



Lab Values in Acute Care Therapy

TO MODIFY TREATMENT OR NOT???

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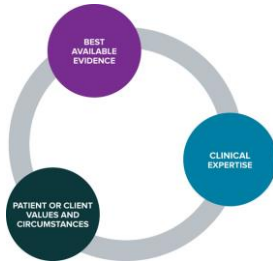
Objectives

- At the end of this course, the participant will be able to:*
- Recognize critical lab values and why they are important to acute therapy treatment plans
 - Identify which lab values will most likely alter intended treatment plan
 - Interpret how treatment options will be modified based upon presence or lack thereof abnormal lab values
 - Explain when/how/why to collaborate with other clinical team members in regards to patient status and treatment appropriateness
 - Formulate reputable documentation in regards to explanation of treatment adaptation

Elements of Evidenced Based Practice

“... it is expected that physical therapists accept **full responsibility** and **accountability** for exercising **professional judgment** within their scope of practice. Physical therapists are responsible for ensuring that their **professional judgment and the needs of the individual** have primacy over organizational, payment, or other pressures that might arise that conflict with what the therapist judges to be the **appropriate action on behalf of an individual**.”

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Patient Management Decision Making

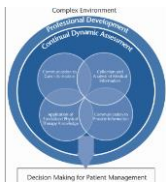


Fig 2

- ❖ Physical Therapist participants viewed their plan of care as a step-wise process from admission to discharge but **NOT** of a linear fashion
- ❖ Particular observance of all clinical signs and symptoms required continual decision making resulting in accommodating change within a single treatment session to re-arranging a total plan of care

Clinical Practice Guidelines

- ❖ EVIDENCED BASED
- ❖ GROUP WITH CLINICAL JUDGEMENT AND PATIENT REQUESTS FOR OPTIMAL OUTCOMES
- ❖ UTILIZE IN COLLABORATION WITH OTHER HEALTHCARE PROFESSIONALS

Rationale For Tests

- ❖ Determine disease etiology of uncertainty
- ❖ Confirmation of suspected diagnosis
- ❖ Differentiate among varied diagnoses
- ❖ Resolve the stage, activity, or severity of disease
- ❖ Detect disease recurrence
- ❖ Assess the effectiveness of therapy
- ❖ Guide the course of therapy

Measurement

- ❖ Volume: (liter, L)
- ❖ Force: (newton, N, kg)
- ❖ Pressure: (pascal, Pa, kg)
- ❖ Energy: (joule, J)
- ❖ Power: (watt, W)

Prior to ANY Patient Intervention

- ❖ Review lab values
- ❖ Recognize whether normal or abnormal for patient's current status
- ❖ Discuss most recent behaviors, changes, and interventions with nursing staff and physicians
- ❖ Determine potential changes in patient's physiology during physical therapy interaction
- ❖ Decide whether to modify the day's plan of action for patient intervention by weighing anticipated benefits versus risks

Considerations to Lab Values

MEDICATIONS PATIENT IS INGESTING THAT COULD ALTER VALUES

TRENDS IN VALUE CHANGES

ADDITION OF INTRAVENOUS INFUSIONS, VITAMINS, AND NEW MEDICATIONS

CHRONIC MEDICAL CONDITIONS

AGE, GENDER, AND RACE OF PATIENT

Normal Vital Sign Readings

- ❖ Heart Rate: 50-120 bpm
- ❖ Systolic Blood Pressure: 80-180 mmHg
- ❖ Diastolic Blood Pressure: 40-110 mmHg
- ❖ SPO₂: Above 90%
- ❖ Respirations: 12-20 breaths per minute
- ❖ Mean Arterial Pressure (MAP): 70-105 mmHg

MAP

- ❖ Average pressure in arteries within one cardiac cycle
- ❖ Recognized as a better indicator of tissue perfusion to vital organs than systolic blood pressure
- ❖ $MAP = \frac{SBP + 2(DBP)}{3}$
- ❖ Recommended to be maintained at ≥ 65 mmHg
- ❖ Hold therapy session if < 60 mmHg



Vital Sign Changes Requiring Termination of Session

- ❖ Dizziness not ceasing within 40 seconds of upright positioning
- ❖ Increase of heart rate of 30 bpm or more over baseline
- ❖ Changes in systolic blood pressure of 30 mmHg or changes in diastolic blood pressure of 10 mmHg
- ❖ New onset of blurring vision
- ❖ Dilated pupils
- ❖ Anginal pain
- ❖ Significant shortness of breath

Incidences to Alter Position of Blood Pressure Measurement

- ❖ PICC (peripherally inserted central catheters) lines
- ❖ Dialysis shunt or fistula
- ❖ Obesity
 - If upper arm is >30 cm, then measure in forearm using radial artery as measure point
- ❖ Radial Artery Graft for CABG
 - Avoid graft site
- ❖ Elderly
 - Avoid areas of excessive bruising/altered skin conditions



Orthostatic Hypotension

- ❖ Drop of systolic pressure by >20 mmHg upon change to upright position of approximately 3 minutes
- ❖ Drop of diastolic pressure by >10 mmHg upon change to upright position of approximately 3 minutes
- ❖ Patient may or may not have symptoms of dizziness, light headedness, and/or blurred vision

Vital Sign Assessment

❖ **Scherer et al study:**

- Pointed out that across all of the interactions surveyed, over half checked heart rate and blood pressure prior to treatment session
- Sessions involving ambulation, two-thirds of the patients did not have consistent heart rate and blood pressure measured
- Concluded that clinical decision making via vital sign monitoring was irregular

❖ **Miller et. al study:**

- Another study revealing inconsistent observation of vital signs during clinical decision making
- Worrisome for the safety of patients as the majority of cardiovascular complications tend to arise only during dynamic activity even if said vital signs were "normal" when tested with patient in resting state

However.....

❖ **Vital signs can be outside of "normal values" but interventions can still take place**

❖ **Patient specific**

❖ **Assess trends within the last 24 hours**

❖ **Asymptomatic**

❖ **Other precipitating factors**

➢ **Examples**

- Heart rate can increase with uncontrolled pain
- Missed dose of beta blockers
- Scheduled time for breathing treatment

Common Barrier

❖ **Vasoactive Drugs:**

- **Most commonly reported barrier to early mobilization**
- **Administered to patients with hemodynamic instability**
- **Can cause compensatory reactions such as reflex bradycardia, tachycardia, tachyarrhythmias, and myocardia ischemia**

Prior Practice vs. Support for Early Mobilization

BED REST AND/OR SEDATION

- Increased contractures
- Weakness
- Neuromyopathies
- Pressure ulcers
- DVTs/PEs
- Increased number of days on ventilator
- Psychological problems

EARLY MOBILIZATION

- Less atrophy
- Improved respiratory clearance
- Decreased pressure ulcers
- Improved appetites and digestion
- Low probability of adverse reactions
- Decreased healing time

So why are we not mobilizing more patients on Vasoactive Therapy??

Hesitancy to accept new practices

Poor multidisciplinary communication and participation

Lack of continual research by the practitioner

Moderate to high doses

Safe Criteria for Beginning and Ending Therapeutic Intervention for Patients in the ICU

System	Starting criteria	Stopping criteria
Cardiovascular	Heart rate: 60-130 beats/min Systolic blood pressure, 90-180 mmHg, or mean arterial pressure, 60-100 mmHg	Heart rate: <60 or >130 beats/min Systolic blood pressure, <90 or >180 mmHg, or mean arterial pressure, <60 or >100 mmHg
Respiratory	Respiratory rate: 5-40 breaths/min SpO2 ≥ 88% FiO2 < 0.6 PEEP < 10 Artificial airway is properly secured	Respiratory rate: <5 or >40 breaths/min SpO2 < 88% Concerns about the disconnection of the artificial airway
Other	Able to open eyes to voice	Changes in consciousness New/symptomatic arrhythmia Chest pain Ventilator asynchrony Falling down Medical device removal Patient intolerance or refusal

Arterial Blood Gases

- ❖ Used to assess gas exchange function of cardiopulmonary system
- ❖ Specifies degree of hypoxia at rest
- ❖ pH, PCO₂, HCO₃⁻, PO₂, O₂
- ❖ Indicates acid-base disorders
 - > Respiratory Acidosis (CO₂ retention)
 - > Respiratory Alkalosis (CO₂ excretion)
 - > Metabolic Acidosis
 - > Metabolic Alkalosis

Oxygen Saturation

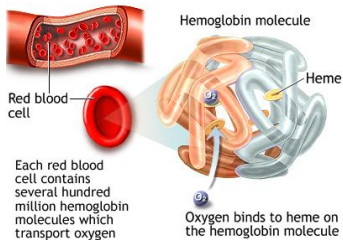
- ◆ Significant component of physical therapy treatment decision making
- ◆ Saturation below 90% impedes pressure of oxygen within arteries thus decreases HgB's ability to carry oxygen to tissues
- ◆ Third or fourth digit (middle and ring finger) are noted to be the most accurate in oxygen saturation measurement
- ◆ Maintain saturation >90% during therapy sessions
- ◆ Modify treatment via frequency of rest breaks, upright posturing, and pursed lip/diaphragmatic breathing instruction to aid in moving CO₂ out of the lungs
- ◆ Ex: Patients with COPD experience air trapping, thus decreased gas exchange and CO₂ retention all due to destroyed alveolar septum

Lab Value Categories

- RELATED TO BLOOD AND COMPONENTS
- RELATED TO ELECTROLYTES
- CARDIAC MARKERS

Hemoglobin (Hgb)

- ✓ Protein responsible for transporting oxygen in bloodstream
- ✓ Normal Values:
 - ♂ Males = 14-17 g/dL
 - ♀ Females = 12-16 g/dL



<https://icim.org/article/364/>

ADAM

Hemoglobin

❖ **Guidance:**

- If <8 g/dL, patient can participate in ADLs, light aerobics, and light resistance training (1-2lbs)
- If <5-7 g/dL, can lead to heart failure or death
- If >20 g/dL, can lead to spontaneous clogging of capillaries
- Typically will transfuse at 7 g/dL

HgB <8 g/dL

- ❖ PREVIOUSLY IT WAS CONTRAINDICATED TO INTERVENE WITH EXERCISE WHEN A PATIENT'S HGB WAS <8 G/DL
- ❖ PETERSON: LESS THAN 10% OF THE INCLUSION CRITERIA EXPERIENCED ADVERSE REACTIONS

Implications of Low HgB

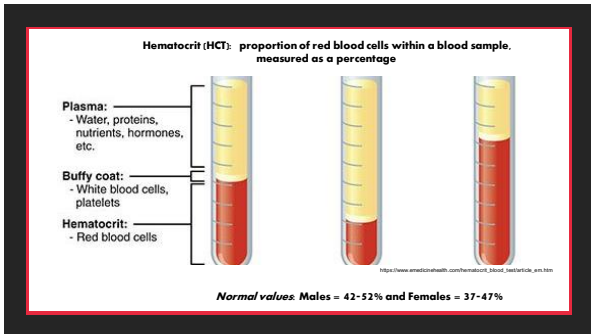
- ❖ **MONITOR SPO₂% TO PREDICT TISSUE PERFUSION**
- ❖ **LOW HGB:**
 - TACHYCARDIA
 - ORTHOSTATIC HYPOTENSION
 - DECREASED ACTIVITY TOLERANCE
 - INCREASED FATIGUE

*Heart rate and cardiac output must increase to ensure enough O₂ to tissues, thus an increase of workload on the myocardium

Blood Transfusions

- ❖ Nursing will monitor and assess patient's vital signs every 5 minutes of the first 30 minutes of each unit hung
- ❖ No mobilizing within this first 30 minutes in order to minimize adverse reactions

However.....



Variables in Hematocrit

LOW HEMATOCRIT

- ❖ Inadequate blood supply of *healthy* RBCs
- ❖ Overabundance of WBCs
- ❖ Vitamin and/or mineral insufficiencies
- ❖ Recent or chronic significant blood loss
- ❖ <15-20% indicates cardiac failure or imminent death

HIGH HEMATOCRIT

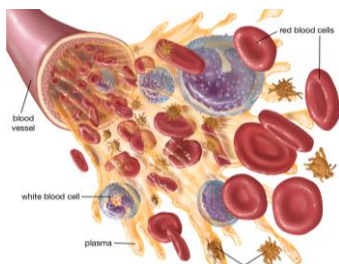
- ❖ Dehydration
- ❖ Polycythemia Vera
- ❖ Lung and/or heart disease
- ❖ Increased blood viscosity thereby decreasing amount of blood and increasing time for essential organs to receive oxygenated blood
- ❖ >60% can cause spontaneous blood clotting

Hematocrit (Hct) Level Activities

- Hct: <25%**
 - No exercise but can do essential ADLs, assistance as needed for safety
- Hct: 25-35%**
 - 1-2 lbs
 - ADLs
 - Light aerobics
- Hct: >35%**
 - Resistive exercise as tolerated
 - Ambulation and self-care as tolerated
 - Aerobics

Platelets

- ✓ Granules contained inside platelets allow for blood clotting
- ✓ Normal value: 150,000-400,000
- ✓ Decreased platelets can be associated with acute kidney injury post operatively



ANTICOAGULANT VERSUS ANTIPLATELET

ANTICOAGULANT	ANTIPLATELET
An agent used to prevent the formation of blood clots	A platelet-blocking drug, which reduces the tendency of platelets in the blood to clump or clot
Slows down clotting and reduce fibrin formation to prevent the formation and growth of clots	Prevents platelets from clumping to prevent the formation and growth of clots
Used for the conditions, which involve stasis, causing the formation of blood clots	Used for the conditions, which involve endothelial damage and platelets sticking to the injured site
Examples: Heparin, warfarin, dabigatran, apixaban, and rivaroxaban	Examples: Aspirin and a P2Y ₁₂ inhibitor used in dual antiplatelet therapy (DAPT)

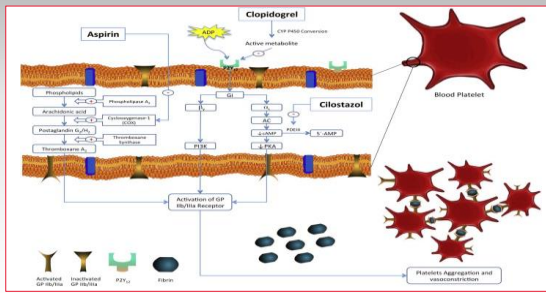
Visit www.PEDIAA.com

<https://pedias.com/wp-content/uploads/2019/07/Difference-Between-Anticoagulant-and-Antiplatelet-Concepts-Summary.jpg>

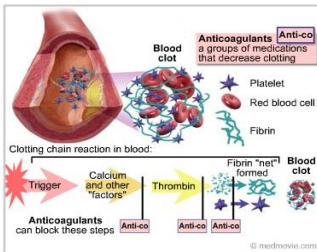
Anti-Platelets:

Medications that will prevent the formation of a blood clot

- ❑ Aspirin
- ❑ Clopidogrel (Plavix)
- ❑ Prasugrel (Effient)
- ❑ Ticagrelor (Briliant)



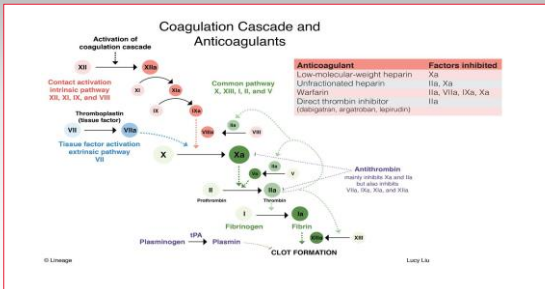
Anticoagulants



<https://www.aarthalab.com/physiology/for-molysis-and-anticoag-ant/>

Blood Thinners

- Drugs that avert or lessen blood coagulation pathway to lengthen time it takes to clot
- Medical Uses:
 - Atrial Fibrillation
 - Coronary Artery Disease
 - Deep Vein Thrombosis
 - Stroke
 - Mechanical Heart Valves
 - Myocardial Infarction
 - Factor V Leiden
 - Pulmonary Embolism
 - Coronary Artery Bypass Grafting
 - Heart Failure



Classes of Anti-Coagulants

VITAMIN K ANTAGONISTS:

- > Warfarin
- > Coumadin

INITIATORS OF VITAMIN K ANTAGONISTS:

- > Heparin
- > Low Molecular Weight Heparins
- Lovenox

Classes of Anti-Coagulants

DIRECT THROMBIN INHIBITORS:

- > Pradaxa

FACTOR XA INHIBITORS:

- > Xarelto
- > Eliquis

Anticoagulants

❖ Warfarin

- Liver uses Vitamin K to create clotting factors and anticoagulants
- Works to interfere with Vitamin K
- Tends to be the mainstay of anticoagulation
- Pro
 - Inexpensive
- Cons
 - Requires additional medication, heparin, within first 3 days to initiate processes
 - Must be monitored by regular INR tests
 - Must consume consistent Vitamin K

❖ Lowenox

- Low molecular weight heparin
- Inhibits factors Xa and IIa
- Given via injection
- Used to initiate warfarin pattern
- However, can be used as a "stand alone"
- Can be used as a prophylactic before long trips or "bridge therapy" while weaning off Warfarin for surgery
- Pro
 - Blood tests are not required to assess blood levels
- Con
 - High cost
 - Very short half life
 - Typically given via intravenous infusion

Anticoagulants

❖ Direct Thrombin Inhibitors

- Pradaxa
- Newest on the market
- Binds to thrombin molecule
- Not used for long term use
- Utilized when Heparin causes "Heparin Induced Thrombocytopenia"
- Pro
 - Doesn't require routine monitoring
- Cons
 - Increased risk of bleeding
 - No standardized test available to determine efficacy

❖ Factor Xa Inhibitors

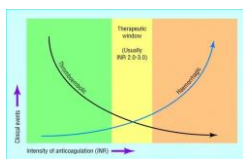
- Xarelto
- Eliquis
- Inhibits clotting factor within the blood system
- Pros
 - Good for patients who struggle to maintain a consistent INR
 - Diet has no effect on Xarelto
 - Does not need to have blood test
- Con
 - No method to reverse process

Testing for Coagulation Effectiveness Using Warfarin

- ❖ INR: International Normalized Ratio
- ❖ Ratio of personal blood coagulation time compared to "normal" blood
- ❖ Used to assess Warfarin effectiveness
- ❖ Target Range: 2.0-3.0

❖ Theories of Exercise and INR Value

1. Increased metabolic rate caused by exercise will cause Warfarin to be metabolized at a faster rate, thus bringing INR ratio down
2. Increased metabolic rate influenced by exercising will decrease availability of circulating Vitamin K via kidney flushing



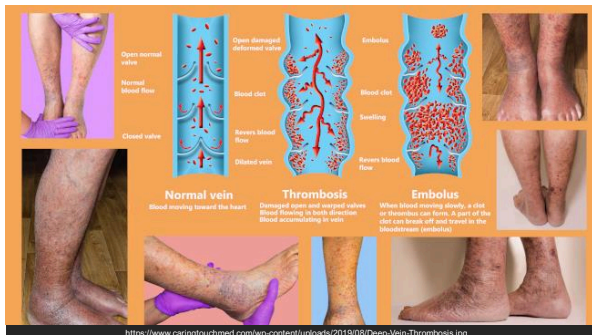
<https://www.quora.com/When-is-it-better-to-take-Eliquis-than-Warfarin-1>

Deep Vein Thrombosis – A Therapist's Role

- Prevention
- Screening
- Team player
- Patient education/Recommendations
- Off-setting long term affects

Signs and Symptoms of a DVT vs. PE

- | | |
|---|--|
| <ul style="list-style-type: none"> <input type="checkbox"/> Deep Vein Thrombosis ○ Swelling ○ Pain ○ Erythema ○ Warmth | <ul style="list-style-type: none"> <input type="checkbox"/> Pulmonary Embolism ○ Sudden shortness of breath ○ Lightheaded/Dizziness ○ Tachycardia ○ Hyperventilation ○ Expelling of blood with cough ○ Chest pain <ul style="list-style-type: none"> ▪ Worsens with deep breath and cough |
|---|--|

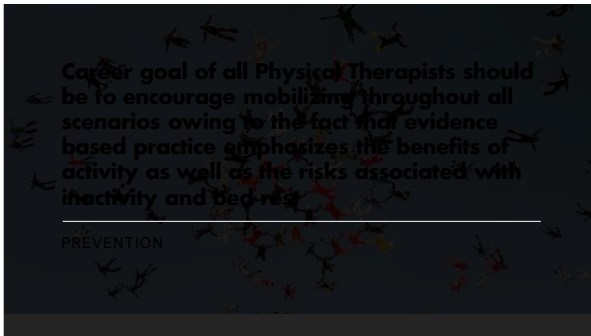




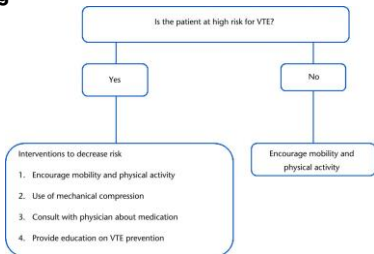
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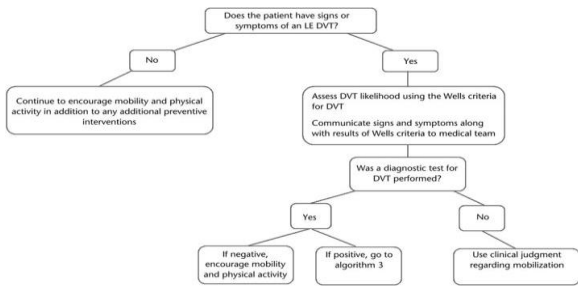
<https://radiance.us/dep-venous-thrombosis/>



Screening



<https://academic.oup.com/view-large/figure/190890837pp0143-fig/01.png>



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THREE FACTORS SUPPORTING FORMATION OF DVTS

- **HYPERCOAGULABILITY**
 - BLOOD CHEMISTRY
- **STASIS**
 - BLOOD FLOW
- **VESSEL INJURY**

Interview Patient & Review Medical History to Screen for DVT Incidence

- Previous venous thrombosis or embolism
- Increased age
- Current cancer and/or cancer treatment
- Infection
- Oral contraceptives or hormonal replacement therapy
- Pregnancy or birthing within the previous 6 weeks
- Immobility due to flying, fractures, recent surgery
- Central Venous Catheters
- Inherited thrombophilia
- Obesity

Wells Criteria

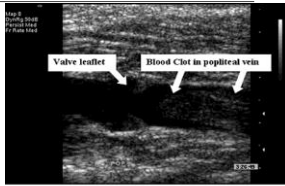
- Very probability - score 0 - 5% DVT
- Low probability - score 1-2 - 17% DVT
- High probability - score ≥ 3 - 40% DVT

Table 1 Modified Wells Criteria: Clinical Evaluation Table for Predicting the Probability of a DVT	
Clinical Characteristic(s)	Score
Active cancer	+1
Paralysis, paresis, or recent plaster immobilization of the lower extremities	+1
Recently bedridden for three days or major surgery within the last 12 weeks	+1
Localized tenderness along the deep venous system	+1
Entire leg swollen	+1
Calf swelling ≥ 3 cm larger than asymptomatic side	+1
Pitting edema confined to symptomatic leg	+1
Collateral superficial veins	+1
Previously documented DVT	+1
Alternative diagnosis at least as likely as a DVT	-2
Clinical Probability of DVT	Total Score
Likely	< 2
Unlikely	≥ 2

<https://theimpulse.org/pe-and-dvt-rules/>

Testing of Suspected DVTs

- **Ultrasound:**
 - Confirmation of a LE DVT = mobilization halted
 - Negative results of LE DVT = safe to mobilize
- **D-dimer:**
 - Measure of the degradation of cross-linked fibrin



Popliteal vein with a floating blood clot (DVT)

<https://redbacteria.wordpress.com/2014/11/13/deep-vein-thrombosis-dvt/>

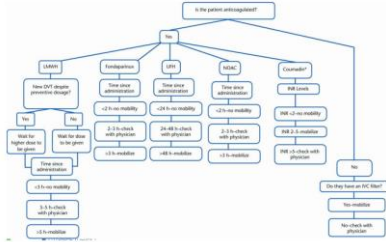
Significant Risk Factors

- Immobilization is a significant risk factor to development of a DVT
- "...recent decreased ability to walk at least 3.1 m (10ft) for [at] least 72 hours and inability to walk at least 3.1 m (10ft)"¹ Higgins, Ellen PT, EdD, CCS, FAPTA, Purok, Michael PT, PhD, CCS, FRCR, Eikel PT, DPT, MEd, CCS, Trigen, Mary PT, PhD, Robson, Dennis PT, MA, DPT, CCS, CEEAA, Asten, Beth MEd, MA, AHP The Role of Physical Therapists in the Management of Individuals at Risk for or Diagnosed With Venous Thromboembolism—Executive Summary of an Evidence-Based Clinical Practice Guideline. *Cardiopulmonary Physical Therapy Journal*. April 2016; Volume 27 - Issue 2 - p42-48
- Limitation to a chair/bed more than half of their waking hours
- Recent long distance travel

Algorithm for Mobilizing Patients with Known Lower-Extremity Deep Vein Thrombosis

DVT = deep vein thrombosis | LMWH = low molecular weight heparin | UFH = unfractionated heparin | NOAC = novel oral anticoagulants
 IMC = international normalized ratio | INR = international normalized ratio

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Anticoagulant Algorithm

Patient Education

- Leg exercises
- Importance of ambulation
- Required hydration
- Automated compression

(a) Inflation, Holding, Deflation

Soft sensor, Pneumatic bladder, Inflation, Holding, Deflation

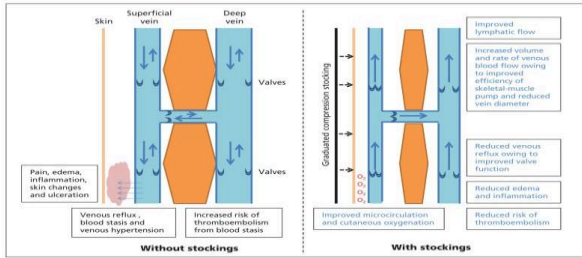
3rd Compression, 1st Compression

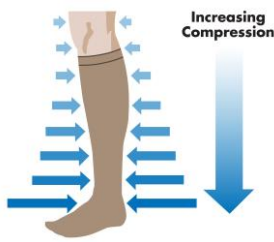
<https://www.innovase.com.au/en/DE11693327905028>

<https://www.gardh.com/product/pneumagress/>

<https://www.ndsp.com/1424-822019/132881.htm>

Graduated Compression Stockings





Sigel Profile (Stocking Profile)

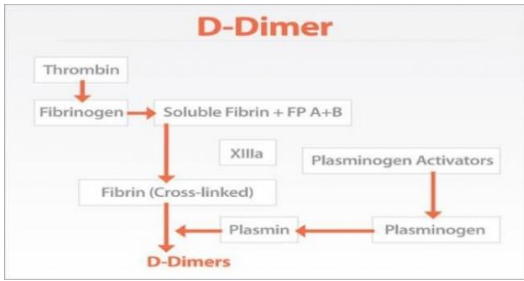
<https://www.pinterest.com/njvashhealth/graduated-compression/>

Graduated Compression

GRADUATED COMPRESSION

- 18 mmHg Ankle
- 14 mmHg
- 8 mmHg
- 10 mmHg
- 8 mmHG Mid-Thigh

- Over 120% of the baseline of max femoral venous blood flow to prevent venous stasis
- Over 60% reduction of DVT
- GCS are used as a concomitant therapy to mechanical and/or medicinal preventative measures will reduce the incidence of DVTs up to 85%



D-Dimer

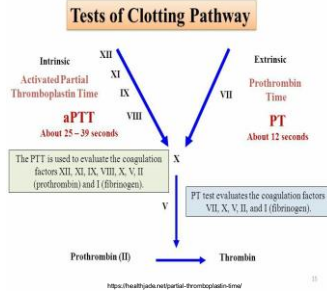
- ❑ Looks for the amount of product stemming from the breakdown of cross-linked fibrin lysis that can be found present in the blood
- ❑ Determines severity of disease
- ❑ Normal: 100-200 ng/mL
- ❑ Elevation proves intravascular coagulation/thromboembolytic disease
- ❑ Negative D-Dimer accurately dismisses the presence of a VTE

INR

- ❑ INR > 4
 - Edge of bed
 - Bed mobility
 - ROM
 - Ankle pumps
 - No resistive exercise
- ❑ INR > 5
 - Hold exercise
 - Evaluate if appropriate to perform bed mobility
 - Edge of bed
- ❑ INR > 6
 - Consider bed rest

Testing for Coagulation Effectiveness Using Heparin

- ❖ PTT: Partial Thromboplastin Time
 - Normal Value: 20-35 sec
- ❖ aPTT: Activated Partial Thromboplastin Time
 - Normal Value: 0.3-0.7 umL
- ❖ Measures clotting time for patients on Heparin



- Patients receiving Low Molecular Weight Heparin (**enoxaparin/Lovenox®**, **dalteparin/Fragmin®**, **tinzaparin/Innohep®**, **nadroparin/Fraxiparine®**) can be mobilized right away.
- Patients receiving IV **heparin** may be anticoagulated for a minimum of 24 hours and the PTT needs to be 70-99 to be in therapeutic range.
- Patients receiving warfarin can take anywhere from *5-7 days for the anticoagulation effect to develop fully*. Therefore, in cases where immediate effect is required, full-dose LMWH or heparin are usually given at the same time (for "bridging therapy" until full anticoagulation with warfarin has been achieved).
- Patients on anticoagulation for prophylaxis, who develop a DVT, need to be changed to some kind of anticoagulation for treatment before it is safe to mobilize them.

Cardiac Biomarkers

- ❖ TROPONIN
- ❖ CREATININE KINASE
- ❖ LACTATE

Troponins

- ❖ Proteins that assist in regulating contractions within skeletal and cardiac muscle fibers
- ❖ Primary testing to diagnose myocardial infarction as well as other cardiac injuries
- ❖ 80% of diagnosed acute MIs will have elevation in troponin levels within 3 hours of chest pain onset (academy of acute care pt 2017 lab values)

MYOCARDIAL INFARCTION

>0.2 mcg/L

RISES 8 hours after MI

PEAKS 12-16 hours after MI

NORMALIZE 1 week after MI

Troponin Detection

Cardiac biomarkers are not discovered within the blood under normal circumstances

Therefore, **HOLD** activity until 24 hours after troponin levels peak **AND** begin trending down

Creatine Kinase

- ❖ Enzyme used to activate the reversible phosphorylation of creatine by means of adenosine triphosphate (ATP) during muscle activity
- ❖ Highest activity found in striated muscle, cardiac tissue, and brain
- ❖ Increases with cerebrovascular events as well as injury, inflammation, or necrosis of skeletal and cardiac tissue
- ❖ Normal levels:
 - Male = 52-336 U/L
 - Female = 38-176 U/L

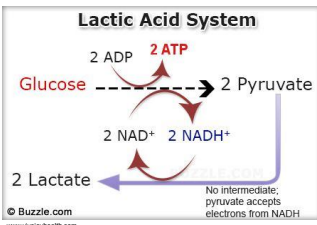
Creatine Kinase Detection

- ❖ Hold activity when CK levels are rising
- ❖ Resume activity once CK levels are trending down towards normal ranges

MYOCARDIAL INFARCTION
ELEVATES 4-6 hours after MI
PEAKS 12-24 hours after MI
CLEARs 48-72 hours after MI

Lactate

SUBSTRATE RELEASED BY MUSCLES, RED BLOOD CELLS, BRAIN, AND OTHER SPECIFIC TISSUES WHEN THERE IS INSUFFICIENT OXYGEN TO AID IN ENERGY PRODUCTION



Lactic Acid

- ❖ Normal: 0.5-1.0 mmol/L
- ❖ Levels above 1.0 mmol/L creates lactic acid due to change in pH
- ❖ Hold activity when levels are > 4 mmol/L

Electrolytes

- ❖ POTASSIUM
- ❖ SODIUM
- ❖ CALCIUM
- ❖ CHLORIDE

Potassium



<https://source.colostate.edu/wp-content/uploads/2015/11/PotassiumNutritionColumn.jpg>

Mineral required for normal functioning of excitable cells (nerves, muscles, and heart)

Normal: 3.7 mEq/L

Hyperkalemia: >5.5 mEq/L

> At risk for cardiac issues

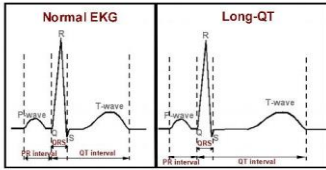
> Collaborate with medical team but most likely activity must be held

Hypokalemia: <2.5 mEq/L

> Life threatening

> Collaborate with medical team but most likely activity must be held

Potassium



<https://www.washingtontra.com/arrhythmias/long-qt-syndrome.php>

Hypokalemia

§ Prolonged Q-T Interval

§ Longer than normal to recharge in between beats

§ Causes subsequent ventricular fibrillation

Hyperkalemia

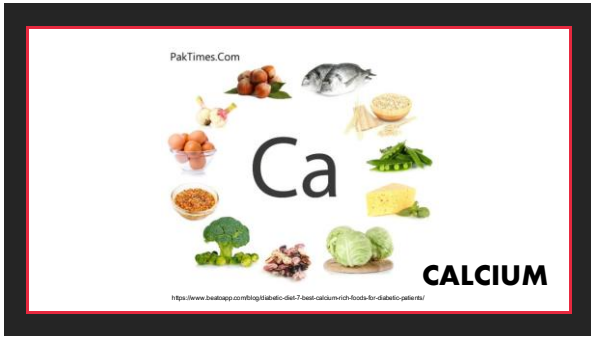
- ❖ Peaked T Waves
- ❖ Widened QRS Complexes
- ❖ Continued peaking of serum potassium will end in bradycardia and asystole

Serum Potassium	Typical ECG Appearance	Possible ECG Abnormalities
Mild (5.5-6.5 mEq/L)		Peaked T waves Prolonged PR segment
Moderate (6.5-8.0 mEq/L)		Loss of P wave Prolonged QRS complex ST-segment elevations Ectopic beats and escape rhythms
Severe (> 8.0 mEq/L)		Progressive widening of QRS complex Sine wave Ventricular fibrillation Asystole Axis deviations Bundle branch blocks Fascicular blocks

<https://twitter.com/medicinedoctor/status/80062094581148900>

However....

Study by Myszenski A, Hannum N, Hudson M, et al. has found safety in PT/OT interventions with serum potassium levels between 3.1 to 5.9 mmol/L



Calcium

- ❖ Mineral required for bone formation, cell division & growth, blood coagulation, muscle contraction, and release of neurotransmitters
- ❖ Normal: 8.6 - 10.3 mg/dL
- ❖ Hypocalcemia:
 - Treatment is challenged via signs-symptoms approach
 - May have cognitive impairment
- ❖ Hypercalcemia:
 - Treatment is challenged via signs-symptoms approach

Sodium

- ❖ Regulatory agent determining amount of water in and around cells
- ❖ Normal: 134 - 142 mEq/L
- ❖ Assists in maintaining normal blood pressure
- ❖ Support nerve and muscle function



<https://www.pinterest.com/pin/7940110295851067/>

Sodium

HYPONATREMIA

- ❖ <130 mEq/L
- ❖ Rapid brain swelling, muscle weakness, seizures, and confusion

HYPERNATREMIA

- ❖ >145 mEq/L
- ❖ Cerebral Hemorrhage
- ❖ S/S = lethargy, weakness, confusion, and tachycardia

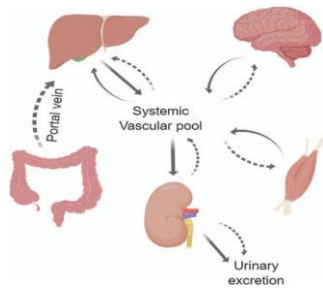
Ammonia

METABOLIC PRODUCT

NORMAL: < 50 MMOL/L

HYPERAMMONEMIA: 150 TO 200 MMOL/L

Varied routes of Ammonia



Medicine @Harvard, 2019 Nov; 91(7): e1781. Published online 2019 Nov 22. doi: 10.1093/med/00000000001781

Hyperammonemia S/S

- ❖ Irritability
- ❖ Headache
- ❖ Vomiting
- ❖ Anorexia
- ❖ Cognitive dysfunction
- ❖ Ataxia
- ❖ Coma
- ❖ Seizures
- ❖ Cerebral edema → Brain herniation

Causes of Hyperammonemia

- ❖ Primarily hepatic dysfunction
- ❖ Reye's Syndrome
- ❖ Certain medications
- ❖ Excessive exertion
- ❖ Kidney disease
- ❖ Alcohol/Drug abuse
- ❖ Smoking

Oncology

FROM COMPLICATIONS OF TREATMENTS TO THERAPEUTIC INTERVENTION

Affects of Oncological Treatments

MENTAL OVERLOAD

- **Central Nervous Symptoms:**
 - Impaired memory
 - Poor concentration

SENSORY DYSFUNCTION

- **Taxanes, Platinum Agents, Vinca Alkaloids, and Thalidomides**
 - Tend to damage peripheral axons and nerve cell bodies
- **Peripheral Nerve Impairments:**
 - Paresthesias, dyesthesias, minimized touch, decreased
- **Vestibular Debilitation:**
 - Vestibular schwannoma
 - Cisplatin (chemo for lung, breast, & ovarian)
 - Vestibular toxicity
 - Ototoxicity

▪ **Red Flag** Unrelenting pain can be a sign of neural compression

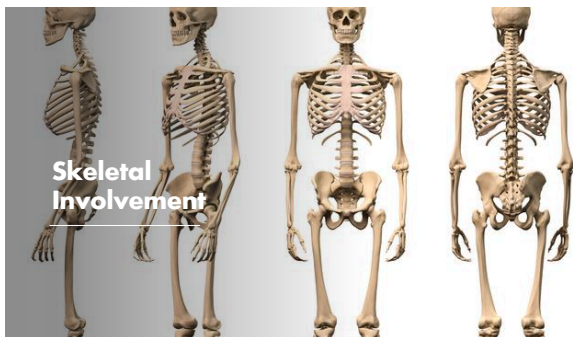
Neuromuculoskeletal Problems from Oncological Treatments

▪ Range of Motion Complications

- Typically occur after surgery and/or radiation rx due to scar tissue formation
- Increased occurrence with radiation over a joint and breast with lymph node removal

▪ Loss of Muscle Strength

- Decrease via tumor-produced inflammatory intermediates that become catabolic causing muscle wasting (cachexia)
- Vinca alkaloids, taxanes, and platinum agents (chemotherapeutics) damage muscle and peripheral nerve tissue
- Corticosteroids damage muscle tissue



- **Common patterns of metastasis to skeleton**
 - Prostate
 - Breast
 - Lung
 - Colon
- **Reduced bone strength as tumor invades the bone structure**
- **Increased risk of pathological fracture**
 - Determined by the amount of cortex invaded by the tumor
 - Increased risk of pathological fractures when >50% of the cortex is affected
 - Proximal femur fracture more likely with a lesion >3.5 cm
 - Assess arising complications in femur for gait and humerus for assistive device use
- **Tumor invasion of the vertebral arch**
 - Segment becomes unstable
 - Can compress spinal cord and adjacent nerve roots
- **Cancer and cancer treatments increase probability of developing osteonecrosis**
 - Proximal or distal femur
 - Proximal humerus, jaw, and metatarsals
 - Red flags are new onset pain and decreased weight-bearing
 - Corticosteroids, hormonal therapies, androgen therapy, and radiation
- **Increased risk of pathological fracture**
 - Determined by the amount of cortex invaded by the tumor
 - Assess arising complications in femur for gait and humerus for assistive device use

Weight-Bearing Precautions With Skeletal Involvement

- **Weight-bearing activities provide protection in diminishing bone density during hormonal treatment**
- **50% of bone degraded:**
 - *Touch-Down or Non-Weightbearing*
- **25-50% of bone degraded:**
 - *Partial weight-bearing*

Cardiovascular, Hematologic, Immunologic, and Respiratory System Dysfunction

- **Chemotherapy can cause thrombocytopenia of which increases the risk of bleeding**
- **Bleomycin, Methotrexate, and Docetaxel**
 - Damage pneumocytes and lung parenchyma
 - Destruction of alveoli
 - Dilatation of air spaces
- **Anthracyclines and Trastuzumab**
 - Damage to cardiac myocytes

However.....

Keeping the above precautions in mind:

- Several studies have reported that rehabilitation for patients with cancer can make significant functional improvements at the same rate as those without cancer performing the same plan of care
- Increasing proof that exercise intervention is improving cancer patient survival rate
- A consistent exercise regime has been considered most effective for reducing cancer symptoms
- Physical functioning is improved
- Decreased anxiety
- Positive impact on BMI, sleep efficiency, activity tolerance, functional mobility, and flexibility

No manual muscle testing in affected limb

No progressive resistive exercises in affected limb

Offloading affected limb with assisted device

Avoid excessive spinal flexion, extension, and rotation.
*Clarify need for bracing

Monitor for increasing functional pain

Generalized Safety Measures for Bone Metastasis

Thrombocytopenia

Myelosuppression from chemotherapy impacts RBC counts

Platelet Counts and Suggested Activity Levels:

- $<10,000$ k cells/uL = significant risk for spontaneous hemorrhage
- $<20,000$ k cells/uL = increased risk of bleeding
 - Restrict activity to walking and activities of daily living
- $>20,000$ k cells/uL = light exercise with symptom monitoring
- $>30,000$ k cells/uL = moderate exercise and light resistive exercise within tolerance

Neutropenia

- ABSOLUTE NEUTROPHIL COUNT LESS THAN 500 MC/L
- TYPICALLY DECREASES 3-7 DAYS AFTER CHEMOTHERAPY

Neutropenia and Infection

- Fever is absolute earliest s/s of infection
- Primary sites include:
 - GI tract, sinuses, lungs, and skin
- Common infections:
 - Sepsis, cellulitis, pneumonia, urinary tract infections, and colitis
- Major cause of morbidity and mortality
- Clinician to ensure hand hygiene but further PPE is not required
- No evidence suggests reducing or eliminating rehabilitation on the basis of decreased neutrophils

Hematology and Cancer Treatments

- Patients are cytopenic at time of Bone Marrow Transplantation and remain so for weeks after
- Prior history of antineoplastic therapies can increase neurotoxicities that will alter peripheral nerve functioning, myopathies due to chronic corticosteroid use, prolonged immobility, nutrition deficits, and altered cognition
- Maintain safe intervention but much evidence reveals improved physical performance and shorter time frame of anemia, thrombocytopenia, and LOS
 - Worsening anemia can decrease activity tolerance and lead to symptoms of fatigue, and dizziness
 - Precaution with progressive resistive and moderate to high intensity aerobic exercise in those with Hgb < g/dL
 - Low intensity exercise to promote improved blood count

RPE CHART
RATE OF PERCEIVED EXERTION

- 10 Max Effort Activity**
Feels almost impossible to keep going. Concerned out of breath, unable to talk.
- 9 Very Hard Activity**
You struggle to complete activities normally. Can barely breathe and speak a single word.
- 7-8 Vigorous Activity**
On the edge of breathing uncontrolled. Breath is shallow, can speak a sentence.
- 4-6 Moderate Activity**
Feels like you can maintain for hours. Breathing heavily, can hold short conversations.
- 2-3 Light Activity**
Feels like you can maintain for hours. Easy to breathe and carry conversations.
- 1 Very Light Activity**
Anything you can do without sweating, including TV and housework.

https://blog.magnifyrun.com/the-definitive-runners-guide-to-perceived-exertion/

Requires patients to internally assess what they are feeling with some cue wording to describe their activity

Borg Rating of Perceived Exertion

A measure of how hard you feel like you're working

1 - 10 Borg Rating of Perceived Exertion Scale	
0	Rest
1	Really Easy
2	Easy
3	Moderate
4	Sort of Hard
5	Hard
6	
7	Really Hard
8	
9	Really, Really Hard
10	Maximal: just like my hardest race

ALWAYS DOCUMENT!!!

Documenting of each encounter should include the following:

- o Patient self-report
- o Indicate specific interventions provided, including frequency, intensity, and duration
- o *Changes in patient impairment, activity tolerance, and participation restriction status as they relate to the plan of care*
- o Response to treatment, including adverse reactions, if any
- o Components that require modification to frequency, intensity and progression goals, including patient adherence to plan of care
- o Consultation with providers/patient/client/family/significant other



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