negative
Diagnosis: Optic Neuritis

**Treatment (Clinically Isolated Syndrome)**
- IV solumedrol 1g daily x 5 days

**Treatment (Multiple Sclerosis)**
- IV solumedrol 1g daily x 5 days

**Treatment (Neuromyelitis Optica)**
- Plasma Exchange
MS Disease Modifying Treatment

- Multiple treatment options
- **Interferon beta**
  - Avonex, Rebif, Betaseron
- **Glatiramer acetate** (Copaxone)
- Tysabri
- **Oral agents**
  - Fingolimod (Gilenya)
  - Dymethyl-fumarate (Tecfidera)
  - Terflunamide (Aubagio)
Pearls and Pitfalls: Optic Neuritis

**Optic neuritis**
- Subacute (days to weeks) unilateral visual loss with painful eye movements
- Central scotoma
- Resolves gradually
- Frequent initial episode of multiple sclerosis

Risk Factors for MS:
- Abnormal MRI
  - Enhancing lesions indicate active disease
- Positive spinal fluid
- CIS with MRI lesion is high risk for MS (>80%)

Indication for starting Disease Modifying Treatment is RRMS
- Low-dose steroids associated with more frequent relapses after optic neuritis
Neurological Case Review

Ataxia Case #1

A 48 y.o. male with a past medical history significant for poorly controlled HTN, ID-T2DM, and HLD presents to the ED for evaluation of a three hour history of unsteadiness of gait. The patient states that while carrying boxes at work; he suddenly became nauseous and developed a dull, 8/10, left-sided occipital HA that radiated to his neck. Seconds later, he became lightheaded and began to experience “swaying of vision” and unsteadiness of gait. When his coworkers seen he was staggering, they quickly rushed to his aid and called 911. While waiting for the EMS to arrive, he was given an ASA to take with a cup of water. The patient had difficulty swallowing the pill. Twenty minutes later EMS arrived, and the patient felt less nauseous but was noted to have a hoarse voice with drooping of his left eyelid.
Neurological Case Review

Ataxia Case #1

Physical examination showed T= 98.4, P = 109, BP = 230/118, R = 20

HEENT: No carotid bruits, neck supple

C/V: RRR no murmurs. No signs of CHF

Neurological Examination

MS: AO to person, place, time, situation; Speech: hoarse; language: fluent; Memory: 3/3 recall at 3min; Registration: 7 digit span

CN: Left pupil 2.5 constricting to 2mm, R pupil 3.5mm, constricting to 2mm; L ptosis; normal fundoscopic exam, VFFTC, EOMI with R beating horizontal nystagmus, decreased pinprick L V1; decreased L corneal reflex; face symmetric; taste not tested; hearing intact to finger rub; decreased palate elevation on L; normal SCM and trapezius strength; tongue midline

Motor: no drift; 5/5 power throughout; normal tone and bulk

Reflexes: 2 + symmetric reflexes with the exception of 1+ ankle jerks; normal plantar responses

Sensory: diminished pinprick R limbs, intact light touch and vibration

Cerebellum: L hemitaxia with dysmetria, dysdiadochokinesis and ataxic L heel/shin

Gait: unable to stand because of severe dizziness
Neurological Case Review

Ataxia Case #1

Summarize Case
A 48 y.o. male with a history of poorly controlled HTN, T2DM, HLD presenting with a constellation of acute complaints including: L neck/occipital HA, dizziness with associated nausea, and ataxia. Neurological examination reveals L Horner's, R beating nystagmus, hoarseness with decreased L palate elevation, face and contralateral body numbness, and L hemiataxia.
Neurological Case Review

Localization

Central vs. Peripheral Nervous System?

Differential Diagnosis

Diagnostic Evaluation and Management
Neurological Case Review

Localization

- Central vs. Peripheral Nervous System
  - Spinal Cord, Brainstem, Cerebellum, Basal Ganglia, Subcortical Structures, Cortex

Differential Diagnosis

Diagnostic Evaluation and Management
Localization

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Differential Diagnosis

Diagnostic Evaluation and Management
Lateral Medullary Syndrome (Wallenberg Syndrome)
# Features of Lateral Medullary Syndrome

<table>
<thead>
<tr>
<th>Dysfunction</th>
<th>Effects</th>
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<tbody>
<tr>
<td>vestibular nuclei</td>
<td>vestibular system: vomiting, vertigo, nystagmus,</td>
</tr>
<tr>
<td>inferior cerebellar peduncle</td>
<td>Ipsilateral cerebellar signs including <strong>ataxia</strong>, <strong>dysmetria</strong> (past pointing), <strong>dysdiadokokinesia</strong></td>
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<tr>
<td>central tegmental tract</td>
<td>palatal myoclonus</td>
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<tr>
<td>lateral spinothalamic tract</td>
<td><strong>contralateral</strong> deficits in pain and temperature sensation from body (limbs and torso)</td>
</tr>
<tr>
<td>spinal trigeminal nucleus &amp; tract</td>
<td>ipsilateral loss of pain, and temperature sensation from face</td>
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<tr>
<td>nucleus ambiguus - (which affects <strong>vagus nerve</strong> and <strong>glossopharyngeal nerve</strong> - localizing lesion (all other deficits are present in lateral pontine syndrome as well)</td>
<td>ipsilateral laryngeal, pharyngeal, and palatal hemiparesis: <strong>dysphagia</strong>, <strong>hoarseness</strong>, diminished <strong>gag reflex</strong> (efferent limb - CN.X)</td>
</tr>
<tr>
<td>descending sympathetic fibers</td>
<td>ipsilateral <strong>Homer's syndrome</strong> (ptosis, miosis, &amp; anhydrosis)</td>
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Blood supply to the brainstem

[Diagram of blood supply to the brainstem with labeled arteries such as Anterior Cerebral A, Posterior Cerebral A, Superior Cerebellar A, Paramedian A, Short Circumferential A, Basilar A, Vertebral A, Anterior Spinal A, Posterior Inferior Cerebellar A, Anterior Cerebral A, and Posterior Cerebellar A.]
Wallenberg syndrome can occur with occlusions of the PICA and/or vertebral artery
Neurological Case Review

Localization
- Central vs. Peripheral Nervous System
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**Differential Diagnosis**

Toxic/Metabolic:
Infectious/Post-Infectious/Autoimmune:
Neoplastic/Paraneoplastic:
Structural:
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Degenerative/Neurogenetic:
Psychiatric:

Diagnostic Evaluation and Management
Neurological Case Review

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Differential Diagnosis Top Considerations

Vascular:
- **Stroke** (Ischemic or Hemorrhagic), Vascular Malformation

Autoimmune/infectious:
- Multiple Sclerosis, Abscess

Neoplastic/Paraneoplastic:
- Posterior Fossa Tumor

Paroxysmal:
- Basilar Migraine
Neurological Case Review

Initial Diagnostic Evaluation

- **Blood Work**
  - CBC, BMP, PT/PTT/INR, Cardiac enzymes (CK, Troponin, CKMB)

- **Neuroimaging**
  - CT Brain without contrast (rule out hemorrhage)

- **Lumbar Puncture**
  - N/A

- **Neurophysiology**
  - N/A

- **Other**
  - EKG
Results

- CBC
  - WBC: 9.8
  - H/H: 14.3/45.8
  - PLT: 365

- BMP
  - Na: 145
  - K: 3.2
  - Cl: 108
  - Bicarb: 26
  - BUN: 15
  - Cr: 1.3
  - Glu: 239
  - Ca: 9.3

- PT: 12
- PTT: 27
- INR: 1.3

- Troponin: <0.01
- CK: 89
- CKMB - 7
EKG
CT Head w/o
CT Head Results?
CT Head Results

Normal CT Head
NOW WHAT?
You have determined he has an ischemic stroke. Would you do TPA?

What is TPA and what are the indications and contraindications?
TPA = Tissue plasminogen activator

TPA is simply a protein involved in the breakdown of blood clots.

As an enzyme, TPA catalyzes the conversion of plasminogen to plasmin, the major enzyme responsible for clot breakdown.
Inclusion criteria for IV-TPA < 4.5 hours

Note: IV-TPA is not FDA approved for 3-4.5 hours but studies have shown benefit and that it can be safely administered.

- Diagnosis of ischemic stroke causing measurable deficit
- Onset of symptoms < 4.5 hours from beginning treatment
- Age > 18
Contraindications for IV-TPA <3 hours

- Significant head trauma or prior stroke in previous 3 months
- Symptoms suggest SAH
- CT demonstrates multi-lobar infarction (hypodensity > 1/3 cerebral hemisphere
- Arterial puncture in a non-compressible site in previous 7 days.
- History of intracranial hemorrhage
- Intracranial neoplasm, arteriovenous malformation, or aneurysm
Contraindications for IV-TPA <3 hours

- Recent intracranial or intra-spinal surgery
- Elevated BP (systolic $\geq 185$ mmHg or diastolic $\geq 110$ mmHg)
- BG concentration $<50$ mg/dL
- Active internal bleeding

- Acute bleeding diathesis (Plt $<100,000$ mm$^3$, Heparin received w/in $48$ hours resulting in elevated aPTT $> \text{upper limit of normal}$, current use of anticoagulant with INR $> 1.7$ or PT $> 15$, current use of direct thrombin inhibitors or direct factor Xa inhibitors with elevated sensitive lab tests)
Contraindications for IV-TPA 3-4.5 hours

- Includes same contraindications for IV-TPA < 3 hours

- Additional exclusion criteria
  - Age > 80 years
  - Severe stroke (NIHSS > 25)
  - Taking oral anticoagulant regardless of INR
  - History of both diabetes and prior ischemic stroke
So, is he an IV- TPA candidate? (Why or why not?)
You have successfully infused IV-TPA after lowering the patient’s BP under 185/110.

(Note: Once TPA is given BP should be maintained < 180/105 x 24 hours; If TPA is not given, allow permissive HTN x 24 hours < 220/120)

After 15 mins, the patient you re-examine the patient and note significant improvements in his neurologic exam.

The patient is sent to the ICU overnight and is stepped down to the floor after repeat Head CT 24 hour from TPA infusion is negative for hemorrhage.
Now what?

What additional studies and interventions would you recommend?
- Telemetry
- MRI/MRA of brain
- Carotid U/S
- 2D echo/TEE
- Cardiac enzymes x3
- Accuchecks, tight glucose control
- Fasting Lipid Profile, Hgb A1c, U-tox
- ASA 325md daily, Aggrenox BID or Plavix
- IV fluids
- Maintain normothermia
- NPO (until passed swallow study)
- PT/OT/ST evaluation
- DVT prophylaxis
MRI DWI
MRI reveals L lateral medullary stroke
CTA Head/Neck
Occluded left vertebral artery
What stroke risk factors does this patient have?
Risk Factors

- Non-Modifiable
  - Age
  - Sex
  - Race-ethnicity
  - Genetic factors

- Hypercoagulable States
  - Elevations of homocysteine
  - Protein C and S deficiency
  - Factor V Leiden mutations
  - Arterial dissections
  - Moya Moya
  - Fibromuscular Dysplasia
  - CADASIL
  - Marfan syndrome
  - Neurofibromatosis
  - Fabry disease

- Modifiable
  - Hypertension
  - Cigarette smoking
  - Diabetes
  - Atrial fibrillation and other cardiac enzymes
  - Dyslipidemia
  - Asymptomatic Carotid Stenosis
  - Sickel Cell Disease
  - Post-menopausal hormone therapy
  - Diet and nutrition
  - Physical inactivity
  - Obesity and body fat distribution
The patient has improved and you are ready to discharge her home. What are some of the measures you must take as a secondary stroke prevention?

- Antiplatelet agent
- Statin
- Good BP control
- Good glucose control
- Physical activity
- No smoking
- Close follow-up with her doctors