Neuro dysfunction patterns by injury

Frontal lobe: contralateral weakness, personality changes/ antisocial behavior, broca's aphasia, delayed or poor initiation.

Parietal Lobe: constructional apraxia and anosognosia, Wernicke's aphasia, homonymous visual defects, impaired language comprehension.

Occipital Lobe: variety of visual deficits (homonymous hemianopsia, visual agnosia, cortical blindness), impaired extra-ocular muscle movement

Temporal Lobe: hearing impairments, memory and learning deficits, wernicke's aphasia, antisocial behaviors

Cerebellum: Ataxia, lack of trunck and extremity coordination, intention tremors, balance deficits, dysdiadochokinesia, dysmetria

Basal Ganglia: bradykinesia and akinesia, resting tremors, rigidity, athetosis, chorea,

Thalamus: thalamic pain syndrome, altered relay of sensory information

Hypothalamus: altered basic homeostasis of body functions, poor autonomic nervous system function, altered function of anterior pituitary gland (ADH secretion and reproduction)

brainstem: Altered consciousness, contralateral hemiparesis or hemiplegia, cranial nerve palsy, altered respiratory patterns, attention deficits.

Right hemisphere: left sided sensory and motor deficits, unable to understand nonverbal communication, difficulty in sustaining movements, poor hand eye coordination and kinesthetic awareness, quick and impulsive, overestimation of abilities.

Left hemisphere: right sided sensory and motor deficits, difficulty understanding and producing language, difficulty sequencing movements, poor logical and rational thought, slow cautious anxious, self depreciating.

Functions of the brain

Frontal Lobe	primary motor cortex responsible for voluntary movements on contralateral side. Broca's area (motor components of speech), cognition, judgement, attention, abstract thinking and emotional control
Parietal lobe	primary sensory cortex integrates sensation from contralateral side of body, short term memory, perception of touch, proprioception pain, and temp sensations
Temporal lobe	Primary auditory cortex, associative auditory cortex, wernicke's area (comprhension of spoken word), long term memory, visual perception, primary visual cortex
Occipital lobe	visual association cortex (processes visual info and applies meaning)
Medulla oblongata	contains centers for vital sign functioning of the cardiac, respiratory, and vasomotor centers,. maintains consciousness and arousal

Functions of the brain (cont)

Hypoth-alamus	critical for maintaing homeostasis. controls primitive drivesrelated to age, agression, emotion, thirst, hunger, sleep wake cycle. Damage to this area can cause problems with temp, water, and behavioral regulation.
Basal ganglia	regulates posture and muscle tone
cerebellum	maintains posture and voluntary muscle movement control
Brainstem	contains cranial nerve nuclei, damage damage can lead to variety of cranial nerve dysfunctions

gait deviations seen w/ stroke

Hip	
Retraction	Increased trunk and LE muscle tone
Hiking	Inadequate hip and knee flexion, increased tone in trunk and LE
Circumduction	Increased extensor tone, inadequate hip and knee flex, increased PF in ankle or footdrop
Inadequate hip flexion	Increased extensor tone, flaccid LE
Knee	
decreased knee flexion during swing	Increased LE extensor tone, weak hip flex
excessive flex during stance	weakness or flaccidity in LE, increased flex tone in the LE
hyper extension during stance	hip retraction, increased extensor tone in LE, weakness in hamstrings, quads, gluteus maximus
Instability during stance	increased LE flex tone , flaccidity or weakness of extensor muscles.
Ankle	
footdrop	increased ext tone, flaccidity
ankle inversion/eversion	increased tone in specific muscle groups, flaccidity
toe clawing	increased flexor tone in toe muscles.

Neuro cranial nerves

1:olfactory	sensory	smell
2=optic	sensory	visual acuity

Neuro cranial nerves (cont)					
3=ocul-omotor	motor	turns eye up, down, and in	screen: observe position of eye Test: persuit eye movements	Impaired eye movments, eye deviation from normal position, ptosis (drooping eyelid), pupillary dilation	cerebrovasculary accident, myasthenia Gravis
4= trochlear	motor	turns adducted eye down			
5=trigeminal	sensory	facial sensation	screen: test pain; light touch sensations forehead, cheecks, jaw, (eyes closed) corneal reflex; touch lightly with wisp of cotton palpate muscles; have pt clench teeth, hold against resistance	Findings: loss of facial sensation, numbness, loss of corneal reflex ipsilaterally; weakness, waisting of muscles for mastication	trigeminal neuralgia, MS
	motor	muscle of mastication (temporalis, and masseter			
6=Abducens	motor	turns eye out			
7=facial	sensory	taste on the anterior 2/3 tongue			

Neuro cranial nerves (cont)					
	motor	facial expressions	screen: test motor function: raise eyebrows, frown, show teeth, smile, close eyes, puff out cheeks	findings: paralysis, ipsilateral fascial muscles, inability to close eye, droop in corner of mouth, difficulty with speech articulation	bells palsy, CNS facial paralysis, stroke
8=vestibulocochlear	sensory	vestibular occular reflex balance, hearing accuity	screen: vestibular function: test balance, eye head coordination (vor gaize stability) cochlear function auditory accuity, use tuning fork on top of head, on mastoid bone.	Findings vestibular: vertigo, disequilibrium, nystagmus. findings coclear: deafness, impaired hearing, tenitis	balance deficiencies.
9=glossopharyngeal	sensory	taste posterior 1/3 of tongue			
	motor	gag reflex, pharynx control, soft palate rising with "ah" sound			
10=vagus	sensory	ANS functions,	screen: examine fro difficulty swallowing, observe motion of soft palate (elevation remains midline) and when pt says "ahh"	Finding: paralysis-palate fails to elevate, asymmetrical elevation, unilateral paralysis.	brain stem or hypothalamus dysfunction

Neuro cranial nerves (cont)

	motor	gag reflex, pharynx control, soft palate rising with "ah" sound			
11=spinal accessory	motor	traps muscle: elevate shoulders, SCM muscle: turn head to side	Screen: examine bulk of muscle, strength-shoulder shrug against resistance, turn head to each side against resistance	finding: atrophy, fasciculation, weakness (PNI); inability to shrug ipsilaterally;(ell)shoulder;shoulder droops. Inability to turn head to opposite side	SCI gullian barr syndrome
12=hypoglossal	motor	tongue movements			

PNF techniques for facilitation

PROPRIOCEPTIVE NEUROMUSCULAR FACILITATION (PNF)

Technique	Description	Purpose	Neurophysiology
Rhythmic Rotation	Active/passive mvmt in rotation along longitudinal axis	- Increase ROM - Good for hypertonicity	- Mechanoreceptors
Rhythmic Initiation	PROM → AAROM → AROM → RROM. Emphasis on agonist unidirectional.	- Initiate mvmt - Teach pattern - Synchronize components	- Decrease level of activity in reticular activating system → leads to decreased alpha motor neuron excitability.
Hold Relax, Active Mvmt	Isometric in mid-shortened pos → relax → lengthened pos → quick stretch → AAROM/AROM/RROM	- Initiation - Hypotonia & Weakness	- Increase gamma bias - Increase stretch sensitivity of intrafusal muscle fibers - Dec. reciprocal inhibition of agonist
Slow Reversal	Concentric contractions of agonists w/o relaxation b/w reversals.	- Increase agonist motion - Strengthen agonist/antagonist	- Inc. alpha motor neuron excitation via successive induction - GTO stretch stimulus
Contract Relax/ Hold Relax	Move body part to limitation & ask for max contract of antag. CR – only rotation HR – no motion	- Tightness (dec. ROM)	- Autogenic Inhibition (GTO) - Renshaw Inhibition - Supraspinal influences
Agonist Reversals	Concentric → Eccentric → Concentric contractions of agonistic muscle repeated	- Inc. control thru lengthened contraction	- Agonist being stretched as lengthened - Inc. gamma bias
Repeated Contractions	Isotonic contraction of agonist. At weakness, repeated stretch back into pattern.	- Facilitate agonist (weakness)	- Stretch reflex - Irradiation
Alternating Isometrics	Isometric of agonist then antagonist w/ hands on same side	- Used as precursor to RS	- Facilitates alpha & gamma motor neurons - Biasing of muscle spindle
Rhythmic Stabilization	Simultaneous isometric of ag/antag w/ hands on different sides.	- Co-contraction - Stabilization	- Same as AI
Slow Reversal Hold	Isometric contraction @ any range w/ SR. Applied where stability needed	- Stability in certain ROM	- Iso-contraction increase recruitment & irradiation
Timing for Emphasis	Whole pattern performed. Once wkness detected, iso-contraction at strong comp. w/ isotonic contraction of weaker comp.	- timing w/in extremity	- irradiation - Facilitation - Normal sequencing
Resisted Progression	Increase strength & enhance normal timing of mvmt. Proximal part stable and distal part mobile	- Increase strength & endurance	- Rex. increases demands - Irradiation - Cortical influence of effort
Normal Timing	Resist concentric motion until poor sequencing observed. Isometric on proximal segment & quick stretch on distal (weaker) segment	- Increase coordination & sequencing	- Mvmt regulated to subcortical levels yielding a more automatic response.

PNF Pattern

UE		
D1F	flex-add-ER	"close your hand, turn, pull arm across face"
D1E	ext-abd-IR	open your hand, turn and push your arm down and out
D2F	Flex-abd-ER	open hand, turn, lft your arm up and out
D2E	ext-add-IR	close hand, turn, pull arm down across body

PNF Pattern (cont)

LE		
D1F	flex-add-ER	bring foot up, turn, and pull leg up and across your body
D1E	ext-abd-IR	push foot down, turn, push leg down and out
D2F	Flex-abd-ER	lift foot up, turn and lift leg up and out
D2E	ext-add-IR	push foot down, turn, and pull leg down and in.
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UMN VS. LMN lesions

	UMN	LMN
Location	CNS	PNS
structures involved	Cortex, brainstem, corticospinal tracts, spinal cord	SC: anterior horn cell, spinal roots, peripheral nerves CN: cranial nerves
Disorders	stroke, TBI, SCI	Polio, guillan-Barre, PNI, peripheral neuropathy, radiculopathy
tone	hypertonia, velocity dependent	decreased or absent, hypotonia, flaccid
Involuntary movements	flexor or extensor muscle spasms	with denervation: fasciculations
strength	stroke: paraparesis, corticospinal lesions:contralateral if above decussation in medulla, Spinal cord lesions: BL loss below level of lesion	Limited distribution: segmental or focal pattern, root innervated pattern.
Muscle bulk	disuse atrophy	neurogenic atrophy
Voluntary movement	impaired or absent: dyssentric patterns, obligatory synergies	weak or absent if nerve interrupted

Neuro muscle tone abnormalities

Hypertonia

Decorticate rigidity: always an UMN lesion, sustained flexor posturing in the UE, sustained extensor posturing in the LE, Diencephalon lesion, sign of severe impairment

Decerebrate: always an UMNL, sustained ext posturing in the UE & LE, Brainstem lesion, sign of severe impairment

Rigidity: Always an UMNL, resistance to passive stretch in agonist & antagonist, Basal ganglia lesion

Cogwheel rigidity: ratchet-like response to quick passive movement; catches/releases/catches.

Leadpipe rigidity: constant rigidity

.

Hypotonia

Neuro muscle tone abnormalities (cont)

Flaccidity: LMNL, Cerebellar lesion, following spinal or cerebral shock, resolves or changes into spasticity.

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Ashworth Scale

0: No increased tone.

1 or 1+: slight increase in tone.

2: moderate increase in tone.

3: PROM is difficult.

4: affected joints are non-moveable (ankylosed)

Deep tendon reflexes commonly tested

Biceps: C5-C6

Brachioradialis: C5-C6

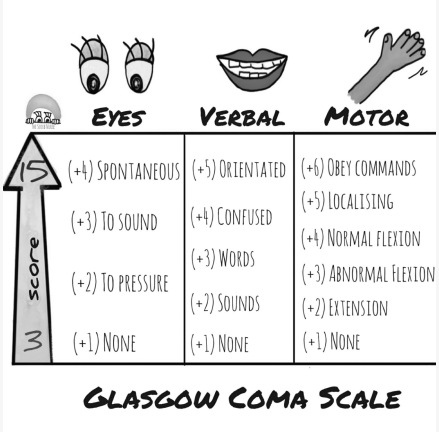
Triceps: C7-C8

Quadriceps: L2-L4

Hamstrings: L5-S3

Achilles: S1-S2

glasgow coma scale



Musculoskeletal ligaments, muscles, bones.

Ligaments: primarily type one collagen types and very strong in scars, generally hypovascular contain mechanoreceptors which contribute to proprioception, free nerve endings which contribute to pain perception. There are varying intrinsic differences within ligaments leading to varying approaches for rehab: extra-articular ligaments heal in an organized and predictable manner while intraarticular ligaments do not heal spontaneously or in a predictable manner.

Ligament sprains: 1-3 degree a few lig fibers - all are torn, caused by excessive load or stretch. pain with stretching (1 & 2), decreased ROM,

Muscle: Primarily made of loose, irregular connective tissue which makes the tissue more pliable and extensible, high vascularization and water content lead to faster healing times, easiest tissue to mobilize following trauma or period of immobilization.

Strain: muscle fibers torn caused by excessive load or stretch to muscle. Weakness, muscle spasms, swelling, disability, pain with isometric contraction, stretches,

Bone: composed of two basic layers: strong, intense outer layer- contributes to its strength, softer, mesh inner layer- stores marrow, covered with periosteum- provides blood to the bone, constantly remodeling- wolf's law (bone remodels based upon needs placed upon it)

Fracture types:

A.) complete: the bone is fx all the way through. Will require immobilization, may require ORIF through surgical intervention using screws, pins, plates to secure bone ends

B.) Incomplete: disrupted integrity of bone. fragments are still somewhat connected. will require immobilization which depends on where it is and WB/NWB status

C.) Stress fx: fine hairline fx occurring w/ little to no soft tissue damage. best seen on x ray 3-4 weeks after incident

D) Open fx: bone protrudes out of skin. Requires open reduction, possibly internal fixation.

E) Greenstick fx: bone is bent and partially fx. typically happens to children because their bones are more flexible.

Musculoskeletal Kinesiology and body mechanics

Concave- convex rule: If the moving surface is convex, the glide will be in the opposite direction the bone moves. If the moving surface is concave, the glide will be in the same direction as the bone.

End Feels:

normal end feels:

Soft: soft tissue approximation

Firm: capsular and ligamentous stretching

Musculoskeletal Kinesiology and body mechanics (cont)

Hard: bone meets
Abnormal end feels:
Boggy: edema, joint swelling
Firm w/ decreased elasticity: fibrosis of soft tissue
Rubbery: muscle spasm
Empty: loose, then very hard, associated with pt muscle guarding to avoid pain
Hypermobility: end feel later than opposite joint
Joint **Close-pack position** *loose-pack*
Facet (spine) **Extension** *Midway between flex & extension*
Temporomandibular **Clenched teeth** *Mouth slightly open*
GHJ **Abd & ER** *55-70° Horiz Add, rotated so forearm is in transverse plane*
Acromioclavicular **Arm abducted to 90°** *Arm resting by side, shoulder girdle in physiological position.*
Ulnohumeral **Extension** *70° elbow flex, 10° supination*
Radiohumeral **Elbow flex 90° forearm sup 5°** *Full ext & supination*
Prox radioulnar **5° supination** *70° elbow flex 35° supination*
Dis radioulnar **5° supination** *10° supination*
Radiocarpal **Ext with radial deviation** *between flex- ext (straight line can pass through 3rd metacarpal & radius) c slight ulnar deviation*
Hip **Full ext, IR & abd** *30° flex, 30° abduction, & slight ER*
Knee **Full ext, & ER of the tibia** *25° flexion*
Talocrural **Max DF** *10° PF, midway between inv & ev.*
Common muscle substitutions:
scapular stabilizers to initiate shoulder mvmt when shoulder abd are weak
lat trunk muscles or tensor fascia latae when hip abd are weak

musculoskeletal joint mobilizations

joint mobilization indications: pain, hypomobility, muscle spasm and guarding, functional ROM limitation

Joint mobilization contra: hypermobility, pregnancy, malignancy, unhealed fx, bone disease, effusion, inflammation, blood thinners

mob grades:
grade 1: Small amp oscillation at beginning of range.
grade 2: Large amp pushing into tissue resistance just short of joint caps.
grade 3: Large amp stretches joint caps
grade 4: Small amp high velocity manipulation past end of passive range

Special tests for musculoskeletal conditions

GHJ **Anterior instability** *apprehension test: assessment of anticipated pain when subject maintained 90 degrees Abd and ER of shoulder.*

Special tests for musculoskeletal conditions (cont)

Posterior and inferior instability *Jerk test: sudden jerk applied to shoulder in 90° flexion and IR (humeral head subluxes off the back of the glenoid) Sulcus sign: an indentation occurs inferior to the acromion as distal distraction is applied to the humerus.*

Subacromial impingement *Hawkins- kennedy: passive 90° flex and IR reproduce pain Neer's: Passive IR and full abd reproduce pain Empty can: shoulder placed at 90° abd 30°horiz add, pain c resistance*

Rotator cuff pathology *Drop arm: unable to slowly lower arm passively abducted to 120° Lag signs: pt unable to maintain IR/ ER*

ACJ *H add: localized pain occurring during H add p/arom.* **SLAP** *active compression: painful pop oc click in 90° flex, 10-15° add and full IR when downward force is applied Biceps load 2: apprehension when asked to flex biceps against resistance at 120° abd.*

Thoracic outlet syndrome *Adson's: radial pulse diminish when arm is extended and ER, pt head rotated toward arm.**Roos: radial pulse diminishes when arm placed in 90° abd, slight H add, elbow flex to 90°, open and close fist for 3 mins.

Elbow ***Ligament instability*** Varus/valgus stress: laxity noticed as varus and valgus stress applied to elbow in 20-0° flex Biceps rupture: Distal bunching of muscle noted and complete loss of function. *

Neuro dys *Flex: pain at the medial epicondyle of elbow, numbness and tingling in ulnar nerve distribution. Reproduced when pt hold c max elbow flex and wrist ext 1 min. Indicates cubital tunnel syndrome.*

Wrist & hand **De Quervain's tenosynovitis (tendonitis of abductor pollicis longus or extensor pollicis brevis)** *eichoff's: pain reproduced when thumb is flexed across palm while moving into ulnar deviation. Finkelstein: pain reproduced when wrist and thumb are pulled into ulnar deviation with distraction force.*

Neuro dys *Phalen's (wrist flexion): tingling and paresthesia reproduced during max wrist flex and hold together for 1 min, indicates carpal tunnel compression of medial nerve. Tinel sign: tingling and paresthesia are reproduced when tapping over carpal tunnel area compressing medial nerve. 2-pt discrimination: asses ability to detect 2 pts of contact at once on palm.*

Hip **DJD** *Scour/grind: P! when compressive force is applied to femur, hip 90° flex, knee max √*

Dys, mob restriction *Patrick (faber): involved leg is unable to assume relaxed posture, P! symptoms c hip √, abd, ER, foot placed proximal to knee in supine*

Muscle length, strength involvement *Thomas test: supine slingle leg hip and knee max √ , if opp limb flexes, indicates tightness of psoas major. Ober: Passive hip extension and lowering from abd, sidelying, tightness of tensor facia lata and or iliotibial band. Ely's : tightness of the rectus femoris when hip of tested limb lifts off testing surface with knee flexion, tested in prone. Trendelenburg sign: observe pelvis of stance leg positive if ipsilateral hip drops when limb support is removed. Indicative of weak glut med or unstable hip*

Knee **1-plain anterior instability** *Lachman: + excessive anterior translation of the tibia compared to the uninvolved limb and lack of firm end feel. Anterior drawer : + excessive anterior translation of the tibia compared to the uninvolved limb.*

Special tests for musculoskeletal conditions (cont)

1-plain posterior instability *Posterior drawer: + excessive posterior translation of the tibia compared to the uninvolved limb. Posterior sag: tibia sags posteriorly(normally extends 1 cm anteriorly beyond femoral condyle) when positioned supine, hip √ 45° knee √ 90°*

1-plain medial-lateral instability *Varus stress test: + excessive lateral mvmt or pain at the lateral knee Valgus stress+ excessive medial mvmt or pain at the knee (both tests performed at 0° and 30°√, + at 0° √ indicates major disruption of the knee and one or more rotary tests +.*

Meniscus tear *McMurray: + reproduction of click and or pain in the knee joint with rotary force applied.*

Musculoskeletal conditions and interventions

Anklyosing Spondylitis: progressive inflammatory disorder that initially affects the axial skeleton, occurs before 40, affects thoracic and lumbar regions, BL SIJ, restricted P/AROM, flexed posture throughout entire spine.
Interventions: flexibility ex to maintain trunk motions and improve joint motions, especially ext. Implement aerobic such as aquatics for improved activity endurance. Include relaxation techniques such as breathing strategies for improved respiratory function

Psoriatic Arthritis: chronic erosive inflammatory disorder that typically occurs in the axial skeleton and digits.
Intervention: joint protection, aerobic activities for reconditioning

Rheumatoid arthritis: chronic systemic autoimmune disorder characterized by periods of acute exacerbation and remission. weight loss, fever, extreme fatigue.
Interventions: joint protection strategies, aerobic conditioning, maintain joint mechanics and connective tissue function

Osteomalacia: decalcification of bones as a result of vit D deficiency, severe pain, fx, weakness, deformities.
Interventions: bone protections strat, areobic conditioning, improve joint mechanics

Osteochondritis dissecans:separation of articular cartilage from underlying bone. Usually involving medial femoral condyle near the interc-ondylar notch, sometimes occurs on the femoral head or the humeral capitellum.
Interventions stretches, bone protection strats, aerobic conditioning, strengthening, power and endurance ex.

Tendinitis: inflammation of tendon caused by microtrauma, direct blow, overuse, excessive tensile force.
Interventions: manual, stretches, endurance conditioning, pt ed.

Bursitis: inflammation of the bursa secondary to overuse, gout, or trauma, or infection. Characterized by pain with rest, and decreased P/AROM due to pain, not in capsular pattern.
Interventions: stretches, manual therapy, endurance training, modalities, pt ed.

Myositis Ossificans: painful condition of abnormal calcification within muscle belly caused by direct trauma. most commonly located in the biceps, brachialis, and quads.
AVOID AGRESSIVE STRETCHING. gentle stretches, manual therapy, endurance conditioning

GHJ dislocation: most common anterior, caused by abduction and forceful ER. Posterior is caused by H Add, and IR. s/p avoid painful positions which may include: GHJ flex 90 deg, H Abd 90+, ER 80.
Interventions: restore normal GHJ motions, strength, endurance and stability.

patellofemoral conditions: abnormal malalignment of the patella. causes pain that is made worse with inactivity.
interventions: McConnel taping, Patellar mobilizations to lessen the abnormality. Correction of muscular imbalances.

Musculoskeletal conditions and interventions (cont)

Osgood-schlatter: jumper's knee, Made worse with activity mechanical dysfunction resulting in traction apophysitis of the tibial tubercle at the patellar tendon insertion. Irregularities of the epiphyseal line.
Interventions: modify activities to prevent excessive stress to irritated site.

Anterior compartment syndrome: Increased compartmental pressure resulting in local ischemic condition. caused by trauma, fx, overdose, muscle hypertrophy. characterized by deep achey feeling, swelling, parasthesia, severe pain,
Acute ACS is considered a medical emergency and requires immediate surgical intervention with fasciotomy to prevent tissue death and permanent disability.

ION concentration changes

hyperkalemia: increased potassium, widened PR interval, QRS wave, and tall T waves, tachycardia (potentially leading to bradycardia, potentially leading to cardiac arrest)

Hypokalemia: ECG changes (flattened T wave, prolonged PR and QT intervals, hypotension, arrhythmias may progress to V-fib .

Hypercalcemia: hypertension, signs of heart block, cardiac arrest

hypocalcemia: arrthmias, hypotension

hypernatremia: increased sodium, hypertension, tachycardia, pitting edema, excessive weight gain

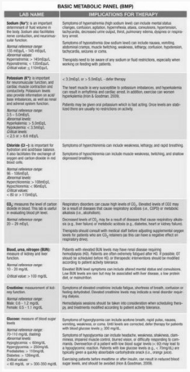
hyponatremia: hypotension, tachycardia

lab values and meaning

COMPLETE BLOOD COUNT (CBC)

LAB TESTS AND RANGES	IMPLICATIONS FOR THERAPY
White blood cell count (WBC): used in determining immune system status, and in detecting the presence of infection or inflammation. *Normal reference range:* 5,000 – 11,000/mm³ *Abnormal levels:* Leukocytosis: > 11000/mm³ Leukopenia: < 5000/mm³ *Critical values:* < 2,000 or > 30,000/mm³	< 500 - is extremely dangerous and can be fatal < 1000 - therapy is generally deferred < 4000 – neutropenic precautions are observed (i.e., strict hand washing; wearing of face mask, gown, gloves; reverse isolation if patient leaves room; sanitizing all equipment brought into room) < 5000 and febrile – therapy is generally deferred > 5000 – light or resistive activity, as tolerated 11,000 and febrile – use caution when exercising Presence of infection can affect occupational performance, as it may increase oxygen demand utilization.
Hemoglobin (Hgb): measures the blood's capacity to carry oxygen. *Normal reference range:* Male: 13 - 18g/dL Female: 12 – 16g/dL *Critical values:* < 5 g/dL - may result in heart failure or death > 20 g/dL - can lead to increased blood viscosity, clogging of capillaries and tissue ischemia	< 8g/dL - defer therapy 8 - 10g/dL - light exercise okay, however vitals should be closely monitored > 10g/dL – resistive exercise okay When hemoglobin levels are low, the heart has to work harder to ensure there is sufficient oxygen transported throughout the body.
Hematocrit (HCT): measures the percentage of red blood cells in total blood volume. Also assists in diagnosis of anemia and polycythemia. *Normal reference range:* Male: 37% – 49% Female: 36% - 46% *Abnormal value:* < 25% *Critical value:* < 20% or > 60%	< 20% - can result in cardiac failure/death < 25% - defer therapy 25% - 30% - ADL and light exercise, as tolerated 30% - can add resistive exercise > 60% - is associated with spontaneous blood clotting Symptoms of low hemoglobin and hematocrit (H & H) include weakness, fatigue, tachycardia, dyspnea on exertion (DOE), heart palpitations, and decreased exercise tolerance, requiring close monitoring of vitals and incorporation of rest breaks.
Platelets: are responsible for blood clotting by forming platelet plugs. *Normal reference range:* 150,000 – 400,000/µL *Abnormal values:* Thrombocytosis: > 1 million/µL Thrombocytopenia: < 150,000/µL *Critical value:* < 20,000/µL	< 20,000/µL - defer therapy due to increased risk of spontaneous bleeding, ecchymosis, or prolonged bleeding time. Tooth brushing may be deferred. 20,000 – 50,000/µL - light active range of motion (AROM), light activities of daily living (ADL), and ambulation are appropriate, however PROM is deferred. < 50,000/µL - no resistive exercise, however ambulation and ADL are permissible. 50,000/µL – may start including resistive exercise. 50,000 - 80,000/µL - minimal resistive exercise, low intensity PRE (progressive resistive exercise), ambulation and ADL okay. 80,000 - 150,000/µL - moderate resistive exercise can be included. >150,000/µL - no activity restrictions. ADL for patients with thrombocytopenia may need to be modified due to the increased risk of bleeding easily from mucosal surfaces (i.e., gums, nose, GI tract, respiratory tract, and uterus). ADL may include use of a soft toothbrush, avoidance of flossing; gentle wiping but avoidance of blowing nose; avoidance of using tampons, or shaving with a straight razor.Fall prevention and safety strategies also should be reinforced.
Red blood cell count (RBC)/ Erythrocyte: are the number of red blood cells found in blood. This value is a reflection of the blood's capacity to transport oxygen and nutrients throughout the body, and is useful in diagnosing anemia and polycythemia *Normal reference range:* Male: 4.5-5.3 mcL Female: 4.1-5.1 mcL *Abnormal values:* Male: > 5.72 mcL Female: > 5.03 mcL	Patients with anemia (decreased number of RBC) may have decreased endurance and aerobic capacity. Symptoms of anemia include weakness, fatigue, dizziness, dyspnea on exertion, and palpitations. Therapists should verify facility policy or consult with medical staff before working with patients while receiving a blood transfusion; low-level or bedside activity may be permissible. Patients with polycythemia (increased number of RBC) have increased risk of stroke and thrombosis. Symptoms can include headache, dizziness, blurred vision, altered mental status, or impaired sensation in the hands or feet.

Lab values and meaning



BASIC METABOLIC PANEL (BMP)

LAB NAME	IMPLICATIONS FOR THERAPY
Sodium (Na^+): is an important determinant of fluid volume in the body. Sodium also facilitates nerve conduction, and neuromuscular function. *Normal reference range:* 135 mEqu/L - 145 mEqu/L *Abnormal values:* Hypernatremia: > 145mEqu/L Hyponatremia: < 135mEqu/L *Critical value:* ≤ 110mEqu/L	Symptoms of hypernatremia (high sodium level) can include mental status changes, confusion, agitation, hyperreflexia, ataxia, convulsions, hypertension, tachycardia, decreased urine output, thirst, pulmonary edema, dyspnea or respiratory arrest. Symptoms of hyponatremia (low sodium level) can include nausea, vomiting, abdominal cramps, muscle twitching, weakness, lethargy, confusion, hypotension, tachycardia, seizures or coma. Therapists need to be aware of any sodium or fluid restrictions, especially when working on feeding with patients.
Potassium (K^+): is important for neuromuscular function, and cardiac muscle contraction and conductivity. Potassium levels also provide information on acid/base imbalances, as well as renal and adrenal system function. *Normal reference range:* 3.5 – 5.0mEq/L *Abnormal levels:* Hyperkalemia: > 5.0mEq/L Hypokalemia: < 3.5mEq/L *Critical levels:* < 2.5 or > 6.6 mEq/L	< 3.2mEq/L or > 5.0mEq/L - defer therapy The heart muscle is very susceptible to potassium imbalances, and hyperkalemia can result in arrhythmia and cardiac arrest. In addition, exercise can worsen hyperkalemia (Irion & Goodman, 2009). Patients may be given oral potassium which is fast acting. Once levels are stabilized there are usually no restrictions on activity.
Chloride (Cl –): is important for hydration and acid/base balance. It also facilitates the exchange of oxygen and carbon dioxide in red blood cells. *Normal reference range:* 96 - 106mEq/L *Abnormal levels:* Hyperchloremia: > 108mEq/L Hypochloremia: < 96mEq/L *Critical values:* < 80 or > 115mEq/L	Symptoms of hyperchloremia can include weakness, lethargy, and rapid breathing. Symptoms of hypochloremia can include muscle weakness, twitching, and shallow depressed breathing.
CO_2: measures the level of carbon dioxide in blood. This lab is useful in evaluating blood pH level. *Normal reference range:* 20 – 29 mEq/L	Respiratory disorders can cause high levels of CO_2. Elevated levels of CO2 may be a result of diseases that cause respiratory acidosis (i.e., COPD) or metabolic alkalosis (i.e., alcoholism). Decreased levels of CO_2 may be a result of diseases that cause respiratory alkalosis (e.g., liver failure) or metabolic acidosis (e.g., diabetes, heart or kidney failure). Therapists should consult with medical staff before adjusting supplemental oxygen levels for patients who are CO_2 retainers (as this can have a negative effect on respiratory drive).
Blood, urea, nitrogen (BUN): measure of kidney and liver function. *Normal reference range:* 10 - 20 mg/dL *Critical value:* > 100 mg/dL	Patients with elevated BUN levels may have renal disease requiring hemodialysis (HD). Patients are often extremely fatigued after HD. If possible, OT should be scheduled before HD, or therapeutic interventions should be modified according to patient activity tolerance. Elevated BUN level symptoms can include altered mental status and convulsions. Low BUN levels are rare but may be associated with liver disease, a low protein diet, or malnutrition.
Creatinine: measurement of kidney function. *Normal reference range:* Male: 0.6 - 1.2 mg/dL Female: 0.5 - 1.1 mg/dL	Symptoms of elevated creatinine include fatigue, shortness of breath, confusion or feeling dehydrated. Elevated creatinine levels may indicate a renal disorder requiring dialysis. Hemodialysis sessions should be taken into consideration when scheduling therapy, and treatments modified according to patient activity tolerance.
Glucose: measure of blood sugar levels *Normal reference range:* 70-110 mg/dL (fasting) *Abnormal levels:* Hypoglycemia: < 60mg/dL Hyperglycemia: > 250mg/dL Prediabetes: > 110mg/dL Diabetes: > 126mg/dL *Critical values:* < 60 mg/dL or > 300-350 mg/dL	Symptoms of hyperglycemia can include acetone breath, rapid pulse, nausea, vomiting, weakness, or coma. Until levels are corrected, defer therapy for patients with blood glucose levels ≥ 300 mg/dL. Symptoms of hypoglycemia can include headache, weakness, shakiness, clamminess, impaired muscle control, blurred vision, or difficulty responding to commands. Overexertion of a patient with low blood sugar levels (< 60) may lead to a hypoglycemic reaction. Patients with low glucose levels (e.g., < 70mg/dL) are typically given a quickly absorbable carbohydrate snack (i.e., orange juice). Exercising patients before mealtime or after insulin, can result in reduced blood sugar levels, and should be avoided (Irion & Goodman, 2009).

cardiovascular dx tests

chest x-ray: lung condition, impact on lung from other conditions, blood vessels, fx, other objects	considerations: radiation
ECG: records electrical activity, Exercise tolerance test	consider: monitored in room via radio transmission, continuous monitoring during intervention, prvide ex guidlines following cardiac procedure
myocardial perfusion imaging: ischemic areas of the heart,	considerations: can visualize areas of old infarct
cardiac catheterization, (coronary angiogram): x-ray images capture to evaluate BP in heart and O2 saturations, Stint	considerations: invasive, dye in arteries, requires IV, 2-3 hrs

Skin changes

clubbing: associated with chronic O2 deficiency and CHF

pale, shiny, dry, loss hair: PVD (arterial insuffiency)

abnormal pigmentation, ulceration, dermatitis, gangrene: PVD

heart anatomy pg142

Right atrium: receives blood from systemic circulation from superior and inferior vena cava
SA-node: near superior vena cava; pacemaker of the heart
AV-node: node floor of Right atrium, receives signal from SA-node/ bundle of HIS, to depolarize and contract ventricles

Right ventricle: receives blood from RA which pumps blood through pulmonary artery to lungs for oxygenation

Left Atrium: receives oxygenated blood from lungs and 4 pulmonary veins

Left ventricle: walls are thicker and stronger than the RV and form most of the left side and apex of the heart.
receives blood from the LA and pumps blood via the aorta throughout the entire circulatory system.

Heart valves

Atrioventricular valves: prevent backflow of the blood into the atria during ventricular systole. close when ventricular walls contract.
right heart valve tricuspid, left heart valve,(bicuspid, mitral)

heart anatomy pg142 (cont)

semilunar valves: prevent backflow of blood from the aorta and pulmonary arteries into the ventricles diastole
pulmonary valve prevent right backflow.
aortic valve prevents left backflow

Arteries, veins and capillaries

Arteries: transport oxygenated blood from the heart, decrease in size and become arterioles and end as capillaries. have contractile abilities, arterial walls are thicker in order to tolerate high BP. Influenced by elasticity and elasibility of vessle walls and peripheral resistance, amount of blood in body change in diameter when triggered by sympathetic activity of the ANS, vasoconstriction or vasodilation

Veins: transport dark unoxygenated blood from peripheral tissues back to the heart. larger capacity and thinner, weaker walls than arteries, greater in number, one way valve to prevent backflow of blood because they do not have contractile abilities. rely on movement of muscle to squeeze blood back to the heart. Venous reflux occurs when the valves dont function properly caused by enlarged or weakened veins. deep veins accompany arteries while superfical's do not. increased blood return with inspiration, compliancy of right heart.

capillaries: minute blood vessels that connect the ends of arteries with the beginning of veins, functions for exchange of nutrients and fluids between blood and tissues. capillary walls are thin and permeable

142,144,

Heart failure

Left ventricular failure

S&S pulmonary congestion:dyspnea, dry cough, orthopnea, paroxysmal nocturnal dyspnea, pulmonary rales, wheezin.

S&S low cardiac output: hypotension, tachycardia, lightheaded/ dizziness, cerebral hypoxia(irritability, restlessness, confusion, impaired memory, sleep disturbances), fatigue, weakness, poor exercise tolerance, enlarged heart on x-ray, S3 sound, possibly S4. murmurs of mitral or tricuspid regurgitation.

Right ventricular failure

S&S pulmonary congestion:dependent edema, weight gain, ascites, liver enlargement

S&S low cardiac output: anorexia, nausea, bloating, cyanosis in the nail beds, RUQ pain, jugular vein distension, R-sided S3 heart sounds, murmurs of pulmonary or tricuspid insufficiency.

Cardiac medications

Pharmacology Study

COMMON CARDIAC MEDICATIONS

Drugs Type	Examples	Side Effects
ACE inhibitors (angiotensin converting enzyme inhibitors) **OR** ARBs (angiotensin II receptor antagonists) These medications block stress hormones and relieve stress on the heart's pumping action. They improve symptoms and reduce hospitalizations for patients with heart failure.	ACE inhibitors: • Benazepril (Lotensin) • Captopril (Capoten) • Enalapril maleate (Vasotec) • Lisinopril (Prinivil, Zestril) • Quinapril (Accupril) • Ramipril (Altace) ARBs: • Candesartan cilexetil (Atacand) • Eprosartan mesylate (Teveten) • Irbesartan (Avapro) • losartan (Cozaar) • telmisartan (Micardis) • valsartan (Diovan)	**Side effect:** A dry, non-productive cough is a common side effect of ACE inhibitors. **Note:** Don't use potassium supplements or salt substitutes without first asking your healthcare providers.
Antiarrhythmics (heart rhythm medications) These control irregular heartbeats — and maintain a normal heart rate and rhythm.	• amiodarone (Cordarone) • disopyramide phosphate (Norpace) • dofetilide (Tikosyn) • flecainide (Tambocor) • mexiletine HCl (Mexitil) • procainamide (Procan, Pronestyl) • propafenone HCl (Rythmol) • propafenone HCl SR (Rythmol SR) • quinadine glucomate (Quinaglute) • sotalol (Betapace, see beta blockers) • tocainide HCl (Tonocard)	**Notes:** • As with any medication, take antiarrhythmics exactly as ordered. • If you're taking some of these medications, you'll need ongoing monitoring by your healthcare provider. • If you're taking an extended-release tablet, be sure to swallow the pill whole — don't break, chew, or crush it.
Anticoagulants and platelet inhibitors ("blood thinners") These cause your blood to take longer to clot, which can reduce the risk of strokes and heart attacks that can occur when blood clots get stuck in small blood vessels.	Anticoagulants: • dalteparin sodium (Fragmin) • enoxaparin (Lovenox) • fondaparinux (Arixtra) • heparin sodium • warfarin (Coumadin) Platelet inhibitors: • aspirin • cilostazol (Pletal) • clopidogril bisulfate (Plavix) • dipyramidamole (Persantine) • prasugrel (Effient) • ticlopidine (Ticlid)	**Side effect:** **Call your healthcare provider if you notice bleeding** from your gums, or blood in your urine or stools.
Antihypertensives (blood pressure medication) These are commonly used to treat high blood pressure by relaxing and widening blood vessels.	• clonidine HCl (Catapres, Dixarit) • doxazosin mesylate (Cardura) • hydralazine HCl • methyldopa (Aldomet) • minoxidil • phenoxybenzamine HCl (Dibenzyline) • phentolamine mesylate (Regtine) • prazosin HCl (Minipress) • terazosin HCl (Hytrin)	**Note:** As with any drug, don't stop using blood pressure medication without first asking your healthcare provider.
Beta blockers **These medications are often prescribed to treat angina, high blood pressure, and irregular heart rhythms. They:** **• Block stress hormones and relieve stress on the heart's pumping action** **• Relax the blood vessels so blood can move more easily** **• Improve the heart's function** **• Reduce symptoms and lessen the chance of future hospitalizations**	• acebutolol HCl (Sectral) • atenolol (Tenormin) • betaxolol (Kerlone) • bisoprolol (Zebeta) • carvedilol (Coreg) • labetalol HCl (Normodyne, Trandate) • metoprolol succinate (Toprol XL) • metoprolol tartrate (Lopressor) • nadolol (Corgard) • nebivolol (Bystolic) • pindolol (Visken) • propranolol HCl (Inderal) • sotalol (Betapace) • timolol maleate (Blocadren)	**Side effects:** • In some people, beta blockers can cause drowsiness. **• Call your healthcare provider right away** If you have any of these side effects: **– Chest pain (may be related to your disease** and not a side effect) **– Fainting or severe dizziness** **– Slow, fast, or irregular heartbeat** **– Swelling of your feet or ankles** **– Unusual bleeding or bruising** **– Unusual weight gain** **– Wheezing or trouble breathing**
Calcium channel blockers **These are commonly used to treat high blood pressure, coronary artery spasms, and angina. They restrict the normal flow of calcium into the cells of the heart and blood vessels, which discourages smaller vessels from narrowing and going into spasm, and also reduces the heart's workload and need for oxygen.**	• amlodipine besylate (Norvasc) • bepridil (Vascor) • diltiazem HCl (Cardizem, Dilacor, Tiazac) • felodipine (Plendil) • isradipine (DynaCirc) • nicardipine HCl (Cardene) • nifedipine (Adalat, Procardia) • nisoldipine (Sular) • verapamil HCl (Calan, Covera, Isoptin)	**Side effect:** Calcium channel blockers can cause swelling in your feet and legs.
Diuretics ("water pills") These help rid your body of excess fluid and salt. They are often prescribed for high blood pressure and congestive heart failure.	• amiloride (Midamor) • bumetanide (Bumex) • chlorothiazide (Diuril) • ethacrynic acid (Edecrin) • furosemide (Lasix) • hydrochlorothiazide (Esidrix, HydroDIURIL, Microzide, Oretic) • indapamide (Lozol) • metolazone (Mykrox, Zaroxolyn) • triamterene (Dyrenium)	**Side effects:** • Diuretics can cause extreme weight loss, lightheadedness, or increased blood pressure.

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Tx considerations for cardiac meds

Ace Inhibitors: watch for potential dizziness or orthostatic hypotension, NSAID's can reduce or negate the effects of the meds. monitor pt closely for elevated BP

Ca+ channel blocker: use PRE scale for monitoring exertion levels. may reduce blood flow to heart muscle and create ischemic response. monitor for orthostatic hypotension.

Alpha blockers: monitor for signs of hypotension, and reflex tachycardia; where heart rate increase to compensate for hypotension

Beta blockers: Use PRE scale, watch for bradycardia and OH, can worsen asthma symptoms.

Diuretics: can cause fluid and electrolyte imbalances; observe pt for muscle weakness or spasms, headache, and poor coordination. Monitor for bradycardia and OH.

Nitrates: observe for dizziness, tachycardia, and OH. Pt may c/o headache.

Lymphedema

etiology: primary lymphedema: congenital; Secondary lymphedema: occurs as a result of injury to lymphatic vessels or parasitic infection.

Progressive over time: w/o tx, may develop into fibrosis, chronic infection, or loss of limb function

Symptoms: heaviness, tightness, or pain, swelling, and persistent edema, loss of ROM and function in an arm or leg

Skin changes: hardening and/or discoloration of skin

Dx: history, visual inspection and palpation, girth measurements.
tests may include: MRI & CT scans; doppler ultrasound, radionuclide imaging of the lymphatic system.

Staging:0-latent, 1-spontaneously reversible, 2-spontaneously irreversible, 3- lymphostatic elephantiasis

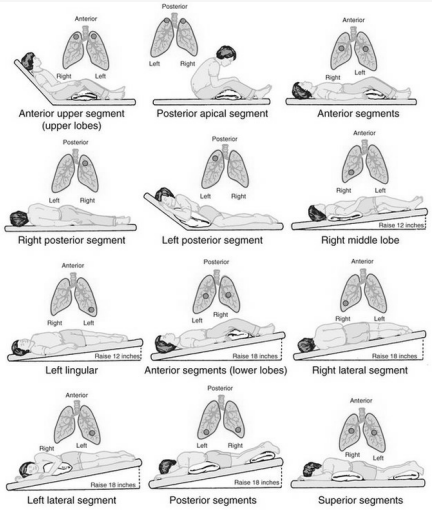
Tx: complete decongestive therapy, manual lymph drainage, short stretch compression bandages, exercises, functional training, skin care and lymphedema education

pulmonary breathing muscles

Resting Inspiration	Diaphragm (Phrenic nerve, C3-5)
Deep inspiration	Diaphragm; SCM, scalenes- elevate 2 upper ribs; levator costarum, scalenes- elevate remaining ribs; pec major, serratus posterior superior(SCM: CN XI, 2, 3, Scalene: lower cervical root)
forced inspiration	muscles of resting and deep inspiration, trapezius, pectorals, serratus, levator scapula (traps: CNX1, pect: medial pectoral C8, T1, serratus: long thoracic C5-7, levator: C3-4, dorsal scapular)
resting expiration	same as resting inspiration, internal intercostals(intercostal nerve T2-6
Forced expiration	muscles of forced inspiration+ abs, quadratus lumborum, lower iliocostalis, serratus posterior inferior. (abs: 7-12 intercostal nerves, iliohypogastric, ilioguinal nerve, QL: 12th thoracic &1st lumbar nerves)

when having difficulty breathing, SCI pts should lay day to help decrease the effects of gravity upon the diaphragm and improve the inspiratory capacity of the lungs.

pulmonary percussion positions



pneumonia

bacterial	*Viral*	*Aspiration*
shaking chills, fever, chest pain if pleuritic involved, productive or purulent, blood streaked, rusty sputum. cackles, tachypnea, increased white blood cell count, hypoxemia, hypocapnea leading to hypercapnea with increasing severity. CXR confirmation of infiltrate.	recent upper respiratory infection, fever, chills, dry cough, headaches, cackles, hypoxemia and hypercapnea, normal wbc count, CXR confirmation of interstitial infiltrate.	aspiration event, dry cough leading productive, dyspnea, tachypnea, cyanosis, tachycardia, wheezes and cackles, hypoxemia hypercapnea, chest pain, fevre, wbc count shows varying degrees of leykocytosis, CXR initially shows pneumonitis. chronic aspiration shows necrotizing pneumonia with cavitation .

pulmonary diseases

TB: airborne, incubation period: 2-10 weeks. to become noninfectious: 2 weeks on antituberculin drugs