













## A&P-Brain Stem

- A. Gross anatomy and relationship with cranial structures
- B. Neocortical and Paleocortical relationships
- C. Relationships with deep cerebral nuclei and cerebellum
- D. Medulla Pathways
- E. Medulla Cranial nerves and their nuclei
- F. Medulla Other nuclei and reticular formation
- G. Medulla Vasculature
- H. Pons Pathways
- I. Pons Cranial nerves and their nuclei
- J. Pons Other nuclei and reticular formation
- K. Pons Vasculature
- L. Mesencephalon Pathways
- M. Mesencephalon Cranial nerves and their nuclei
- N. Mesencephalon Other nuclei and reticular formation
- O. Mesencephalon Vasculature

## A&P-Cranial Nerve

- A. Olfactory-tract-bulb-olfactory cortex
- B. Optic nerve chiasm-tract-lateral geniculate
- C. Oculomotor nerve-midbrain
  - 1. Edinger-Westphal nucleus
- D. Trochlear nerve-midbrain
- E. Trigeminal nerve-pons/midbrain
- F. Abducens nerve-pons
- G. Facial-nerve-pons
  - 1. Superior salivatory n.
- H. Vestibular cochlear-pons sva (special visceral afferent)
- I. Glossopharyngeal –medulla
  - 1. Inferior salivatory n.
- J. Vagus nerve-medulla
  - 1. Nucleus tractus solitarius
- K. Spinal accessory-medulla/cord
- L. Hypoglossal-nerve-medulla

## Physiology-Cranial Nerve

- A. Sensory
  - 1. GSA (general somatic afferent)--touch, pain, temperature, proprioception-V,VII,IX,X'
  - 2. SSA (special somatic afferent)--hearing, balance-VIII
  - 3. GVA (general visceral afferent)--mechanical, chemosensory-V,VII,IX,X
  - 4. SVA (special visceral afferent)--taste, olfaction-I,VII,IX,X
- B. Motor

1. GSE (general somatic efferent)--skeletal muscle control-III,VI,IX,XII
2. GVE (general visceral efferent)--autonomic control-III,VII,IX,X
3. SVE (special visceral efferent)--brachiomeric control-V,VII,IX,X,XI

## A&P-Head & Face Pain

- A. Cranial bones, sutures, foramina
- B. Potential sites of neural compression
- C. Pain sensitive structures of the head
- D. Upper cervical spinal cord anatomy
- E. Location of cranial nerves and their nuclei
- F. Neocortical and Paleocortical relationships
- G. Relationships with deep cerebral nuclei and cerebellum
- H. Vasculature

## A&P-Cerebellum

- A. Deep cerebellar nuclei
  1. Fastigial
  2. Interpositus (Emboliform, Globus)
  3. Dentate
- B. Cortex Layers
  1. Granular layer-granule, golgi cells
  2. Purkinje layer-purkinje cells
  3. Molecular layer-stellate & basket cells, parallel fibers
- C. Pathways
  1. Afferent Pathway-
    - a. Mossy fiber
      - i. destination: deep cerebellar nuclei & granular cells; originate from:
        - 1) DSCT/VSCT (descending spinocerebellar tract, vestibulospinal tract)
        - 2) pontine reticular formation
    - b. Climbing fibers
      - 1) Destination: deep cerebellar nuclei & purkinje cells
      - 2) Originate from: inferior olive
      - 3) Parallel fibers activated by climbing fibers in molecular layer:
      - 4) Destination
      - 5) Origination
    - c. Peduncles
      - 1) Superior-brachium conjunctiva
      - 2) Red nucleus-parvocellular
      - 3) Middle-brachium pontis
      - 4) Red nucleus-magnocellular
      - 5) Ventral lateral ventral anterior n. thalamus
      - 6) Inferior-restiform body
      - 7) Mossy-body



- d. Cortex
  - 1) Spinal Cord
  - 2) Brain Stem
- e. Efferent Pathway
  - 1) Spinal Cord
  - 2) Brain Stem
- f. Cortex
- D. Functional Anatomy
  - 1. Cerebrocerebellum-lateral
  - 2. Spinocerebellum-intermediate
  - 3. Vestibulocerebellum-midline
- E. Developmental functional anatomy
  - 1. Neocerebellum
  - 2. Paleocerebellum
  - 3. Archeocerebellum

## Functional Physiology - Cerebellum

- A. Feedback
  - 1. Data of motoric activity that actually took place as measured by the various receptors that is sent back to CNS by afferent proprioceptive system via DSCT and SCT.
  - 2. Sensory input into cerebellum
- B. Feed forward
  - 1. Data that is fed forward to the cortex by the dentate prior to and during execution of commands.
  - 2. Input into cortex
- C. Efferent copy: Define: Brain relays copy of motoric commands to contralateral cerebellum via ipsi pontine reticular formation to be analyzed by contra cerebellum (comparing command versus actual expression that is taking place so that modulation can be implemented.)
- D. Initiating
  - 1. Movement
  - 2. Thought
- E. Cessation
  - 1. Movement
- F. Surround Inhibition-priming of basket and stellate active inhibition of purkinje system to allow ease of summation of deep cerebellar nuclei related to an expected summation as a consequence of carried out patterns of movement.

## A&P-Basal Ganglia

- A. Striatum/Neostriatum, used interchangeably
  - 1. Caudate: concerned with emotion and head and face
  - 2. Putamen: concerned with neck and below

3. Globus Pallidus: main inhibitory system and developmentally linked to Substantia Nigra
  4. Globus Pallidus Externa (GPe)
  5. Globus Pallidus Interna (GPi)
- B. Substantia Nigra
1. Substantia Nigra Pars Compacta (SNc)
  2. Substantia Nigra Pars Reticulata (SNr)
  3. Subthalamic Nucleus (STN)
  4. Direct Pathway: multiple brain areas, primary premotor frontal areas, fire to excite Neostriatum, which fires to inhibit GPi, which inhibits thalamic nuclei that excite frontal motor areas: excitation of inhibition of inhibition results allows for thalamic excitation of frontal motor areas.
- C. Indirect Pathway: multiple brain areas excite neostriatum which fires to inhibit GPe's inhibition of STN's excitation of GPi: excitation of inhibition of inhibition of excitation of inhibition ultimately results in inhibition of motoric output.
- D. Functional output is not always direct or indirect, i.e., indirect pathway may inhibit motoric output that is antagonistic to excitation of an action that will contradict a movement that will result in instability.
- E. Substantia Nigra (Mesencephalon)
1. reticulata: functions similarly to the pallidum
  2. compacta: neurotransmitter dopamine to the neostriatum
    - a. D1 receptors in Direct Pathway are excitatory
    - b. D2 receptors in Indirect Pathway are inhibitory
- F. Limbic Component
1. nucleus accumbens (NA)
  2. ventral pallidum
  3. ventral tegmental area (VTA): VTA efferents provide dopamine to NA in reward learning.

## A&P-Reflexogenic System

- A. Monosynaptic reflex-(MSR)(DTR)-muscle spindle (1a)-ventral horn cell
- B. Disynaptic reflex-muscle spindle(1A)-1A interneuron-antagonist ventral horn cell
- C. Multisynaptic reflex-suprasegmental control, modulation, of ventral horn cell
- D. Pyramidal system-corticospinal, corticobulbar
- E. Extrapyramidal system-basal ganglia, nigrostriatal, cerebellum, vestibular
- F. Rubrospinal
- G. Reticular formation
- H. Medial
- I. lateral
- J. Vestibulospinal
- K. Medial
- L. Lateral
- M. Tectal spinal
- N. Superior collicular

## O. Inferior collicular

### A&P-Autonomic Nervous System

- A. Most rostral portion the hypothalamus with sympathetic and parasympathetic divisions
  - 1. Sympathetic: fight or flight; increases hr, dilates pupils (10% control of size), sweat stimulated, blood diverted from GI tract to skeletal muscles, sphinctors of alimentary tract are closed
  - 2. Parasympathetic: adapts the eyes for close up viewing, constricts pupils (90% control of size), slows hr, promotes secretion of salivary and intestinal juices, accelerates intestinal peristalsis.
  - 3. Sympathetic and parasympathetic combined in sexual intercourse
- B. Sympathetic & Parasympathetic
  - 1. Controlling fibers in hypothalamus and brainstem send central fibers to synapse upon the preganglionic fibers in the bs and spinal cord (IML)
  - 2. From IML, preganglionic neurons project out of CNS to synapse upon neurons in autonomic ganglia.
  - 3. Unmyelinated postganglionic fibers emerge and form terminal networks in target tissues
- C. Sympathetic post ganglionic fibers synapse:
  - 1. Nearest ganglion to accompany spinal nerves and supply sweat and vessels
  - 2. Ascend to synapse in superior, middle, or stellate ganglion (fusion of inferior and first thoracic ganglia) and post ganglionic fibers supply head, neck, upper limbs and heart
  - 3. Descend to synapse in lumbar or sacral ganglia and post ganglionic fibers enter lumbosacral plexus for blood vessels and skin of lower limbs
- D. Parasympathetic post ganglionic fibers
  - 1. Cranial PS System: pregang fibers emerge in four cranial nerves to synapse on:
    - a. in CN III to ciliary gang: post gang fibers to sphinctor of pupil and ciliary muscle (accommodation reflex).
    - b. in CN VII to pterygopalatine gang: lacrimal and nasal glands; in CN VII to submandibular gang to submandibular and sublingual glands.
    - c. in CN IX to otic gang: parotid gland.
    - d. in CN X to mural or intramural: to heart, lungs, lower esophagus, stomach, pancreas, gall bladder, small intestine, and ascending transverse parts of colon.
- E. Neurotransmission
  - 1. Symp pregang: Ach
  - 2. PS pregang: Ach
  - 3. Symp postgang: norepinephrine (except sweat = Ach)
  - 4. PS postgang: Ach

## A&P-Limbic System

- A. Brainstem
  - 1. Ventral tegmentum
  - 2. Reticular formation
  - 3. Locus coeruleus
  - 4. Lateral dorsal tegmental nucleus
  - 5. Pedunculopontine nucleus
- B. Deep brain structures
  - 1. Amygdala
  - 2. Hippocampus
  - 3. Nucleus accumbens
  - 4. Parahippocampus
  - 5. Subiculum
  - 6. Perirhinal cortex
  - 7. Hypothalamus
  - 8. Entorhinal cortex
  - 9. Cingulate gyrus
  - 10. Septal nuclei

## A&P-Lobes of the Brain

- A. Gross anatomy and relationship with cranial structures
- B. Main anatomic areas for each Lobe
  - 1. Frontal
    - a. Gyri- precentral, superior, paracentral, cingulate, middle, inferior
  - 2. Parietal
    - a. Gyri- postcentral, superior, inferior (angular, supramarginal), paracentral, precuneus, cingulate
  - 3. Occipital
    - a. Cuneus, lingual, lateral
  - 4. Temporal
    - a. Superior, middle, inferior, lingual, parahippocampal
  - 5. Insula
  - 6. Additional landmarks- saggital sulcus, central sulcus, sylvian fissure, parieto-occipital sulcus, calcarine fissure, temporal-occipital notch, uncus of the temporal lobe, frontal/temporal/occipital pole
  - 7. Generalized functional designations for neocortex
    - a. Paleo-neocortex
    - b. Neo-neocortex
  - 8. Functional areas of the frontal lobe
    - a. Motor, premotor, prefrontal
  - 9. Six layers of human cerebral cortex
  - 10. Localization of primary sensory and motor functions
  - 11. Relationships with deep nuclei, brainstem, spinal cord and cerebellum

## A&P Brain & Its Environment

### A. Brain

#### 1. Brain:

- a) Develops embryologically from neuroectodermal tube (adult ventricles)
- b) Medial surfaces of the diencephalon form the walls of the 3rd ventricle
- c) 3rd ventricle:
  - i. Opens into lateral ventricles thru interventricular foramen of Monro
  - ii. Continuous posteriorly with cerebral aqueduct of Sylvius
  - iii. Continuous with the 4th ventricle (pons and medulla)
- d) 4th ventricle:
  - i. Continuous with central canal of the caudal medulla and spinal cord
- e) Four sulci:
  - i. Central
  - ii. Lateral
  - iii. Parietooccipital
  - iv. Calcarine
- f) Four lobes:
  - i. Frontal
  - ii. Parietal
  - iii. Temporal
  - iv. Occipital
- g) Insula: overlies site where telencephalon and diencephalon fused during embryological development

#### 2. Environment

- a) Meninges
- b) Epidural space
- c) Dura Mater
- d) Arachnoid Mater
- e) Pia Mater
- f) Subdural space
- g) CSF
- h) Blood brain barrier

#### 3. Dural venous sinuses:

- a) Superior sagittal sinus transverse sinuses
- b) Several smaller sinuses
  - i. inferior sagittal sinus
  - ii. occipital sinus, and
  - iii. inferior
- c) superior petrosal sinuses

#### 4. Dural vasculature and innervation:

- a) Maxillary artery
- b) The middle meningeal artery
- c) Ophthalmic artery
- d) Occipital artery
- e) Vertebral arteries

- f) Primary sensory innervation
- g) Sensory innervation of the posterior fossa of the dura
- 5. Cerebrospinal Fluid: Formed by filtration of blood through the fenestrations of the choroidal capillaries that circulates through the ventricles of the brain.
- 6. Blood Supply of Brain:
  - a) Arterial Internal carotid system:
    - i. Internal carotid artery pathway and bifurcation
    - ii. posterior communicating artery
    - iii. anterior choroidal artery
  - b) Anterior Cerebral Artery
    - i. Branches
    - ii. Supply frontal & parietal lobe
    - iii. Occlusion-restricted contralateral motor and somatosensory deficits
  - c) Middle Cerebral Artery
    - i. Large
    - ii. Many branches
    - iii. Supplies deep brain structures
    - iv. Lenticulostriate arteries
      - 1) Ganglionic or penetrating branches collect anterior to the base of the brain and are called the anterior and posterior perforated substances.
      - 2) Frequently involved in strokes.
      - 3) Small damage to these arteries can equal disproportionate damage
      - 4) Vertebral Basilar system:
        - a) Pathway
        - b) Branches
          - i. The posterior spinal artery
          - ii. The anterior spinal artery
          - iii. The posterior inferior cerebellar artery
  - d) The Basilar Artery
    - 1) Pathway
    - 2) Supplies
      - a) Anterior Inferior Cerebellar Artery
        - i. Supplies inferior surface cerebellum (flocculus)
        - ii. Supplies parts of pons
        - iii. Supplies Internal Auditory Artery-occlusion can give rise to vertigo and ipsilateral deafness
      - b) Superior Cerebellar Artery
        - i. Supplies superior surface of cerebellum
        - ii. Supplies caudal brain
        - iii. Supplies rostral pons
        - iv. Unnamed Branches
        - iv. Supply Pontine arteries
        - v. Supply remainder of the pons
  - e) Posterior Cerebral Artery
    - 1) Pathway

- 2) Supplies the medial and inferior surfaces of the occipital and temporal lobes.
- 3) Gives rise to the Posterior Choroidal Arteries
  - a) Supply the choroid plexus of the third ventricle
  - b) Supply body of the lateral ventricle.
- 4) Occlusion of a posterior cerebral artery at its origin leads to visual field losses.
  - a) Circle of Willis:
- 5) Composition
- 6) Result of occlusion
  - a) Venous Drainage
- 7) Superficial groups
  - a) Pathway
  - b) Drainage
- 8) Deep groups
  - a) Initial drainage
  - b) Drainage into straight sinus
- 9) Basal vein
  - a) Drains some deep structures
  - b) Empties into the straight sinus.

## A&P-Neuroendocrine

- A. Neuroendocrine cells
  1. Endocrine system
  2. Nervous system
  3. Hypothalamic/pituitary portal system
- B. Hypothalamus
  1. Supraoptic and paraventricular nuclei
- C. Pituitary Gland
  1. Anterior pituitary (adenohypophysis) i.e. Rathke' pouch
  2. Blood supply
    - a. Superior hypophysial arteries
    - b. Internal carotid arteries
    - c. Posterior pituitary (neurohypophysis) i. Pituitary stalk
  3. Other structures information and relationships between the hypothalamus and pituitary:
    - a. Infundibulum
    - b. Median eminence
    - c. Tuber cinerium
    - d. Sella turcica
    - e. Blood brain barrier
    - f. Mamillary bodies

## A&P-Pain

- A. Spinothalamic pathway, a lateral pain pathway: 3 neuron pathway
  1. Trunk and Limbs: 2nd order neuron in posterior gray horn and crosses to ascend via spinothalamic pathway to ventral posteral lateral nucleus of thalamus and then to primary somatic sensory cortex (location, severity) and lateral sulcus (visual attention to stimulus source).
  2. Head and Neck: 2nd order neuron in the spinal nucleus of the trigeminal nerve and travels via trigeminal thalamic projection to contralateral ventral posterior medial nucleus and then to primary somatic sensory cortex and lateral sulcus.
- B. Spinoreticular/trigeminoreticular
  1. Polysynaptic via spinoreticular and trigeminoreticular tracks to 1) the contralateral medial dorsal thalamic nucleus and then on to the interior cingulate cortex (concerned with effective/emotional component of pain) and 2) reticular formation of medulla and pons. Many fibers do not cross the midline.
- C. Spinomesencephalic: via anterolateral quadrant of spinal cord projects neurons from laminae I and V to mesencephalic reticular formation and periaqueductal gray and then via spinoparabrachial tract to the parabrachial nuclei that then project to the amygdala that is involved with the affective/emotional component of the pain experience.
- D. Cervicothalamic tract: nociceptive neurons in laminae III and IV mostly cross the midline and ascend in the medial lemniscus of the brain stem to lateral cervical nucleus in the midbrain and then to the ventroposterior lateral and posteromedial nuclei of the thalamus. Some axons from laminae III and IV project through the dorsal columns of the spinal cord and terminate in the gracile and cuneate nuclei of the medulla.
- E. Spinohypothalamic tract: neurons in laminae I, V, and VIII project directly to the supraspinal autonomic control centers and activates neuroendocrine and cardiovascular responses associated with pain.
- F. Fibers
  1. C fibers (unmyelinated, .5 – 2 m/s); dull, achey pain; polymodal nociceptors (mechanical deformation, intense heat/cold, and irritant chemicals).
  2. delta fibers (myelinated, 25 m/s); sharp pain; severe mechanical deformation of the skin.
- G. 1st order pain neurons activate segmental IML
- H. Mesencephalic pain inhibition
  1. Peri-aqueductal gray matter (PAG) sends excitatory projections to the Nucleus Raphe Magnus that sends bilateral caudal projections (serotonergic) via Lissauer's tract to terminate in the substantia gelatinosa at all levels of the spinal cord to excite enkephalinergic interneurons (GABA-ergic) that are inhibitory to the second order pain neuron.
  2. Locus ceruleus neurons (noradrenergic) descend to inhibit the second order pain neuron.
- I. Segmental pain inhibition: A fibers (mechanoreceptors) activate inhibitory interneurons that in turn inhibit excitatory interneurons and second order neuron of the pain pathway.



## Disorders & Diagnoses

### Red Flag/Scope of Practice

Meningitis: neck rigidity, severe headache and high fever

Increased intracranial pressure: eye exam ophthalmoscope-bulging optic disc with severe headache on same side

Blood pressure: diastolic 110+ or systolic 180+; headache

Blood pressure adult: diastolic 50- or systolic 80- with presenting symptoms

Heart Rate/Rhythm: presentation: SOB, diaphoresis, chest pain, left arm pain, thoracic back pain; Rate above 140+ at rest with no medication indicator

Cauda Equina Syndrome-disc patients: saddle pain, inability to urinate, urinate or defecate without knowing it

Cavernous Sinus Syndrome: fever, head/face pain, infection in nasal triangle

Subarachnoid hemorrhage (subdural, epidural): "worst headache I've ever had"

Blood sugar non-fasting: below 50mg

Blood sugar non-fasting: above 300 mg/desiliter with no history of diabetes and with diaphoresis, lowered level of alertness

Sepsis: Blood sugar above 120 fasting in non-diabetic patient: look for sepsis and ship; fever or abnormally low for individual (>97 <100); HR >100 bpm; Resp rate > 20 cpm

Emergent Stroke: lethargy, lower level of consciousness

Respiration: below 7 and above 20 OR in a known patient plus or minus 5 either direction at rest with altered breath sounds

Visual field defects: Pie in sky/ floor; hemifield loss; Quadrantanopia; loss of central vision; peripheral visual loss (tunnel vision)

Temperature: hypothermia below 96core/95oral; hyperthermia above 103core/102oral; history of vomiting

Projectile vomiting or unremitting vomiting

### Disorders-Peripheral Nerve

- A. motor root lesion
- B. sensory root lesion
- C. motor & sensory root lesion
- D. compressive root mechanisms
  - 1. disc lesion
  - 2. inflammatory lesion (Sclerotogenous pain referral)
- E. trauma
  - 1. biomechanical, i.e., lifting
  - 2. motor vehicle accident
  - 3. vertebral fracture
  - 4. vertebral compression fracture
- F. lumbosacral plexus lesions
  - 1. lumbar plexus lesion
- G. intrapment neuropathies
  - 1. radial nerve

2. median nerve
  - a. pronator syndrome
  - b. carpal tunnel syndrome
3. ulnar nerve
4. sciatic palsy
5. systemic peripheral neuropathy
  - a. diabetic neuropathy
6. rheumatoid arthritis

## Disorders-Spinal Cord

- A. Spinal Cord Injury: Lateral lesion
- B. Spinal Cord Injury: Anterior lesion
- C. Spinal Cord Injury: Posterior lesion
- D. Spinal Cord Injury: Complete lesion
- E. Compressive mechanisms
- F. Syrinx
- G. Ventral horn cell disease
- H. Multiple sclerosis
- I. Dorsal column disease
- J. Vascular disease
- K. Cauda Equina Syndrome

## Disorders-Brain Stem

- A. White matter disease
- B. Ventricular lesions
- C. Medulla ventral
- D. Medulla Lateral
- E. Medulla Craniocervical junction
- F. Medulla Integrative
- G. Pons Ventral
- H. Pons Dorsal
- I. Pons Lateral
- J. Pons Paramedian
- K. Pons Integrative
- L. Mesencephalon Tegmental
- M. Mesencephalon Tectal
- N. Mesencephalon Integrative

## Disorders-Cranial Nerve

- A. Tumors-locations
- B. Vasculature
  - 1. TIA—transient ischemic attack
  - 2. Stroke
  - 3. AVM—arteriovenous malformation
  - 4. aneurysm
- C. Trauma
- D. Infection
- E. Congenital anomalies
- F. Plasticity/deafferentation
- G. Hemisphericity
- H. Macular degeneration, RAPD—relative afferent papillary defect
- I. Nerve palsies—CN III, Facial

## Disorders-Head & Face Pain

- A. Migraine
- B. Cluster headache
- C. Cervicogenic headache
- D. Tension type headache
- E. Temporal neuritis
- F. Subarachnoid hemorrhage
- G. Trigeminal neuralgia
- H. Atypical facial pain
- I. Temporo-mandibular joint pain

## Disease Processes-Cerebellum

- A. Atrophy
- B. Injury
- C. Toxicity
- D. Genetic diseases
- E. Concomitant deafferentation
- F. Pathway disease-spinocebellar
- G. Tumor
- H. Stroke
- I. Ischemia
- J. Location-tremor-symptoms

## Disorders & Diagnoses-Basal Ganglia

- A. Movement Disorders
  - 1. Parkinson's Disease: loss of SNc dopamine to neostriatum
  - 2. Huntington's disease: damage to neostriatum
  - 3. Ballismus: STN damage
  - 4. Tourette's syndrome: lack of inhibition of pathways resulting in motor tics and at least one phonic tic.
  - 5. Obsessive-Compulsive disease: dopaminergic hyperfunction in the prefrontal cortex and serotonergic hypofunction in the basal ganglia.
  - 6. Dystonia: increased and sustained output of motoric centers; begins focally and spreads unilaterally and then bilaterally.
  - 7. Wilson's Disease: hepatolenticular degeneration (copper metabolism)

## Diseases-Reflexogenic

- A. Tumor
- B. Vasculature-obstruction/tone modulation
  - 1. Stroke
  - 2. TIA
  - 3. Aneurism
- C. Deafferentation
- D. Genetic disease
- E. Toxicity
- F. Hemisphericity

## Disorders-Autonomic Nervous System

- A. Sympathetic Escape (decreased pontine control)
  - 1. End organ effect: i.e., tachycardia on right and arrhythmia on left;
  - 2. End organ effect: i.e., intestinal hypofunction;
  - 3. Other
- B. Reynaud's phenomenon
- C. Complex Regional Pain Syndrome
- D. Sympathetic aggravation of immune response (asthma)
- E. Horner's syndrome

## Disease/Diagnoses-Limbic System

- A. Depression
- B. Anxiety
- C. Autonomic dysregulation/autonomia
- D. Emotional manifestations or lack of:
  - 1. Right hemisphere - sadness, fear, disgust
  - 2. Left hemisphere - euphoria, anger, excessive surprise, unwarranted bliss
- E. R. Neurodegenerative disorders
- F. Developmental disorders
- G. Dysautonomia

## Disorders-Lobes of the Brain

- A. Functional categories
  - 1. Attentional
  - 2. Emotional
  - 3. Memory
  - 4. Sensory
  - 5. Sensorimotor integration & Movement Execution
  - 6. Interhemispheric disconnection
  - 7. Dementia
- B. Anatomic categories
  - 1. Occipital
  - 2. Temporal
  - 3. Parietal
  - 4. Frontal
  - 5. Callosal
- C. Terminology of Symptoms-
  - 1. Neglect
  - 2. Akinesia
  - 3. Perseveration
  - 4. Echolalia
  - 5. Akinetic
  - 6. Hallucinations
  - 7. Agnosia
  - 8. Alexia
  - 9. Dysgraphia
  - 10. Aphasia
  - 11. Anomia
  - 12. Apraxia
  - 13. Acalculia
  - 14. Palsy
  - 15. Hemianopia

## Disease Processes-Brain & Its Environment

- A. Stroke
- B. Transient ischemic attacks
  - 1. Hard lesion (clot)
  - 2. Physiological lesion
- C. Aneurysms
- D. Arteriovenous malformations
- E. Meningitis
- F. Encephalitis
- G. Leakage of CSF
- H. Increased intracranial pressure
- I. Cavernous sinus syndrome/thrombosis

## Disorders-Neuroendocrine

- A. Hyperprolactinemia
  - 1. Associated conditions
    - a. Hypogonadism
    - b. Amenorrhea
    - c. Galactorrhea
  - 2. Disease states
    - a. Pituitary tumors
      - i. Prolactinomas
      - ii. Adenomas secreting GH and prolactin
      - iii. Adenomas secreting ACTH and prolactin (Cushing's disease)
      - iv. Nonfunctioning chromophobe adenomas compressing pituitary stalk
    - b. Hypothalamus
      - i. Sarcoidosis
      - ii. Craniopharyngiomas
      - iii. Cranial irradiation
      - iv. Empty sella syndrome
      - v. Aneurysm
    - c. Other diseases
      - i. Primary hypothyroidism
      - ii. Chronic renal failure
      - iii. Cirrhosis
      - iv. Chest wall trauma
- B. Hypoprolactinemia
  - 1. Panhypopituitarism
- C. Growth Hormone (Somatotropin)
  - 1. Acromegaly
  - 2. Gigantism
- D. Pituitary Dwarfism
  - 1. Gonadotropin:
    - a. Ectopic secretion
      - i. Germinomas
      - ii. Precocious puberty
      - iii. Pituitary adenomas
        - 1) FSH secreting
        - 2) LH secreting
  - 2. Thyrotropin
    - a. GH
      - i. Acromegaly
      - ii. Depression
        - 1) Hyperthyroidism
        - 2) Primary hypothyroidism
        - 3) Secondary hypothyroidism
          - a) Pituitary disease
          - b) Hypothalamic disease

- iii. Pituitary or TSH induced hyperthyroidism
      - 1) Tumors
      - 2) Resistance to thyroid hormone
      - 3) Adrenocorticotrophic Hormone (ACTH):
        - a) Excess ACTH
          - a. Cushing's syndrome
          - b. Nelson's Syndrome
        - ii. Causes of excess Cortisol:
          - a. Pituitary ACTH
          - b. Ectopic ACTH
          - c. Adrenal tumors
          - d. Exogenous corticosteroid administration
        - iii. ACTH Deficiency:
          - a. After prolonged glucocorticoid administration
- E. Deficiency of Vasopressin (Diabetes Insipidus)
  - 1. Causes affecting pituitary or hypothalamus:
    - a. Neoplastic lesions
    - b. Infiltrative lesions
    - c. Surgery
    - d. Isotopic ablative therapy
    - e. Severe head injuries
- F. Syndrome of Inappropriate AVP Secretion (SIADH):
  - 1. Causes
    - a. Lung carcinoma
      - i. Small cell
      - ii. Oat cell
    - b. Nontumorous lung tissue
      - i. TB
      - ii. Pneumonia
      - iii. Other pulmonary diseases
- G. Thyroid Disorders
  - 1. Sick euthyroid
  - 2. Simple nontoxic goiter
    - a. Iodine deficiency
  - 3. Hypothyroidism
    - a. In children – Cretinism
    - b. In adults
  - 4. Thyrotoxicosis
    - a. Abnormal thyroid stimulator
      - i. Grave's disease
        - 1) Hyperthyroidism
        - 2) Diffuse goiter
        - 3) Ophthalmopathy
        - 4) Dermopathy
          - a) Trophoblastic tumor
          - b) Intrinsic thyroid autonomy

- i. Hyperfunctioning adenoma
    - ii. Toxic multinodular goiter
  - c) Disorders of hormone storage
    - i. Thyoiditis
      - a. Subacute
      - b. Chronic
    - ii. Ectopic thyroid tissue
      - a. Functioning follicular carcinoma
  - d) Complications of thyrotoxicosis
    - i. Thyrocardiac disease
    - ii. Thyrotoxic crisis
  - e) Thyroiditis
  - f) Thyroid tumors
    - i. Adenomas
    - ii. Carcinomas
- H. Diseases of the Adrenal Cortex
  - 1. Hyperfunction of the Adrenal Cortex
    - a.Excess cortisol
      - a) Cushing's syndrome
      - b) Causes
        - i. adrenal hyperplasia
        - ii. neoplasia
        - iii. exogenous
    - b. Aldosteronism
      - a) Hyper secretion of aldosterone
      - b) Primary aldosteronism
        - i. adrenal adenoma
        - ii. adrenal carcinoma
      - c) Secondary aldosteronism
        - i. renin angiotensin system
        - ii. Syndromes of adrenal androgen excess
          - a.Hirsutism
            - 1. Oligomenorrhea
            - 2. Acne
            - 3. Virilization
            - 4. Causes in women
  - I. Familial
  - J. Idiopathic
  - K. Polycystic ovaries
  - L. Tumor
  - M. Congenital adrenal hyperplasia;
    - 1. Hypofunction of the Adrenal Cortex
    - 2. Addison's disease
      - a.Primary adrenocortical insufficiency
        - a) Causes
          - i. Idiopathic



- ii. surgical removal
    - iii. destruction from infection
    - iv. hemorrhage
    - v. tumor
  - b. Secondary adrenocortical insufficiency
    - a) Causes
      - i. Hypopituitarism
      - ii. exogenous steroid
      - iii. steroid from tumor
    - c. Acute adrenocortical insufficiency
      - a) Causes
        - i. Sepsis
        - ii. surgical stress
        - iii. hemorrhagic destruction of both adrenal glands
          - a. anticoagulant therapy
          - b. sometimes during pregnancy

## I. Pheochromocytoma

1. Chromaffin tumors
  - a. Catecholamines
  - b. Adrenal medulla
2. Familial
  - a. Autosomal dominant
  - b. Neurofibromatosis type II
  - c. Tumors are bilateral
3. Extraadrenal
  - a. abdomen ganglia
    - i. celiac
    - ii. superior mesenteric
    - iii. inferior mesenteric
4. Associated diseases
  - a. medullary carcinoma of thyroid in MEN
  - b. Type II and III neurofibromatosis

## J. Diabetes Mellitus

1. Type I (IDDM)
2. Type II (NIDDM)
3. Secondary diabetes
  - a. Pancreatic disease
  - b. hormone abnormalities
  - c. drug or chemical induced
  - d. insulin receptor abnormalities
  - e. genetic syndromes
    - i. Complications of DM
      - a. i. Diabetic ketoacidosis
      - b. Hyperosmolar coma
      - c. Late Complications
        - 1) Circulatory abnormalities

- 2) Retinopathy
- 3) Diabetic foot ulcers
- 4) Diabetic Neuropathy
- 5) Peripheral polyneuropathy
- 6) Mononeuropathy
  - a) Autonomic neuropathy
  - b) Variety of skin lesions

#### K. Abnormalities of Testicular Function

1. Hypothalamic/Pituitary
2. Testicular
  - a. Klinefelters Syndrome or XX male
  - b. Acquired defects due to
    - i. viral infection
    - ii. trauma
    - iii. radiation drugs
    - iv. systemic diseases
3. Sperm transport

#### L. Abnormalities of the Ovaries

1. Ovaries
2. Menstrual Cycle
3. Menopause i. Osteoporosis

#### M. Disorders affecting Multiple Endocrine Systems

1. Multiple Endocrine Neoplasia, Type I (Werner syndrome)
2. Multiple Endocrine Neoplasia, Type II (Sipple syndrome)
3. Multiple Endocrine Neoplasia, Type III

### Disease Processes/Diagnoses-Pain

- A. Complex regional pain syndrome
- B. Neurogenic inflammation: local C fiber release of one or more peptide substances, notably substance P, which binds with receptors on the walls of arterioles, leading to arteriolar dilatation, and also binds with receptors on the surface of mast cells, stimulating them to release histamine which increases capillary permeability and leads to local accumulation of tissue fluid, the wheal response.
- C. Chronic pain associated with decreased brainstem function.
- D. Chronic pain associated with decreased internuncial function.
- E. Hypoxic nociceptive depolarization
- F. Neuropathic pain: secondary to direct injury to nerve
- G. Fibromyalgia
- H. Labor pain
- I. Post surgical acute pain
- J. Cancer related pain
- K. Arthritic pain
  1. Rheumatoid
  2. Osteo

- L. Muscle pain
  - 1. Spasm
  - 2. Pull
  - 3. Tear

## Diagnostic Issues Relevant to Each Neuro Area

### Diagnostic Issues - Receptors

- A. History taking differentiating possible disorders of environmental receptor organs vs other causes
- B. Complete neurological examination
- C. Visual examination using otoscope and ophthalmoscope of the fundus, auditory canal, oral cavity, nasal cavity
- D. Visual acuity testing using Snellen Eye chart
- E. Auditory acuity testing using tones, Weber and Rinne tests
- F. basic smell testing, taste testing
- G. Differential testing for peripheral vs central vertigo
- H. Romberg's test, finger to nose and observation of smooth pursuits
- I. Dix-Hallpike maneuver
- J. Interpretation of auditory, visual and vestibular function special testing
- K. Assessment of muscle tone, strength, joint position sense, joint range of motion and position
- L. Assessment of cutaneous modalities of warm/cold, sharp/dull, pain perception, two point discrimination, graphesthesia

### Diagnostic Procedures-Peripheral Nerve

- A. Cervical MRI
- B. Thoracic MRI
- C. Lumbosacral MRI
- D. Shoulder MRI
  - 1. brachial plexus
  - 2. shoulder soft tissue
- E. Upper extremity Nerve conduction velocity testing without needle EMG
- F. Upper extremity Nerve Conduction velocity testing with needle EMG
- G. Lower extremity Nerve conduction velocity testing without needle EMG
- H. Lower extremity Nerve Conduction velocity testing with needle EMG
- I. Laboratory testing
  - 1. heavy metals
  - 2. serum B12
  - 3. Complete Blood Count
  - 4. Comprehensive Metabolic Profile
  - 5. Urinalysis
  - 6. Genetic testing
- J. Cardiac testing
  - 1. Doppler
  - 2. ECG
  - 3. Echo Cardiogram
  - 4. Cardiac Stress test

- K. Xray:
1. Cervical spine
  2. Thoracic spine
  3. Lumbosacral spine
  4. Shoulder series
  5. Elbow series
  6. Wrist series
  7. Hand series
  8. Hip series
  9. Knee series
  10. Ankle series
  11. Foot series

### Diagnostic Issues-SC

- A. History taking differentiating spinal cord lesions from lesions elsewhere
- B. Complete neurological examination with emphasis on: Muscle spindle reflexes
- C. Complete neurological examination with emphasis on: Strength
- D. Complete neurological examination with emphasis on: Primitive reflexes
- E. Complete neurological examination with emphasis on: Assessment of tone
- F. Complete neurological examination with emphasis on: Tactile sensation testing
- G. Localization of spinal cord lesions at different levels
- H. Differentiating between a single lesion, multiple lesions and systemic lesions

### Diagnostic Issues-Brain Stem

- A. History taking differentiating spinal cord lesions from lesions elsewhere
- B. Complete neurological examination with emphasis on: Muscle spindle reflexes
- C. Complete neurological examination with emphasis on: Strength
- D. Complete neurological examination with emphasis on: Primitive reflexes
- E. Complete neurological examination with emphasis on: Assessment of tone
- F. Complete neurological examination with emphasis on: Tactile sensation testing
- G. Localization of spinal cord lesions at different levels
- H. Differentiating between a single lesion, multiple lesions and systemic lesions

### Diagnostic Issues-Cranial Nerve

Eg. Distinguishing Horner's syndrome from cranial nerve disorder  
Simple versus pathological anisocoria

### Diagnostic Issues-Head and Face Pain

- A. History taking differentiating primary head pain lesions with secondary or sinister ones
- B. Complete neurological examination with emphasis on:
  - a. Cranial nerve testing
  - b. Autonomic assessment

- c. Muscle spindle reflexes
- d. Strength
- e. Primitive reflexes
- f. Assessment of tone
- g. Tactile sensation testing
- C. Use of diagnostic imaging
- D. Differentiating between a single lesion, multiple lesions and systemic lesions

## Diagnostic Issues-Cerebellum

- A. Neurological exam
  - 1. Extremity execution of coordinated movements
  - 2. Core execution of coordinated movements
- B. Differentiating tremors
  - 1. Resting
  - 2. Dystonic
  - 3. Orthostatic
  - 4. Essential
  - 5. Intention
  - 6. Parkinsonian
  - 7. Physiologic
  - 8. Rubral
- C. Oculomotor abnormalities
  - 1. Hypometria/hypermertia
  - 2. Saccades\pursuits
  - 3. Canal related movements
- D. Frank pathology
  - 1. Tumors
  - 2. Genetic disease
  - 3. Degenerative disease
  - 4. Toxicities

## Diagnostic Issues-Basal Ganglia

- A. History taking differentiating central/basal ganglionic lesions from peripheral lesions.
  - 1. History of areas of function
    - a. Motoric function
    - b. Frontal related function:
      - 1) Right and left executive control
      - 2) Trouble with saccade function
      - 3) Hypertonia
      - 4) Posture of pyramidal paresis
    - c. Cerebellum related function:
      - 1. balance,
      - 2. coordination,

3. dizziness (spin)
  4. Eye control problems,
  5. Repetitive sprain/strains,
  6. Hypotonia
  - d. Mesencephalon
    1. Trouble with light
    2. Heart rate (may be perceived as panic attacks)
    3. Visual problems
    4. Sleep problems
    5. Decreased energy
    6. Gut trouble
    7. Activated by inflammatory immune cytokine receptors?
  - e. Emotion and control or physical output secondary to emotion (caudate/limbic)
- B. Complete neurological examination with emphasis on:
- a. Frontal output:
    1. Saccades
    2. Vertical optokinetics
    3. Monotone and melodic sequencing
    4. Analysis capability
    5. Understanding humor
  - b. Cerebellum
  - c. Mesencephalon
  - d. Thalamus:
    1. Perception right vs. left vision,
    2. Sound
    3. Touch modalities
  - e. ANS
  - f. Heart, Lungs, Abdomen
  - g. Posture:
    1. pyramidal paresis
    2. Flexor tone
    3. Hemiparesis

## Diagnostic Issues-Autonomic Nervous System

- A. History taking including lifestyle factors
- B. Complete neurological examination with emphasis on:
  1. Pupillary response
  2. Corneal reflex (pontine cis)
  3. Hr
  4. SpO2
  5. Skin color
  6. Capillary filling
  7. Limbic changes to above (such as emotional testimony)
  8. Gut function

9. Adrenal function (lab testing or ability to sleep through night)
10. ALL cranial nerves

## Diagnostic Issues-Limbic System

- A. Neurological exam
  1. Evaluation of emotional expression and manifestation
    - a. Responses to humor
    - b. Responses to pain
    - c. Responses to suffering
    - d. Responses to joy
    - e. Responses out of context
    - f. Responses to sadness
  2. Sexual Issues
    - a. Drives
    - b. Frequency
    - c. Ability
      - i. Erection
      - ii. Lubrication
      - iii. Arousal
      - iv. Orgasm
  3. Relationship tactics
    - a. Aggressive
    - b. Submissive
    - c. Argumentative
    - d. Perspective
    - e. Optimistic/pessimistic
    - f. Complimentary
    - g. Length of relationships
  4. Autonomic
    - a. Anxiety
    - b. Bowel regularity
    - c. Bladder regularity
    - d. Blood pressure
    - e. Heart rate
    - f. Sweating
    - g. Extremity temperatures
    - h. Emotional effects of autonomic
  5. Reflexes
  6. Blind spots
- B. Spiritual
  1. Hallucinations
    - a. Visual
    - b. Auditory
    - c. Somatosensory
    - d. Olfactory



- e. Gustatory
- 2. Introversion/extroversion

## Diagnostic Issues-Lobes of the Brain

- A. History taking differentiating hemispheric lesions from lesions elsewhere
- B. Complete neurological examination with emphasis on:
  - 1. Hemispheric localization
  - 2. Cognitive functions
  - 3. Primary and secondary sensory and motor functions
  - 4. Related “lower/reflexive” functions
- C. Localization of lesions go specific or grouped by gyri
- D. Differentiating between a single lesion, multiple lesions and systemic lesions
- E. Use of Broadman’s taxonomy.

## Diagnostic Issues-Brain & Its Environment

- A. Special Studies for Diagnosis (referred):
  - 1. CT angiography
  - 2. MRI/MRA of brain
  - 3. Lumbar puncture
- B. Complete neurological examination by clinician.
- C. Emergent vascular accident-get transport to ED
- D. Discriminate between occlusive transient ischemia and physiologic ischemia

## Diagnostic Issues-Pain

- A. History taking differentiating:
  - 1. Nociceptive receptor activation
  - 2. Decreased supra-segmental pain inhibition
  - 3. Neuropathic
  - 4. Central lesions
  - 5. Organic pain
  - 6. Situational issues potentiating pain
  - 7. Other (text box)
    - a. Divorce
    - b. Grief
    - c. Financial difficulty
    - d. Loss of any sort (empty nest, loss of status, move to new local, etc.)
    - e. Drug &/or alcohol abuse
    - f. Chronic prescription drug use
    - g. Other (text box)
- B. Complete neurological examination with emphasis on:
  - 1. Autonomic Nervous System
  - 2. Complete brainstem function
    - a. Mesencephalic
    - b. Pontine.

- c. Limbic system contributions
- d. Cortical centers of pain appreciation regarding:
  - 3. Location
  - 4. Severity of receptor activation
  - 5. Effect
- B. Other
- C. Situational: post-surgical, cancer, children issues etc. western pro-inflammatory diet, trauma, gambling addictions, poor nutrition, domestic violence, elder abuse, neglect

## Treatment & Rehabilitation

### Rehab for Neuron

- A. Rehabilitation or treatment
  - 1. Increase activation
  - 2. Inhibit activation
  - 3. Promote cell proliferation by increasing fuel delivery but not exceeding the metabolic rate of the area being stimulated
- B. Specific adjustments will increase O<sub>2</sub>
- C. Specific Adjustments will increase activation
- D. Nutrition to increase activation.

### Rehab Principles-Receptors

- A. Environmental receptors transduce external stimulus into an electrochemical event that may change the CNS
- B. To achieve great probability of CNS change: fast adapting receptors need to be stimulated with varying amplitudes or patterns
- C. To achieve great probability of CNS change: slowly adapting receptors will maintain a change in firing rate with a new, but constant stimulus
- D. Receptors that fire frequently (slowly adapting or associated with a frequently changing system) and are very responsive to change (high sensitivity) often have the greatest CNS input; these are mostly proprioceptors and vestibular receptors

### Rehabilitation Applications-Receptor

- A. Visual stimulus and filtering
- B. Auditory training with tones, clicks and music
- C. Olfactory and gustatory stimulus techniques
- D. Vestibular training (yaw, pitch and roll)
- E. Therapeutic caloric
- F. Canalith repositioning
- G. Crude and accurate touch stimulation
- H. Chiropractic adjusting technique
- I. Range of motion therapeutics (resistance training, stretch, muscle work)

### Referral Principles for Peripheral Nerves

- A. Refer only until a definitive cause is known:
  - 1. Orthopedic Surgeon
  - 2. Neurosurgeon
  - 3. Cardiologist
  - 4. Endocrinologist
  - 5. Primary Care Physician (if not you)
  - 6. Rheumatologist

- B. Refer and Co-treat with other practitioner
  - 1. Occupational therapist
  - 2. Primary Care Physician (if not you)
- C. Treat without Co-Management
- D. Refer based upon outcome of initial trial therapy

## Treatment Modalities Peripheral Nerve

- A. Spinal manipulation
- B. Extremity manipulation
- C. Nutritional support (vitamins, minerals)
- D. Muscle tone modulation
  - 1. Electrical muscle stimulation
  - 2. Myofascial release
  - 3. Massage
  - 4. Fast stretch
  - 5. Slow stretch
- E. Thermotherapy (hot or cold)
- F. Central integrated state (to increase or decrease)

## Rehab Principles Peripheral Nerve

- A. Physical Rehab in office
- B. Physical Rehab at home
- C. Cortical stimulation

## Rehab Principles Spinal Cord

- A. Central vs Peripheral nerve lesions and limitations to regeneration
- B. Segmental relationships
- C. Peripheral signaling into cord
- D. Supra-segmental signaling into cord
- E. Decompression and vascular controls
- F. Metabolic capacity
- G. Central integrated state and potential for plastic change
- H. To achieve great probability of CNS change: fast adapting receptors need to be stimulated with varying amplitudes or patterns
- I. To achieve great probability of CNS change: slowly adapting receptors will maintain a change in firing rate with a new, but constant stimulus
- J. Receptors that fire frequently (slowly adapting or associated with a frequently changing system) and are very responsive to change (high sensitivity) often have the greatest CNS input; these are mostly proprioceptors and vestibular receptors

## Rehab Applications Spinal Cord

- A. Cross crawl
- B. Segmental spindle and GTO reflexes

- C. Vestibular reflexes
- D. Bladder control
- E. Gait retraining
- F. Brain based therapies
- G. Crude touch, pain, temperature and accurate touch modalities
- H. Chiropractic adjusting technique
- I. Range of motion therapeutics (resistance training, stretch, muscle work)
- J. Mental imagery

## Rehab Principles - Brain Stem

- A. Central vs Peripheral nerve lesions and limitations to regeneration
- B. Segmental relationships
- C. Peripheral signaling into cord
- D. Supra-segmental signaling into cord
- E. Decompression and vascular controls
- F. Metabolic capacity
- G. Central integrated state and potential for plastic change
- H. To achieve great probability of CNS change: fast adapting receptors need to be stimulated with varying amplitudes or patterns
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## Rehab Applications - Brain Stem

- A. Cross crawl
- B. Segmental spindle and GTO reflexes
- C. Vestibular reflexes
- D. Bladder control
- E. Gait retraining
- F. Brain based therapies
- G. Crude touch, pain, temperature and accurate touch modalities
- H. Chiropractic adjusting technique
- I. Range of motion therapeutics (resistance training, stretch, muscle work)
- J. Mental imagery

## Rehab Principles - Cranial Nerve

- A. Restore/maintain-fuel
- B. Surgical referral –removal/eliminate/repair frank pathology
- C. Monitor metabolic capacity
- D. Improve plasticity
- E. Active activation
- F. Active inhibition

- G. Create symmetry/balance in functionality from right and left

## Rehab Applications - Cranial Nerve

- A. Olfaction:
  - 1. Olfaction identification-peppermint/lavender
  - 2. Olfaction localization
- B. Visual:
  - 1. Hemi-field stimulation
  - 2. Color stimulation
  - 3. Optokinetic stimulation
  - 4. Accommodation exercises
  - 5. Localization
  - 6. Blocking techniques
- C. Oculomotor:
  - 1. .saccades
  - 2. 3/4/6
  - 3. Pursuits
  - 4. VOR—vestibular Ocular reflex
  - 5. OPK—optokinetic
  - 6. Memorized targets
- D. Edinger-Westphal:
  - 1. Light stimulation-frequency/color/intensity
  - 2. Accommodation-near/far exercises
- E. Trigeminal:
  - 1. therapeutic exercises –chewing
  - 2. Myofascial release
  - 3. Manipulation
  - 4. Sensory stimulation-V-I,V-II,V-III
- F. Facial:
  - 1. Muscle activation
  - 2. Cortical based facial expression
  - 3. Limbic based facial expression
- G. SSN:
  - 1. Corneal stimulation
  - 2. Gag stimulation
  - 3. Caloric stimulation
  - 4. Odor stimulation
- H. Cochlear:
  - 1. Tone recognition
  - 2. Sound localization
  - 3. Rhythm
  - 4. Metronome
  - 5. Music
- I. Vestibular:
  - 1. Angular acceleration

2. Linear acceleration
  3. Visualization
  4. Glossopharyngeal
  5. Taste stimulation
- J. Vagus:
1. Carotid compression
  2. Angular acceleration
  3. Corneal stimulation
  4. Other (text box)
- K. Spinal accessory:
1. Myofascial release
  2. Therapeutic exercises
  3. Manipulation
  4. Slow/fast stretch
  5. Other (text box)
- L. Hypoglossal:
1. Therapeutic exercises

## Rehab Principles-Head & Face Pain

- A. Central vs Peripheral nerve lesions and limitations to regeneration
- B. Cranial nerve sensory and motor relationships
- C. Peripheral signaling into brainstem
- D. Supra-segmental signaling into brainstem
- E. Metabolic capacity
- F. Central integrated state and potential for plastic change
- G. To achieve great probability of CNS change: a. fast adapting receptors need to be stimulated with varying amplitudes or patterns
  1. slowly adapting receptors will maintain a change in firing rate with a new, but constant stimulus
- H. Receptors that fire frequently (slowly adapting or associated with a frequently changing system) and are very responsive to change (high sensitivity) often have the greatest CNS input; these are mostly proprioceptors and vestibular receptors

## Rehabilitation Applications-Head & Face Pain

- A. Sympathetic inhibition
- B. Mechanisms of nerve decompression
- C. Oxygenation (decreased CO<sub>2</sub>)
- D. Vestibular reflexes
- E. Autonomic controls
- F. Gait retraining
- G. Brain based therapies
- H. Crude touch, pain, temperature and accurate touch modalities
- I. Chiropractic adjusting technique
- J. Range of motion therapeutics (resistance training, stretch, muscle work)
- K. Mental imagery

- L. Desensitization
- M. Sleep patterning
- N. Breathing exercises

## Rehabilitation Principles-Cerebellum

- A. Location:
  - 1. Midline
  - 2. Intermediate
  - 3. Lateral
- B. Sidedness
- C. Metabolic indicators
- D. Manifestation:
  - 1. Disdiadochokinesia
  - 2. Dysmetria
  - 3. Tremor
  - 4. Balance
  - 5. Speech
  - 6. Bradykinesia
  - 7. Limbic relationships
  - 8. Vestibular interactions
- E. Canal relationships/Angular acceleration
- F. Otolithic relationships/Linear acceleration

## Treatment Issues-Cerebellum

- A. Supplementation
- B. Fuel delivery
- C. Metabolic stability
- D. Modulation
- E. Medical referral

## Rehabilitation Applications-Cerebellum

- A. Cross-crawl
  - 1. Bilateral
  - 2. Ipsilateral
- B. Finger-to-nose
- C. Balance
  - 1. Rhomberg
  - 2. Tandem Gait
  - 3. One leg standing
- D. Finger to finger
  - 1. Ipsilateral
  - 2. Contralateral
  - 3. Target shifting



- 4. Computerized target shifting
- E. Rapid coordinated finger movements-Piano playing
- F. Temperature gradient and modulated calorics
- G. Novel and known faces
- H. Alternating movements
- I. Active passive/movement
- J. Visualization
- K. Vestibular integration
  - 1. Linear/angular acceleration
  - 2. Ocular activation
    - a. VOR
    - b. Pursuit/cicade targeting
- L. Extremity temperature
- M. Electrical modulation:
  - 1. Passive
  - 2. Active
- N. Visualization activity

## Rehabilitation Principles - Basal Ganglia

- A. CIS assessment of component nuclei
- B. Activation of appropriate nuclei:
  - 1. frontal mechanisms to activate striatums
  - 2. mesencephalic activation to activate frontal lobe
  - 3. mesencephalic inhibition to limit active pathway and frontal lobe
  - 4. cerebellum activation or inhibition depending upon state of contralateral mesencephalon
  - 5. cerebellum mossy fiber or climbing fiber activation for increased surround inhibition or for purkinje inhibition
- C. Measurement of metabolic capacity
  - 1. ANS:
    - a. SpO2
    - b. HR
    - c. Respiration
    - d. Skin color
    - e. Capillary filling
    - f. skin temperature
- D. Measurement of component tissue Central Integrated State (CIS), with example of mesencephalon:
  - 1. Pupillary response
  - 2. CN III
    - a. Ipsi med rectus
    - b. Inf rectus,
    - c. Inf oblique
    - d. All ipsi sub rectus
    - e. Contra sup rectus

3. Contralateral limb flexors, ocular convergence, bilateral activation of sympathetic pathway.

## Rehabilitation Principles-Autonomic Nervous System

- A. Pontine inhibition of sympathetics
- B. Frontal activation of pontine centers
- C. Limbic activation of hypothalamus
- D. Adrenal activation of sympathetics
- E. Measurement of metabolic rate:
  1. Pulse oximetry
  2. Heart rate
  3. Pupillary response
  4. Respiratory rate
  5. Erector pilar
  6. Muscle activation
  7. Skin color

## Rehabilitation Principles-Limbic System

- A. Sidedness
- B. Metabolic indicators
- C. Sensory stimulation
  1. Light
    - a. Quadrant specific stimulation
    - b. Light frequencies-color
    - c. Intensity
    - d. Quality
      - i. Bars
      - ii. Opk
      - iii. Still/movement
  2. Sound
    - a. Localization
    - b. Pitch
    - c. Music
      - i. hemisphere specific
      - ii. emotion specific
      - iii. rhythm
      - iv. tempo
  3. Olfaction
    - a. Pleasant versus non-pleasant
    - b. Olfactory localization  
Olfactory identification
  4. Touch
    - a. Vibration
    - b. Localization
    - c. Pressure

- d. Pain/pleasure
- 5. Gustatory
  - a. Bitter
  - b. Sweet
  - c. Sour
- D. Connotation of a paragraph for right hemisphere. (interpretive meaning)
- E. Enteroception concentration (focus on body part or system) for right hemisphere.
- F. Vocalization of text for left hemisphere.
- G. Spatial awareness for right hemisphere.
- H. Mathematical calculations for left hemisphere
- I. Spatial awareness and manipulation right hemisphere

## Rehab Principles-Lobes of the Brain

- A. Functional vs Pathological lesions
- B. Left-right relationships
- C. Ascending and descending relationships
- D. Metabolic capacity
- E. Central integrated state and potential for plastic change
- F. Central changes associated with correction of joint biomechanics
- G. Frequency, intensity and durations factors in promoting central plasticity

## Rehab Applications-Lobes of the Brain

- A. Right-left hemisphere relationships with joint mechanoreceptor activity
- B. Local brain functions as rehab
  - 1. (Open ended box)
- C. Visual stimulation
  - 1. General
    - a. Hemi-field glasses
    - b. Eyelights
    - c. Other(Open Ended Box)
  - 2. Right brain
    - a. Modalities you use (open ended box)
  - 3. Left brain
    - a. Modalities you use (open ended box)
  - 4. Auditory stimulation
    - a. Right Brain
      - i. Novel
      - ii. Nature
      - iii. Poetry via audio
      - iv. Other (open ended box)
    - b. Left brain
      - i. Familiar
      - ii. Strong beat
      - iii. Prose via audio

- iv. Other (open ended box)
- 5. Olfactory stimulation
- 6. Gustatory stimulation
- 7. Tactile stimulation
  - a. Vibration
  - b. Light touch
  - c. Textures
  - d. Eyes closed identification
- 8. Cognitive activation
  - a. Right brain
    - i. Mazes
    - ii. Spatial tasks
    - iii. Novel faces
    - iv. Other (open ended box)
  - b. Left brain
    - i. Word problems/games
    - ii. Sequencing activities
    - iii. Planning activities
    - iv. Other (open ended box)
- 9. Vestibular activity
- 10. Categorizing, sequencing
- 11. Decision making
- 12. Spatial relationships
- 13. Memory
- 14. Accurate touch

## Rehab Principles-Brain & Its Environment

- A. Special Studies for Diagnosis (referred):
  - 1. CT angiography;
  - 2. MRI/MRA of brain
  - 3. Lumbar puncture
- B. Complete neurological examination by clinician.
- C. Emergent vascular accident-get transport to ED
- D. Discriminate between occlusive transient ischemia and physiologic ischemia

## Rehab Applications-Neuroendocrine

- A. Rehab Application
  - 1. Laboratory
    - a. Serum Prolactin levels
    - b. Glucose tolerance tests
    - c. Serum T3, T4 and FT4I
    - d. Calcium levels
    - e. Potassium levels
    - f. Vitamin D levels
    - g. Basal and random GH levels

- h. Hormone levels
- i. Osmolality
  - 1) Plasma
  - 2) Urinary
- j. Dehydration test
- k. 24 Hr urine
- l. Cortisol Response
  - i. Plasma cortisol
  - ii. Urinary cortisol
- m. Urine pH
- n. Urinary glucose and ketones
- 2. Radiographically
  - a. CT/MRI scanning of hypothalamus/pituitary area of brain
  - b. Conventional skull x-rays
  - c. CT scan of abdomen
- 3. Clinically
  - a. History
    - i. Sexual
    - ii. Menstrual
    - iii. Breast
    - iv. Vision
    - v. Headaches
    - vi. Menstrual
    - vii. Sleep cycle
  - b. Physical and Neurological exam
    - i. Cranial Nerves
    - ii. Palpation
    - iii. Visual field
    - iv. Cardinal gaze
    - v. Pupillary responses
    - vi. Skin and hair texture and distribution
    - vii. Core temperature
  - c. Rehab Principle
    - i. Patient education
    - ii. Refer out for medical management
      - 1. Drug therapy
      - 2. Surgery

## Rehab Principles-Pain

- A. Segmental relationship to pain inhibition
- B. Mesencephalic relationship to pain inhibition
- C. Supra-segmental signaling into cord
- D. Hypoxic relief
- E. Metabolic capacity

- F. Central integrated state and potential for plastic change
- G. To achieve great probability of CNS change:
  - a. Fast adapting receptors need to be stimulated with varying amplitudes or patterns
  - b. Slowly adapting receptors will maintain a change in firing rate with a new, but constant stimulus
- H. Receptors that fire frequently (slowly adapting or associated with a frequently changing system) and are very responsive to change (high sensitivity) often have the greatest CNS input; these are mostly proprioceptors and vestibular receptors. Proprioceptors inhibit pain segmentally and vestibular receptors activate pontine inhibition of IML.
- I. Cortical stimulation left and/or right

## Treatment Modalities-Pain

- A. Thermal
  - 1. Ice/cold packs
  - 2. Heat packs
  - 3. Alternating heat and cold
  - 4. Other (text box)
- B. Interferential
- C. Ultrasound
- D. Massage
- E. Cortical stimulation
  - 1. Right brain modalities
  - 2. Left brain modalities
- F. Exercise
- G. Vibration
- H. Light touch
- I. Adjustments
- J. Oxygen therapy (gain referral if necessary in your state/province)
- K. Referral for allopathic intervention
- L. Other (text box)
  - 1. Vestibular stimulation/spins, calorics, OPK, Metronome, visual stimulation, auditory stimulation, olfactory stimulation, etc.
  - 2. Vestibular spin or up/down
  - 3. Cold laser
  - 4. Light, sound, tens, balance, vestibular, eye motions, saccades, pursuits, smell and other therapies for brain based rehab
  - 5. Oxygen therapy is not allowed in KY
  - 6. Referral when indicated
  - 7. Oxygen therapy no allowed in NY
  - 8. Anti-inflammatory nutrition and vitamin therapy
  - 9. Laser, Needle acupuncture
  - 10. Low Level Laser
  - 11. Cold Laser Therapy

## Special Studies by Neuraxis Area and Overall

### Special Studies Neuron

- A. Blood work
- B. SPO2
- C. EMG & NCV

### Diagnostic Procedures/Special Studies-Peripheral Nerve

- A. Cervical MRI
- B. Thoracic MRI
- C. Lumbosacral MRI
- D. Shoulder MRI
  - 1. Brachial plexus
  - 2. Shoulder soft tissue
- E. Upper extremity Nerve conduction velocity testing without needle EMG
- F. Upper extremity Nerve Conduction velocity testing with needle EMG
- G. Lower extremity Nerve conduction velocity testing without needle EMG
- H. Lower extremity Nerve Conduction velocity testing with needle EMG
- I. Laboratory testing
  - 1. Heavy metals
  - 2. Serum B12
  - 3. Complete Blood Count
  - 4. Comprehensive Metabolic Profile
  - 5. Urinalysis
  - 6. Genetic testing
- J. Cardiac testing
  - 1. Doppler
  - 2. ECG
  - 3. Echo Cardiogram
  - 4. Cardiac Stress test
- K. Xray:
  - 1. Cervical spine
  - 2. Thoracic spine
  - 3. Lumbosacral spine
  - 4. Shoulder series
  - 5. Elbow series
  - 6. Wrist series
  - 7. Hand series
  - 8. Hip series
  - 9. Knee series
  - 10. Ankle series
  - 11. Foot series

## Diagnostic Testing Modalities-Limbic System

- A. MRI
- B. MRa
- C. EEG

## Special Studies for Diagnosing & Treating Patients

- A. How important is your knowledge about the following special studies in diagnosing and treating your patients and how frequently do you order them? How do you manage the special studies (perform yourself, refer, etc.)
  - 1. Imaging studies:
    - i. Arteriograms/Angiography
    - ii. Barium Studies
  - 2. Lower GI
    - i. Bone density scan
    - ii. CT Scans
    - iii. Diagnostic Ultrasound
    - iv. Doppler Vascular Studies
    - v. fMRI
    - vi. MRI
    - vii. MRa
    - viii. Myelogram
    - ix. Nuclear Medicine Bone Scan
    - x. Plain Film Radiology
    - xi. PET
    - xii. Regional cerebral blood flow
    - xiii. SPECT
    - xiv. Other imaging studies (text box)
  - 3. Electro-diagnostic Studies:
    - i. Evoked Potentials
      - 1. Brainstem Auditory Evoked Potentials
      - 2. Visual Evoked Potentials
      - 3. Somatosensory Evoked Potentials
    - ii. Electrocardiogram
      - 1. Exercise stress test
      - 2. Chemical stress test
    - iii. Electroencephalography
    - iv. Electronystagmography
    - v. Needle Electromyography
    - vi. Nerve Conduction Velocity
    - vii. Quantitative Electroencephalography
  - 4. Other diagnostic Studies
    - i. Auscultatory Examination:
      - 1. Subclavian bruit
      - 2. Carotid bruit



3. Temporal bruit
4. Intracranial (Orbital) bruit
5. Heart
6. Lungs
7. Abdomen
- ii. Audiometric Examination
- iii. Typanography
- iv. Bronchoscopy
- v. Balance Testing
- vi. Bimanual pelvic exam
- vii. Caloric Testing
- viii. Colonscopy
- ix. Diagnostic educational testing
- x. Endoscopy
- xi. Fundoscopy
- xii. Just Noticeable Difference Testing
5. Touch and distance apart
6. Mammogram
7. Neuro-psychologic testing
8. Behavioral testing
9. PAP
10. Posturography
11. Quantitative Strength Testing
12. Skin temperature
13. Spirometry
14. Video nystagmography
15. Visual studies
  - i. Ansler grid
  - ii. Florescein
  - iii. Retinal photpgraphy
  - iv. Visual field, perimetry
16. Laboratory Studies
  - i. Basic Metabolic Profile
  - ii. Biopsy
    1. Bowel
    2. Lung
    3. Nerve
    4. Muscle
    5. Liver
    6. Kidney
    7. Skin
    8. Stomach, other GI
    9. Cervical
    10. Ovarian
    11. Uterine
    12. Cysts

- a. CBC
  - b. CBC with diff
  - c. Culture & sensitivity
  - d. Cytokine levels
13. DNA testing
  14. Food allergy/sensitivity
  15. Genetic testing
  16. Heavy metal testing
  17. Hemoglobin A1C
  18. HIV
  19. Testing for Illegal drugs
  20. Kidney panel
  21. Liver panel
  22. Lumbar Puncture
    - a. Hemorrhage
    - b. Cells
    - c. Electrophoresis
    - d. Glucose
    - e. Opening pressure
  23. Lyme testing
  24. Ova & Parasite
  25. Pharmacokinetics testing-monitor therapeutic blood levels, detecting early toxicity
  26. Postprandial blood glucose
  27. Salivary cortisol
  28. Serum Folate
  29. Serum Vit B12
  30. Serum 25 hydroxy - vitamin D
  31. Sputum culture
  32. Stool analysis fat content
  33. Thyroid Function
    - a. TSH
    - b. Free T4
    - c. Calculated Free T3
    - d. Reverse T3
    - e. T3 uptake
    - f. Thyroid Antibodies
  34. UA with microscopic, cast
  35. 24 hr VMA
  36. 24 hr Urinary halide with Iodine loading

## Other Special Studies Mentioned in Open Ended Survey Responses

Reverse T3 and T3 uptake not offered by my lab (Canada) otherwise I would do them.

The vast majority of the time, MRI and other visualization/radiology exams have already been done, such as opening pressure on lumbar puncture or SPECT or PET or MRI or fMRI or biopsy, EMG, NCV, EEG, ECG and if I suggest or order such tests it is always in coordination with the primary care physician or specialist. Of course, if I find something on independent management that requires primary care, there is a referral or consultation.

Overall, this survey has been a great review of what I know and a great reminder of what I don't know or need to learn more about. Thanks.

Hormone panels: some of these tests are not familiar to me. This is also very dependent on location. In Europe, much harder for DC to order labs, must go through GP... also cannot take own x-rays, etc.

Cardiac panel, DHEA, Serotonin, Glucose, Catecholamines, I work as an FNP.

HLA B27, RA latex, Fluorescent antinuclear antibodies, Uric Acid, C reactive protein, Cardiac enzymes, in Australia, we cannot order any of these tests. I run general chemistries in my office and routinely order blood work on my patients.