Updated 2017

ACADEMY OF ACUTE CARE PHYSICAL THERAPY

Laboratory Values Interpretation Resource

Academy of Acute Care Physical Therapy – APTA Task Force on Lab Values

2017 Members

James Tompkins, PT, DPT | Co-Chair
Traci Norris, PT, DPT, GCS | Co-Chair
Kim Levenhagen, PT, DPT, WCC | Co-Chair
Kate Adeletti, PT, DPT, NCS
Courtney Bryan, PT
Malinda Brown-Crowell, PT, DPT, GCS
Jamie Dyson, PT, DPT
Komal Shah, PT, DPT, NCS
Kathy Swanick, PT, DPT, OCS
Julie Terrell, DPT
Risa Maruyama, PT, NCS
Caitlin Price

2012 Members

Roya Ghazinouri | Chair
Samidha Deshmukh
Sharon Gorman, PT, DPTSc, FNAP, GCS
Angela Hauber
Mary Kroohs
Elizabeth Moritz
Babette Sanders, PT, DPT, MS, FAPTA
Darin Trees, PT, DPT, CWS

2008 Members

Holly McKenzie, PT, DPT
Dawn Piech, PT, MPT
Jim Smith, PT, DPT, MA

Approved by Academy of Acute Care Physical Therapy – APTA
Board of Directors: 8/2008, 12/2011, 1/2017

Evolution of the 2017 Edition of the Laboratory Values Interpretation Resource by the Academy of Acute Care Physical Therapy

As emerging research regarding early mobilization and advancements in medical practice is evolving, the Academy of Acute Care Physical Therapy – American Physical Therapy Association Task Force on Lab Values took on the mission of updating the Laboratory Values Interpretation Resource to better accommodate practitioners' needs. The task force consisted of physical therapists from across the country in various acute care settings. Based on practitioners' feedback, this document was adapted to improve usability in the busy acute care setting.

The task force set out to use current literature from the past five years. Original sources were captured and referenced for each item. The task force collaborated with university librarians to ensure the comprehensiveness of the literature search. After consulting with clinical lab scientists, the task force was unable to identify a gold standard in regard to a laboratory guide listing reference values (see disclaimer). For the purpose of consistency, the task force decided to use the reference values from one reputable laboratory values textbook, unless there was a clinical practice guideline related to that laboratory value. Each laboratory test captured in this 2017 version has a brief explanation of the test or laboratory panel, reference values, clinical presentation, and clinical implications. In response to unmet clinical decision-making needs from membership thus far, updates have been made to the content from the previous version, and a new point-of-care document listing key laboratory tests has been created for this version. As the task force closes its current work on this project, it does so in the understanding that this living document needs continuous updating to ensure that the needs of clinicians will be appropriately accommodated.

Disclaimer

The reference ranges and recommendations in this resource are based on the current, best-available evidence. Considering the absence of a universal reference range for any of the more than 5,000 lab tests in existence, accredited laboratories are required to establish and validate their reference values at least annually. Thus, any given result should be interpreted based on the reference value of the laboratory in which the test was performed. Reference values must be updated each time a new reagent kit or diagnostic instrument is added. In addition, differences in patient populations (ethnicity, age, gender, behaviors, and culture) might result in variability of reference ranges. Abnormal values are defined as those results that are outside a specific range obtained from a cohort of healthy individuals.[1]

Physical therapists have the professional responsibility to provide excellent care, adhere to high standards, and collaborate with other healthcare providers to achieve optimal health outcomes for their patients. Acute care physical therapists work in an environment that is quickly evolving and therefore should be knowledgeable regarding critical laboratory values and safe mobility recommendations. Lundberg (1972) defined a critical value as a "physiological state at such variance with normal as to be life threatening unless something is done promptly and for which some corrective action can be taken."[2] As critical values might evolve quickly in the acute care setting, physical therapists should be vigilant in reevaluating safe and effective patient management. Although the recommendations made in this document are evidence-based, the final judgment regarding the appropriateness of particular physical therapy interventions should be made by the clinician. The goal of clinical standardization is not to produce rigid guidelines; it is to establish an evidence- and consensus-founded treatment approach that could change and evolve based on the patient's clinical presentation and individual values, as well as expectations and preferences.

Today's electronic health record environment allows for fast retrieval of laboratory results. Test names and specific value ranges are easily visualized with high-priority findings (i.e. critical alerts), having predetermined indicators or color highlights to bring attention to medical team.

Table of Contents

1. **Understanding Lab Values**
    a. Trends
    b. Risk vs. Benefit of the Therapeutic Intervention
    c. Acute vs. Chronic Considerations of the Therapeutic Intervention
    d. Gender, Race, and Culture Considerations
    e. Age Considerations
2. **Complete Blood Count (CBC)**
    a. White Blood Cells
    b. Platelets
    c. Hemoglobin
    d. Hematocrit
3. **Electrolyte Panel**
    a. Sodium (Na)
    b. Potassium (K)
    c. Calcium (Ca)
    d. Chloride (Cl)
    e. Phosphate (PO_4)
    f. Magnesium (Mg)
4. **Kidney Function**
    a. Blood Urea Nitrogen (BUN)
    b. Serum Creatinine
5. **Endocrine**
    a. Glucose/Criteria for Diagnosis of Diabetes
    b. Hgb A1C
    c. Thyroid Function Tests
6. **Acid-Base Disorders**
    a. Respiratory Alkalosis
    b. Respiratory Acidosis
    c. Metabolic Alkalosis
    d. Metabolic Acidosis
7. **Liver Function/Hepatic Panel**
    a. Serum Albumin/Pre-Albumin
    b. Serum Bilirubin
    c. Ammonia
    d. Model for End-Stage Liver Disease (MELD)
    e. FK Trough (Tacrolimus/Prograf Test)
8. **Lipid Panel**
    a. High-Density Lipoprotein (HDL)
    b. Low-Density Lipoprotein (LDL)
    c. Triglycerides
    d. Total Cholesterol

9. Bleeding Ratio/Viscosity
    a. International Normalized Ratio (INR)
    b. Activated Partial Thromboplastin Time (aPTT)
    c. Prothrombin Time (PT)
    d. Anti-Factor Xa Assay
    e. D-Dimer
    f. Algorithm for Mobilizing Patients with Known Lower-Extremity Deep Vein Thrombosis
10. Cardiovascular-Specific Labs
    a. Troponin
    b. B-Type Natriuretic Peptide (BNP)
    c. Creatinine Kinase (CK)
11. References
Appendix A: Point-of-Care Document

1. Understanding Lab Values

a. Trends

Physical therapists should not rely exclusively on a single laboratory finding; instead, they should also consider a variety of other clinical factors. For instance, clinicians should be aware of the time the laboratory specimen was drawn, potential drug interactions, or the patient's recent meals. Likewise, it is important to understand the significance of trends in the values over time. Electrolyte panels might change with intravenous infusions, medications, and diet. Patients with chronic medical conditions, such as anemia, might be asymptomatic during exercise, while a patient with a precipitous drop in hemoglobin and hematocrit might require urgent medical attention.

When a patient presents with symptoms of a suspected myocardial infarction (MI), cardiac biomarker laboratory tests are ordered to assist with a differential diagnosis. Cardiac biomarkers are materials released into the bloodstream when the heart is under stress. Typically, under normal circumstances, these substances do not appear in circulation; however, when there is insufficient blood flow to the heart, markers associated with myocardial injury increase in a predictable fashion. Up to 80% of patients with an acute MI will present with an elevation of troponin within 3 hours of onset of chest pain.[3]

However, not all patients with cardiac impairments present with obvious symptoms, and they might not have undergone diagnostic testing. It is not uncommon for patients with complex comorbidities and non-specific and subtle symptoms, including unexplained fatigue and weakness, to be referred to acute care physical therapy. It is, therefore, prudent for therapists to be aware of the presence of cardiac biomarkers and potential delays in the diagnosing of cardiac ischemia.

b. Risk vs. Benefit Considerations of the Therapeutic Intervention

The fundamental consideration when reviewing patient laboratory findings is toward determining an appropriate plan of care and weighing the anticipated benefit of a therapy intervention against the potential risk to the patient.

Physical therapists should carefully anticipate the physiological changes that might have occurred whenever a laboratory value is out of range. They should also be aware of the heightened risk level if a value should fall into the critical range. It is critical to understand pertinent lab values and the subsequent potential of adverse events when practicing in this kind of practice setting. In weighing risks and benefits, physical therapists should also consider the potential benefits from a therapeutic plan that increases the patient's activity. Immediate risks and benefits, as well as the longer-term consequences over the episode of care, should be assessed. To fully explore the potential effects of physical therapy intervention, collaboration with other members of the interprofessional medical team is often necessary. It is prudent and congruent with standards of professionalism for physical therapists to assist with the development of facility policies, procedures, and protocols to aid in the clinical decision-making process regarding the use of lab values in determining the intensity level of therapeutic interventions.

c. Acute vs. Chronic Considerations of the Therapeutic Intervention

In addition to comparing a patient's specific laboratory values to known reference ranges for a population, clinical decisions require understanding of the patient's symptoms and the dynamic physiological changes indicated by the laboratory tests. As an example, acute laboratory value changes, such as those associated

with blood loss due to trauma or surgery, might require the physical therapist to select a more conservative plan of care. At the same time, such acute changes might also suggest the potential for more serious adverse events contributable to the limited amount of time to physiologically compensate for this acute change. Patients with chronic medical conditions often have more chronic changes in lab values, commonly associated with these conditions (e.g., congestive heart failure [CHF], chronic obstructive pulmonary disease [COPD], anemia) or longer-term medical interventions (e.g., chemotherapy, radiation therapy). Under these circumstances, it is prudent for the physical therapist to allow the patient a period of time for his or her body to adapt to the changes in lab values. In turn, this interim period might allow patients to have more resources toward dealing with potential adverse events caused by increasing cardiorespiratory demand, mobility, and exercise.

d. Gender, Race, and Culture Considerations

Census 2010 indicated increased minority demographic shifts in the United States.[4] McClatchey noted that "genetic heterogeneity within a population leads to person-to-person phenotypic differences that can contribute to the variability in laboratory test results."[4] Some diseases are more prevalent in specific races and ethnicities. For example, sickle cell anemia is more prevalent in populations with sub-Saharan African ancestry than with Caucasians.[5] That being said, it is not possible to determine whether racial differences in laboratory values are genetic or related to lifestyle alone, due to culture and food preferences (e.g., cholesterol).[6] Therefore, physical therapists should be mindful of potential racial differences in laboratory values.

Genetic heterogeneity at the molecular level can lead to differences in the reactivity of an individual's DNA, proteins, or cells toward the nucleic acid probes and antibodies that are used as reagents in many diagnostic tests.[4] This type of genetic heterogeneity might result in false-negative findings. As the field of clinical laboratory medicine progresses, genetic variability will become an increasingly more important consideration in the development of new tests and in analyzing results from the current test.

In the United States, African Americans tend to have increased muscle mass and skeletal structures compared to their Caucasian counterparts. Therefore, racial differences in serum levels of creatinine kinase and lactate dehydrogenase in adults, and in serum alkaline phosphatase in children, are noted. African Americans also tend to have higher serum total protein levels and higher serum levels of alpha, beta, and gamma globulins, IgG, and IgA, than Caucasians.[4]

African Americans tend to have lower hemoglobin (Hgb) values compared to Caucasians.[6] In addition, HgbA1c (A1c) lab values can be altered in patients with sickle hemoglobin, which is present in 8% of the African American population.[7] Other studies have noted racial differences in mean hematocrit (Hct) readings that decreased over time due to quality of care rendered during the onset of end-stage renal disease, regardless of socioeconomic status.[8] Cultural competence is a non-negotiable skill, subject to rigorous testing similar to any other core component of the physical therapy profession.[9] Leavitt posited "future research stands to provide a wealth of knowledge on the link between genetics and disparities in health, but the differences remain to be seen."[10] For those reasons, physical therapists must consider racial variations in laboratory values in order for culturally competence care.

Sex and Gender Considerations:[11] Many lab results will have reference ranges reported as age-specific or sex-specific values. With regard to interpretation of these reference ranges regarding sex-specific norms, the therapist needs to consider the patient's biological sex, gender, and gender identity to avoid referencing the incorrect "normal" value. A review of the differences of these terms is provided in Table 1.

Table 1: Definitions pertaining to sex and gender roles.[12]

Term	Definition
Sex	Categorical differentiation between men and women, assigned at birth based on brief visual examination of external genitalia.
Gender	Binary social construct involving characteristics distinguishing men from women.
Gender Identity	Person's sense of being male or female.
Transsexual	Outdated term for person who feels they were assigned the incorrect sex.
Transgender	Overarching term for persons with various identities and expressions that are associated with assignment of incorrect sex.
Transition	Legal, medical, and surgical processes that a transsexual person might experience to correct the incongruence of incorrect sexual assignment.
Transwoman	A person who identifies as female but was assigned the male sex.
Transman	A person who identifies as male but was assigned the female sex.

Individual patients might be in the process of transitioning to their preferred gender through medical (i.e., hormone replacement therapy), surgical (i.e., gender reassignment surgery), and/or legal (i.e., amending legal documents to reflect gender identity) means to correct incongruence of sex. Physical therapists should determine if patients in transition are currently under medical treatment for this transition, which could occur prior to or in conjunction with surgical transition, and will be continued after surgical transition. If the patient is on hormone replacement therapy, physical therapists should use the transitioned gender to determine the reference value. If the patient is not receiving hormone therapy, physical therapists should use the patient's biological sex to determine the reference value. For example, a transwomen on estrogen replacement therapy should have her lab values compared to normal values of females due to the effects of estrogen on her physiology, whereas a transman on testosterone should have his lab values compared to those of males due to the effects of testosterone on his physiology. The key factor is not whether the medical record assigns a patient a particular sex or whether the patient has undergone sexual reassignment surgery, but whether patients are taking hormone therapy that will affect their physiology and lab chemistry. Knowing the medical transition status of a transsexual person reduces the risk of misinterpretation of lab values and ensure correct application of normal reference values consistently.[12]

e. Age Considerations

This outline was created to assist the clinician with lab value considerations for the general population. The clinician should be aware that "norms" are created for the healthy adult, and each patient's lab values should be interpreted within the context of the patient's current medical status. That is to say, when reading the value ranges in this section, be aware that considerations for mobility might vary based on the patient's age and current medical condition. For example, an 18-year-old boy with a below-normal hematocrit might tolerate this lower level better than a 90-year-old male with the same low hematocrit. Thus, a clinician might be more willing to mobilize a patient with a below-normal value who is younger and has overall more reserve. Conversely, patients being treated for certain blood cancers can more safely participate in mobility with lower platelet levels vs. the general population, the latter likely being at an increased risk of bleeding.

We have not included lab ranges for the pediatric population. Please refer to the Academy of Pediatric Physical Therapy for more information, as normative values might differ from the adult populations.

2. Complete Blood Count (CBC)

Complete Blood Count (CBC) Provides results regarding the concentration of red blood cells, white blood cells, and platelets in a blood sample.[1]		**Causes**	**Presentation**	**Clinical Implications**
White Blood Cells Routine test to identify the presence of infection, inflammation, allergens. **REFERENCE VALUES**[13] **5.0-10.0** 10^9/L	**Trending Upward** *(leukocytosis)*[13] > 11.0 10^9/L	Infection Leukemia Neoplasm Trauma Surgery Sickle-cell disease Stress/pain Medication-induced Smoking Obesity Congenital Chronic inflammation Connective tissue disease	Fever Malaise Lethargy Dizziness Bleeding Bruising Weight loss (unintentional) Lymphadenopathy Painful inflamed joints	Symptoms-based approach when determining appropriateness for activity, especially in the presence of fever. Consider timing of therapy session due to early-morning low level and late-afternoon high peak.[14]
	Trending Downward *(leukopenia)*[13] < 4.0 10^9/L	Viral infections Chemotherapy Aplastic anemia Autoimmune disease Hepatitis	Anemia Weakness Fatigue Fever Headache Shortness of breath	Symptoms-based approach when determining appropriateness for activity, especially in the presence of fever.[14]
	Trending Downward *(neutropenia)*[13] < 1.5 10^9/L 0.5-1.0 10^9/L = moderate neutropenia < 0.5 10^9/L= severe neutropenia	Stem cell disorder Bacterial infection Viral infection Radiation	Low-grade fever Skin abscesses Sore mouth Symptoms of pneumonia	Neutropenic precautions (dependent on facility guidelines).[14] Symptoms-based approach when determining appropriateness for activity, especially in the presence of fever.[14]

Complete Blood Count (CBC)		Causes	Presentation	Clinical Implications
Platelets **REFERENCE VALUES** **140-400 k/uL**[13]	**Trending Upward** *(thrombocytosis)* > 450 k/uL	Splenectomy Inflammation Neoplasm/cancer Stress Iron deficiency Infection Hemorrhage Hemolysis High altitudes Strenuous exercise Trauma	Weakness Headache Dizziness Chest pain Tingling in hands/feet	Symptoms-based approach when determining appropriateness for activity; monitor symptoms; collaborate with interprofessional team.[13-15] Elevated levels can lead to venous thromboembolism.
	Trending Downward *(thrombocytopenia)* < 150 k/uL	Viral infection Nutrition deficiency Leukemia Radiation Chemotherapy Malignant cancer Liver disease Aplastic anemia Premenstrual and postpartum	Petechiae Ecchymosis Fatigue Jaundice Splenomegaly Risk for bleeding	In presence of severe thrombocytopenia (< 20 k/uL): Symptoms-based approach when determining appropriateness for activity; collaborate with interprofessional team (regarding possible need for/timing of transfusion prior to mobilization)[14] Fall risk awareness (risk of spontaneous hemorrhage).[16,17]
Hemoglobin Assess anemia, blood loss, bone marrow suppression **REFERENCE VALUES** **Male:** 14-17.4 g/dL[13] **Female:** 12-16 g/dL[13] ***Note:*** *Values are slightly decreased in elderly.*[13]	**Trending Upwards** *(polycythemia)*	Congenital heart disease Severe dehydration (or hemoconcentration) Chronic obstructive pulmonary disease (COPD) Congestive heart failure (CHF) Severe burns High altitude	Orthostasis Presyncope Dizziness Arrhythmias CHF onset/exacerbation Seizure Symptoms of transient ischemic attack (TIA) Symptoms of MI Angina	Low critical values (< 5-7 g/dL) can lead to heart failure or death.[13] High critical values (> 20 g/dL) can lead to clogging of capillaries as a result of hemoconcentration.[13] Symptoms-based approach when determining appropriateness for activity, monitor symptoms, collaborate with interprofessional team.[14]

Complete Blood Count (CBC)		Causes	Presentation	Clinical Implications
Hemoglobin (cont.) Assess anemia, blood loss, bone marrow suppression **REFERENCE VALUES** **Male:** 14-17.4 g/dL[13] **Female:** 12-16 g/dL[13] ***Note:*** *Values are slightly decreased in elderly.*[13]	**Trending Downward** *(anemia)*	Hemorrhage Nutritional deficiency Neoplasia Lymphoma Systemic lupus erythematosus Sarcoidosis Renal disease Splenomegaly Sickle cell anemia Stress to bone marrow RBC destruction	Decreased endurance Decreased activity tolerance Pallor Tachycardia	Monitor vitals including SpO_2 to predict tissue perfusion. May present with tachycardia and/or orthostatic hypotension. Medical team might monitor patients with pre-existing cerebrovascular, cardiac, or renal conditions for ineffective tissue perfusion related to decreased hemoglobin.[18] If <8 g/dL: Symptoms-based approach when determining appropriateness for activity; collaborate with interprofessional team (regarding possible need for/timing of transfusion prior to mobilization).[13-15,19] Consultation with the interprofessional team as while as monitoring of signs and symptoms is imperative since hemoglobin levels and blood transfusions is individualized.[18] • hospitalized patients who are hemodynamically stable and asymptomatic may transfuse at 7 g/dL • post surgical cardiac or orthopedic patients and those with underlying cardiovascular disease may transfuse at 8 g/dL. • patients with hematological disorders, oncological disorders and severe thrombocytopenia ,or chronic transfusion-dependent anemia: no transfusion threshold recommendation is available.

Complete Blood Count (CBC)		Causes	Presentation	Clinical Implications
Hematocrit Assess blood loss and fluid balance. **REFERENCE VALUES** **Male:** 42-52%[13] **Female:** 37-47%[13] ***Note:*** *Values are slightly decreased in the elderly.* [13]	**Trending Upward** *(polycythemia)*	Burns Eclampsia Severe dehydration Erythrocytosis Tend to be elevated with those living in higher altitude Hypoxia due to chronic pulmonary conditions (COPD, CHF)	Fever Headache Dizziness Weakness Fatigue Easy bruising or bleeding	Low critical value (<15-20%) cardiac failure or death.[13-15] High critical value (>60%) spontaneous blood clotting.[13-15] Symptoms-based approach when determining appropriateness for activity; monitor symptoms; collaborate with interprofessional team[13-15]
	Trending Downward *(anemia)*	Leukemia Bone marrow failure Multiple myeloma Dietary deficiency Pregnancy Hyperthyroidism Cirrhosis Rheumatoid arthritis Hemorrhage High altitude	Pale skin Headache Dizziness Cold hands/feet Chest pain Arrhythmia Shortness of breath	Patient might have impaired endurance; progress slowly with activity. Monitor vitals including SpO_2 to predict tissue perfusion. Might present with tachycardia and/or orthostatic hypotension. Medical team might monitor patients with pre-existing cerebrovascular, cardiac, or renal conditions for ineffective tissue perfusion related to decreased hematocrit.[18] If < 25%: Symptoms-based approach when determining appropriateness for activity; collaborate with interprofessional team (regarding possible need for/timing of transfusion prior to mobilization)[13-15,18]

3. Electrolyte Panel

Electrolyte Reference Values		Causes	Presentation	Clinical Implications
The Basic Metabolic Panel (BMP) is a group of specific tests for electrolyte level, blood sugar, kidney status and acid-base balance. Significant changes in electrolytes, acid-base balance, renal function and blood sugar may indicate kidney failure, respiratory distress, and impaired cognitive status. Changes in sodium, potassium and calcium alter the excitability of neurons, cardiac, and skeletal muscles that can produce arrhythmias, weakness, and spasms/tremors.[1]				
Sodium (Na) Primary determinant of extracellular fluid volume. **REFERENCE VALUES** **134-142 mEq/L**[13]	**Hypernatremia** *(sodium level > 145 mEq/L)* **Trending Upward**	Increased sodium intake Severe vomiting CHF Renal insufficiency Cushing's syndrome Diabetes[20]	Irritability Agitation Seizure Coma[21] Hypotension Tachycardia Decreased urinary output[22]	Impaired cognitive status. Seizure precautions for patients with past medical history.[21]
	Hyponatremia *(sodium level < 130mEq/L)* **Trending Downward**	Diuretic use Gastrointestinal impairment Burns/wounds Hypotonic IV use Cirrhosis[20]	Headache Lethargic Decreased reflexes Nausea and vomiting (N/V) Diarrhea Seizure Coma Orthostatic hypotension Pitting edema[21]	Impaired cognitive status. Monitor vitals secondary to risk for orthostatic hypotension.[23]
Potassium (K) Important for function of excitable cells such as nerves, muscles, and heart. **REFERENCE VALUES** **3.7-5.1 mEq/L**[13]	**Hyperkalemia** *(serum potassium levels > 5.5 mEq/L)* **Trending Upward**	Renal failure Metabolic acidosis Diabetic ketoacidosis (DKA) Addison's disease Excess potassium supplements Blood transfusion[20]	Muscle weakness/paralysis Paresthesia Bradycardia Heart block Ventricular fibrillation Cardiac arrest[21]	Patient at risk for cardiac issues > 5 mEq/L: Use symptoms-based approach when determining appropriateness for activity [1,20,21] Might exhibit muscle weakness during intervention.
	Hypokalemia *(serum potassium levels < 3.5 mEq/L)* **Trending Downward**	Diarrhea/vomiting Gastrointestinal impairment Diuretics Cushing's syndrome Malnutrition Restrictive diet ETOH abuse[20]	Extremity weakness Decreased reflexes Paresthesia Leg cramps EKG changes Cardiac arrest Hypotension Constipation[21]	Symptoms-based approach when determining appropriateness for activity.[1,20,21] Severe hypokalemia < 2.5 mEq/L: collaborate with interprofessional team.

Electrolyte Reference Values		Causes	Presentation	Clinical Implications
Calcium (Ca) Important for bone formation, cell division and growth, blood coagulation, muscle contraction, and release of neurotransmitters. **REFERENCE VALUES** **8.6-10.3 mg/dL**[13]	**Hypercalcemia** *(high levels of calcium in blood)* **Trending Upward**	Excessive calcium supplements/antacids Bone destruction – tumor Immobilization Fracture Excessive vitamin D Cancer Renal failure[20]	Ventricular dysrhythmias Heart block Asystole Coma Lethargy Muscle weakness Decreased reflexes Constipation Nausea/vomiting[21]	Symptoms-based approach when determining appropriateness for activity.[1,20,21]
	Hypocalcemia *(low levels of calcium in blood)* **Trending Downward**	ETOH abuse Poor dietary intake Limited GI absorption Pancreatitis Laxative use[21]	Anxiety Confusion Agitation Seizure EKG changes Fatigue Numbness/tingling Increased reflexes Muscle cramps[21]	Might have impaired cognitive abilities. Symptoms-based approach when determining appropriateness for activity.[1,20,21]
Chloride (Cl) Important for fluid balance and acid base status. **REFERENCE VALUES** **98-108 mEq/L**[13]	**Hyperchloremia** *(high levels of chloride in blood)* **Trending Upward**	High-salt, low-water diet Hypertonic IV Metabolic Acidosis Renal failure[21]	Lethargy Decreased level of consciousness Weakness Edema Tachypnea Hypertension (HTN) Tachycardia[21]	Determine if appropriate for treatment if exhibiting decreased level of consciousness.[21]
	Hypochloremia *(low levels of chloride in blood)* **Trending Downward**	Low salt diet Water intoxication Diuresis Excessive vomiting and/or diarrhea[21]	Agitation Irritability Hypertonicity Increased reflexes Cramping Twitching[21]	Monitor level of consciousness and motor function.[1,20,21]

Electrolyte Reference Values		Causes	Presentation	Clinical Implications
Phosphate (PO_4) Necessary for bone formation, acid-base balance, and storage and transfer of energy. **REFERENCE VALUES** **2.3-4.1 mg/dL**[13]	**Hyperphosphatemia** *(high level of phosphate in blood)* **Trending Upward**	Bone destruction – tumor Immobilization Fracture Excessive vitamin D Cancer Renal failure[21]	Ventricular dysrhythmia Heart block Asystole Coma Lethargy Muscle weakness Decreased reflexes Constipation Nausea/vomting[21]	Symptoms-based approach when determining appropriateness of activity.[1,20,21]
	Hypophosphatemia *(low level of phosphate in blood)* **Trending Downward**	ETOH abuse Poor dietary Intake Limited GI absorption Pancreatitis Laxative Use[21]	Anxiety Confusion Agitation Seizure EKG changes Fatigue Numbness/tingling Increased reflexes Muscle cramps[21]	Might have impaired cognitive abilities. Symptoms-based approach when determining appropriateness for activity.[1,20,21]
Magnesium (Mg) Concentrated in bone and muscle; concentration primarily regulated by kidneys (ordered separately from BMP). **REFERENCE VALUES** **1.2-1.9 mEq/L**[13]	**Hypermagnesemia** *(high level of magnesium in blood)* **Trending Upward**	Increased intake of antacids/magnesium citrate Renal failure Leukemia Dehydration[21]	Diaphoresis N/V Drowsiness Lethargy Weakness flaccidity Decreased reflexes Hypotension Heart block[21]	Symptoms-based approach when determining appropriateness for activity.[1,20,21]
	Hypomagnesemia *(low level of magnesium in blood)* **Trending Downward**	ETOH abuse Eating disorders Diuresis DKA Medications[21]	Increased reflexes Tremors Spasticity Seizures Nystagmus EKG changes (premature ventricular contraction (PVC) → v-tach →v-fib) Emotional lability[21]	Symptoms-based approach when determining appropriateness for activity.[1,20,21]

4. Kidney Function

Kidney Function Reference Values		Causes	Presentation	Clinical Implications
Blood Urea Nitrogen (BUN) Evaluates kidney function. **REFERENCE VALUES** **6-25 mg/dL**[13]	**Trending Upward**	High-protein diet Renal failure Decreasing volume CHF GI Bleed Fever Increased protein Catabolism[21]	HTN Fluid retention Fatigue Poor appetite N/V Itchy/dry skin Decreased cognition Dyspnea Bone pain[21]	Decreased tolerance to activity.[21] Symptoms-based approach when determining appropriateness for activity.[1,20,21]
	Trending Downward	Hepatic disease Malnutrition[21]	Uncommon; usually not a concern[21]	Symptoms-based approach when determining appropriateness for activity.[1,20,21]
Serum Creatinine Evaluates kidney function. **REFERENCE VALUES** **Male:** 0.7-1.3 mg/dL[13] **Female:** 0.4-1.1 mg/dL[13]	**Trending Upward**	Renal disease Muscular dystrophy Rhabdomyolysis Dehydration[21]	Reduced urine output Dark-colored urine Edema Back pain Fatigue Low fever Loss of appetite Headache Confusion Dyspnea[21]	Decreased tolerance to activity.[19] Symptoms-based approach when determining appropriateness for activity.[1,20,21]
	Trending Downward	Age Pregnancy Low muscle mass Liver disease Low-protein diet[21]	Fatigue (this is uncommon; can be precursor to autoimmune disease)[21]	Symptoms-based approach when determining appropriateness for activity.[1,20,21]

5. Endocrine

Glucose Reference Values		Causes	Presentation	Clinical Implications
Glucose[24] Measures blood glucose at the time sample obtained. **REFERENCE VALUES** **70-100 mg/dL** **FASTING PLASMA GLUCOSE (FPG)** **90-130 mg/dL** **Criteria for the Diagnosis of Diabetes**[24] **FPG > 126 mg/dL *OR*** **2-hour Plasma Glucose > 200 mg/dL**	**Hyperglycemic Trending Upward** *(> 200 mg/dL)*	Diabetes mellitus[21] Sepsis Brain Tumors Certain medications IV glucose After a meal Pancreatitis	Diabetic ketoacidosis Severe fatigue[21]	Decreased tolerance to activity. [21] Symptoms-based approach to appropriateness of activity.[1,20,21]
	Hypoglycemic Trending Downward *(< 70 mg/dL)*	Excess insulin[21] Brain injury Pituitary deficiency Malignancy Addison's disease	Lethargy Irritability Shaking Extremity Weakness Loss of consciousness[21]	May not tolerate therapy until glucose level increased.[21] A glucose target between 140-180 mg/dL is recommended for most patients in noncritical care units while hospitalized.[24]

Hgb A1C Reference Values	Causes	Presentation	Clinical Implications
Hgb A1C[24] Shows the average level of blood glucose control over the previous 3 months. **REFERENCE VALUES** **Normal: < 5.7%** **Pre-diabetes mellitus: 5.7 - 6.4%** **With diabetes mellitus: > 6.5%** *(poor glucose control)*	Diabetes mellitus	Eye disease Heart disease Kidney disease Nerve damage Stroke Gum disease Non-traumatic amputations[24]	Monitor vitals if poorly controlled diabetes. Educate importance of exercise for blood sugar control. Consider for wound care management.[24]

Thyroid Function Reference Values[1]		Presentation	Clinical Implications
Thyroxine (T4) **REFERENCE VALUES** **Total 4.5-11.5 µg/dL** **Triiodothyronine (T3)** **REFERENCE VALUES** **80-200 ng/dL** **Thyroid – Stimulating Hormone (TSH)** **REFERENCE VALUES** **0.3-3.0 U/mL** ***Note:*** *Increased TSH and decreased T4 = thyroid disease; decreased TSH = pituitary disease*	**Hyperthyroidism** **Increased T3 and/or T4**	Tremors Nervousness/lability Weakness/muscular atrophy Increased reflexes Fatigue Tachycardia – increased cardiac output Arrhythmias (atrial fibrillation) Hypotension Chronic periarthritis Proximal weakness Also affects: integumentary, gastrointestinal and genitourinary systems	Decreased exercise tolerance – both strength and capacity. Monitor heart rate and blood pressure. Patient at risk for dysrhythmias during exercise. Patient in a hypermetabolic state will deplete nutrients quickly with exercise.[1]
	Hypothyroidism **Increased TSH** **Decreased T3 and or T4**	Slow Speech/Hoarseness Slow Mental Function Ataxia Proximal muscle weakness Carpel tunnel syndrome Prolonged reflexes Paresthesia Muscular/joint edema Back pain Bradycardia CHF Poor peripheral circulation Hyperlipidemia HTN Also affects: integumentary, gastrointestinal and genitourinary systems	Hypothyroidism – frequently accompanied by myalgia and CK elevation. More prone to skin tears. Activity intolerance; should improve with treatment of hypothyroidism. Rhabdomyolysis, although rare, can appear in the presence of heavy exercise, alcohol, or medications. Monitor heart rate – bradycardia.[1]

6. Acid-Base Disorders[1,13,25-27]

Normal Values: pH 7.35-7.45 PaO_2 80-95 mmHg $PaCO_2$ 37-43 mmHg HCO_3 20-30 mmol/L[13]

	Cause		Symptoms		Implications
Respiratory Alkalosis **pH ≥ 7.45** **$PaCO_2$ ≤ 35 mmHg**	Anxiety sedatives Chronic obstructive pulmonary disease (COPD) Pain Fever	CHF CVA PE meningitis Psychosis	Dizziness Paresthesia Chest pain	Confusion Seizure	May need to coordinate treatments around ventilation. Expect somnolence and fatigue.[20]
Respiratory Acidosis **pH ≤ 7.35** **$PaCO_2$ ≥ 45 mmHg**	Decreasing ventilation Depression of central respiratory center (drugs vs. cerebral disease)	Neuromuscular disease (ALS, GBS, MD) Asthma/chronic obstructive pulmonary disease (COPD)	Confusion Fatigue and/or lethargy	SOB Somnolence	May need to coordinate treatments around ventilation. Expect somnolence and fatigue.[20]
Metabolic Alkalosis **pH ≥ 7.45** **HCO_3 ≥ 30 mmol/L**	Severe vomiting Diarrhea Severe dehydration (diuretics) Retention of bicarbonate	Decreasing ventilation Causing increasing Hypercapnia Cystic fibrosis Chloride-resistant	CO_2 retention		May need to coordinate treatments around ventilation. Expect somnolence and fatigue.[20]
Metabolic Acidosis **pH ≤ 7.35** **HCO_3 < 24 mmol/L**	Increased acid production Decreased renal acid Excretion	Laxative abuse Thiazide diuretics Massive diuresis	Lactic acidosis Ketoacidosis Kidney disease Cardiac arrhythmia w/ pH < 7.1[20,28-30]	Diarrhea or other intestinal losses Anxiety related to hypoxia	May need to coordinate mobility around dialysis (CVVHD vs. HD). Expect somnolence and fatigue.[20] Consider risk of arrhythmias with mobility.[20]

Anion Gap[13]

The difference between free cations and free anions. The major free cations are Sodium (Na+) and Potassium (K+). The major anions are Chloride (Cl−) and Bicarbonate (HCO3−).

The anion gap (AG) it is calculated from the equation AG= [(Na+) + (K+)] − [(Cl−) + (HCO − 3)]- note- K+ may or may not be included- refer to your specific lab to know if K+ is included in Anion Gap

REFERENCE VALUE

8 to 16 mEq without K+

12 to 20 mEq with K+

Clinical Considerations – Elevated Anion Gap

- ETOH Ketoacidosis
- Uncontrolled diabetes-Increased ketoacids
- Methanol intoxication- Increased formic acid
- Tissue hypoxia-Increased lactic acid
- Ketogenic diet
- Fasting
- Poisoning- salicylate, ethynol, methanol

Clinical Decisions

Use a systems-based approach based on the cause of the elevated AG level, not the value itself.

7. Liver Function/Hepatic Panel

Liver Function/Hepatic Panel Reference Ranges Assesses the liver's ability to clear bilirubin, total protein, and albumin.		**Causes**	**Presentation**	**Clinical Implications**
Serum Albumin Half-life of 21 days. **3.5-5.2 g/dL**[13] **Serum Prealbumin** Half-life 2 days; detects current nutritional status within a patient's body.[13] **19-39 mg/dL**[13] 0-5 mg/dL = severe protein depletion 5-10 mg/dL = moderate protein depletion 10-15 mg/dL (mild protein depletion)[13]	**Trending Upward**	Severe infections Congenital disorders Severe dehydration Hepatitis Chronic inflammation Tuberculosis Overdose of cortisone medications CHF Renal Disease Cancer[21]	Clinical features are dependent on the cause (i.e. renal, cardiac, TB, etc.)[21]	Assess integumentary daily Collaborate with the interprofessional team regarding nutrition[31]
	Trending Downward	Infection Nutritional compromise Inflammation Liver disease Crohn's disease Burns Malnutrition Thyroid disease[21]	Peripheral edema Non-healing wound Hypotension[21]	Assess integumentary daily. Collaborate with the interprofessional team regarding nutrition. Low levels occur with prolonged hospital stay.[13] Serum Albumin: < 3.0 g/dL nutritionally compromised; < 2.8 g/dL generalized symmetrical peripheral edema, poor wound healing, potential drug toxicity Serum Pre-Albumin: < 10 g/dL significant nutritional risk, poor wound healing, generalized edema

Liver Function/Hepatic Panel Reference Ranges Assesses the liver's ability to clear bilirubin, total protein, and albumin.		**Causes**	**Presentation**	**Clinical Implications**
Serum Bilirubin Total bilirubin **0.3-1.0 mg/dL**[13] **Critical value: > 12 mg/dL**[13]	**Trending Upward**	Cirrhosis Hepatitis Hemolytic anemia Jaundice Transfusion reaction Bile duct occlusion Chemotherapy	Patients with severe disease might have fatigue, anorexia, nausea, fever, and, occasionally, vomiting. Might have loose, fatty stools.	Symptoms-based approach when determining appropriateness for activity. [1, 18, 19] Adapt education if decreased cognition. Patients with advanced disease are at risk for osteoporosis and bleeding due to deficiencies of fat soluble vitamins.
Ammonia (NH_3) **15-60 µg/dL**[13] Evaluates liver function and metabolism. The liver converts ammonia from blood to urea. If the liver is damaged, then increased ammonia levels are noted.	**Trending Upward**	Cirrhosis Severe hepatitis Reye's syndrome Severe heart disease Kidney failure Severe bleeding of stomach or intestines (GI system)	Hepatic encephalopathy Confusion Lethargy Dementia Daytime sleepiness Tremors Breakdown of fine motor skills Numbness and tingling (peripheral nerve impair) Speech impairment	Might need to alter communication and education, and designate patient as an increased fall risk, if encephalopathy present.[1]

Model for End-Stage Liver Disease (MELD) and MELD-Na[32-35]

Serum bilirubin, serum creatinine, and INR are laboratory measurements that are utilized to determine a score on the traditional Model for End-Stage Liver Disease (MELD) equation. The MELD score accurately predicts the survival for adult patients with advanced liver disease. MELD scores are one of the considerations for allocation of liver transplants.

Recently, the Organ Procurement and Transplantation Network (OPTN) made a change to incorporate serum sodium as another variable for those individuals with a MELD score of greater than 11 (known as the MELD-Na score). Therapists should be aware of the altered values implications for each of these laboratory measures when devising a plan of care with patients who are being considered for, or are on, the list for liver transplantation.

FK Trough (Tacrolimus/Prograf Test)

Avila, J., Zivkovic, S. (2015). The Neurology of Solid Organ Transplantation. Current neurology and neuroscience reports, 15(7), 1-10.
Physical therapists should review FK trough (Tacrolimus/Prograf test) to assess for trends (spikes) when evaluating patients for safe exercise prescription. The drug is essentially fully metabolized in the liver and intestinal wall, with multiple factors affecting the pharmokinetic and metabolic profile (age, sex, other organ impairment, diet, and concomitant medications). Tacrolimus is a highly effective immunosuppressant for lowering the risk of organ transplantation. While dosing is being established by the physician, patients might show tremors, seizures, elevated heartrate, HTN, blurred vision, nausea and vomiting, and ataxia with increasing trends. Therapeutic range: 6-15 ng/mL

8. Lipid Panel [36]				
High-Density Lipoprotein (HDL) "Good" cholesterol: It helps to remove excess cholesterol deposits from the arterial lining. Higher levels can reduce the incidence of coronary heart disease.	**Males ≥ 40 mg/dl** **Females ≥ 50 mg/dl**			
Low-Density Lipoprotein (LDL) "Bad" cholesterol: It deposits in the arterial lining and compromises blood flow.	**Desired Level** **< 100 mg/dl**	Borderline high: 130-159 mg/dl	High: 160-189 mg/dl	Very high: ≥ 190 mg/dl
Triglycerides	**Normal** **< 150 mg/dl**	Borderline high: 150-199 mg/dl	High: 200-499 mg/dl	Very high: ≥ 500 mg/dl
Total Cholesterol	**Desired Level** **< 200 mg/dl**	Borderline high: 200-239 mg/dl	High: ≥ 240 mg/dl	

Clinical Implications: Cardiovascular disease is the No. 1 cause of death in the United States, with an estimated 1.5 million heart attacks and 5 million strokes occurring annually – many in individuals who have no prior symptoms. Prevention of ischemic cardiovascular events is of fundamental importance. Risk factors – including age, smoking status, hypertension, diabetes, cholesterol, and HDL cholesterol – are used to identify individuals likely to have an ischemic event.[37]

9. Bleeding Ratio/Viscosity

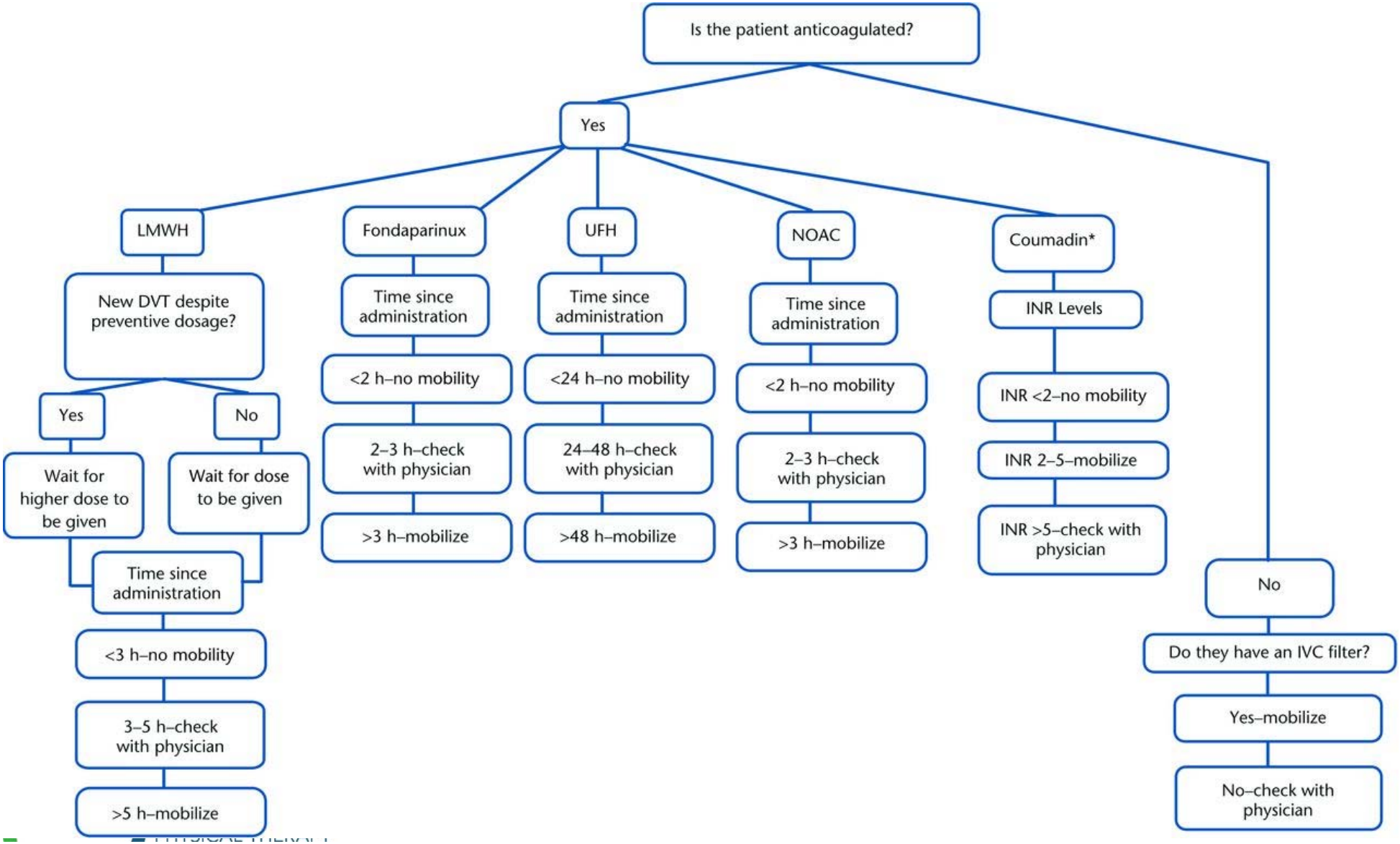
Serum Viscosity

International Normalized Ratio (INR)	
Normal range	0.8-1.2[13]
Therapeutic range for stroke prophylaxis	2.0-2.5[38]
Therapeutic range (VTE, PE, patients with atrial fibrillation)	2.0 to 3.0[39]
Therapeutic range for patients at higher risk (prosthetic heart valves)	2.5-3.5[39]
Therapeutic range for patients with lupus anticoagulant	3.0-3.5[39]
Patient at higher risk for bleeding	> 3.6[13]
Activated Partial Thromboplastin Time (Heparin)	
Normal range	21-35 seconds[13] > 70 seconds signifies spontaneous bleeding[13]
Therapeutic for effectiveness of anticoagulant	2-2.5 times normal range (60-109 seconds) Variability in reagents[13]
Prothrombin Time (Coumadin)	
Normal Range	11-13 sec[13]
High risk for bleeding into tissue; utilize caution and discuss with interprofessional team	> 25 sec
Anti-Factor Xa Assay (Unfractionated Heparin (UH) and Low Molecular Weight Heparin [LMWH])[40,41]	
Therapeutic ranges of: LMWH UH	 0.5-1.2 IU/mL 0.3-0.7 IU/mL
Prophylactic ranges of: LMWH UH	 0.25-0.5 IU/mL 0.1-0.4 IU/mL

Due to the D-dimer test's high sensitivity and poor specificity, a positive test (>400-500 ng/mL) does not indicate a VTE. If a patient has a high pretest probability (Well's Clinical Prediction Rules) of developing a VTE, anticoagulant therapy is initiated, regardless of D-dimer test results. Older age, infections, burns, and heart failure can result in an elevated D-dimer test. If a patient has low pretest probability and has a high D-dimer, further testing (duplex ultrasound) is warranted.[42]

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
INR = international normalized ratio | **IVC** = inferior vena cava



10. Cardiovascular-Specific Labs

Cardiovascular-Specific Labs

Troponin I (cTnI) and T (cTnT)

cTnI and cTnT are two biomarkers that are sensitive, specific indicators to the myocardium of the heart. They are released when cardiac injury occurs (6 hours after insult to 3 days), and they serve as the greatest use for diagnosing a myocardial infarction (> 0.10 ng/mL). Because hospitals often use different assays to measure the presence of troponin, there are different diagnostic cutoff values. Newer highly-sensitive assays can detecting circulating troponin in healthy "normal" individuals at levels as low as (N < 0.03 ng/mL) in their blood. Therefore, it is pertinent that the clinician observes the trend of troponin levels, vigilantly monitors for cardiac symptoms, and alters the PT session accordingly.

It should be noted that troponin may also be elevated in other situations in which there is stress to the heart but not in the setting of myocardial infarction. These instances include the following: rhabdomyolysis with cardiac damage; renal failure; inflammatory disease, such as myocarditis or endocarditis; hypertrophic cardiomyopathy; drug toxicity; critical illness; congestive heart failure; cardiac surgery, including ablation, defibrillation, and cardioversion; large body-surface-area burns; aortic valve disease; aortic dissection; pulmonary embolism or pulmonary hypertension; COPD; blunt thoracic damage; or acute neurologic disease, such as stroke or subarachnoid hemorrhage.[3,43-45]

B-Type Natriuretic Peptide (BNP)

BNP is the strongest independent predictor of congestive heart failure (CHF), with an odds ratio of 29.60.[46] Various studies have shown a correlation that circulating BNP concentrations increases with the severity of CHF, based on the New York Heart Association (NYHA) functional classification system. There are age-related reference values norms for males and females, but for the simplicity of this document, only interpretative levels for a diagnosis of CHF are provided. Values tend to increase with age and are higher in women.[47-49]

BNP	NYHA Classification
BNP <100 pg/mL[46]	Indicates no heart failure
BNP 100–300 pg/mL[46]	**Class I** – Cardiac disease, but no symptoms and no limitation in ordinary physical activity (i.e. no shortness of breath when walking, climbing stairs, etc.). Symptoms-based approach when determining appropriateness for activity.[1,20,21]
BNP > 300 pg/mL[46]	**Class II** – Mild symptoms (mild shortness of breath and/or angina) and slight limitation during ordinary activity. Symptoms-based approach when determining appropriateness for activity.[1,20,21]
BNP > 600 pg/mL[46]	**Class III** – Marked limitation in activity due to symptoms, even during less-than-ordinary activity (i.e. walking short distances [20–100 m]). Comfortable only at rest. Symptoms-based approach when determining appropriateness for activity.[1,20,21]
BNP > 900 pg/mL[46]	**Class IV** – Severe limitations. Experiences symptoms even while at rest. Symptoms-based approach when determining appropriateness for activity[1,20,21]

The following confounding factors can contribute to an elevated BNP: gender (females have higher levels); race (African-American and Hispanic subjects have higher levels than Caucasians); anemia; atrial fibrillation. Obesity is associated with lower BNP levels.[49]

Creatinine Kinase (CK)

Creatinine Kinase (CK)[50] is an isoenzyme that is released into the blood when skeletal, brain, or cardiac muscle is injured.	**Normal = 30-170 U/L** **Adult Males: 52-336 U/L** **Adult Females: 38-176 U/L**
CK1-BB brain tissue	Rarely present, but described as a marker for adenocarcinoma of the prostate, breast, ovary, colon, gastrointestinal tract, and for small-cell anaplastic carcinoma of lung. BB has been reported with severe shock and/or hypothermia, infarction of bowel, brain injury, and stroke.
CK2-MB cardiac muscle	Commonly elevated in myocardial infarction within 3-6 hours of cardiac injury and then returns to normal within 2-3 days (peaks 18-24 hours). Useful for diagnosing re-infarction. Might be elevated in cases of carbon monoxide poisoning, pulmonary embolism, hypothyroidism, crush injuries, and muscular dystrophy. Sensitivity and specificity are not as high as troponin levels.
CK3-MM skeletal muscle	Can have an increase following strenuous exercise, but not considered rhabdomyolysis.[51,52] Intramuscular injection can increase.

11. References

1. Goodman C, Fuller K. *Pathology Implications for the Physical Therapist*. 4th ed. St. Louis: Elsevier Saunders; 2015.
2. Lundberg GD. It is time to extend the laboratory critical (panic) value system to include vital values. *MedGenMed.* 2007;9:20.
3. Thygesen K, Alpert JS, Jaffe AS, et al. Third universal definition of myocardial infarction. *Circulation.* 2012;126:2020-2035.
4. McClatchey KD, Amin HM, Curry JL. *Clinical laboratory medicine : self-assessment and review*. 2nd ed. Philadelphia: Lippincott Williams & Wilkins; 2002.
5. Grosse SD, Odame I, Atrash HK, Amendah DD, Piel FB, Williams TN. Sickle cell disease in Africa: a neglected cause of early childhood mortality. *Am J Prev Med.* 2011;41:S398-405.
6. Overfield T. *Biologic variation in health and illness : race, age, and sex differences*. 2nd ed. Boca Raton: CRC Press; 1995.
7. Hart CB. Race differences in long-term diabetes management in an HMO: response to Adams et al. *Diabetes Care.* 2006;29:1461-1462; author reply 1462.
8. Ward MM. Laboratory abnormalities at the onset of treatment of end-stage renal disease: are there racial or socioeconomic disparities in care? *Arch Intern Med.* 2007;167:1083-1091.
9. Purtilo RB. Thirty-first Mary McMillan lecture. A time to harvest, a time to sow: ethics for a shifting landscape. *Phys Ther.* 2000;80:1112-1119.
10. Leavitt RL. *Cultural competence : a lifelong journey to cultural proficiency*. Thorofare, NJ: SLACK Inc.; 2010.
11. Ghazinouri R, Deshmukh S, Gorman S, et al. Lab Values Interpretation Resources. 2013; http://c.ymcdn.com/sites/www.acutept.org/resource/resmgr/imported/labvalues.pdf. Accessed September 13, 2016.
12. Polly R, Nicole J. Understanding the transsexual patient: culturally sensitive care in emergency nursing practice. *Adv Emerg Nurs J.* 2011;33:55-64.
13. Fischbach FT, Dunning MB. *A manual of laboratory and diagnostic tests*. Ninth edition. ed. Philadelphia: Wolters Kluwer Health; 2015.
14. DeVita VT, Lawrence TS, Rosenberg SA. *Devita, Hellman, and Rosenberg's cancer : principles & practice of oncology*. 10th edition. ed. Philadelphia: Wolters Kluwer; 2015.
15. Boissonnault WG. *Primary care for the physical therapist : examination and triage*. 2nd ed. St. Louis, Mo.: Elsevier/Saunders; 2011.
16. Capone LJ, Albert NM, Bena JF, Tang AS. Predictors of a fall event in hospitalized patients with cancer. *Oncol Nurs Forum.* 2012;39:E407-415.
17. Wildes TM, Dua P, Fowler SA, et al. Systematic review of falls in older adults with cancer. *J Geriatr Oncol.* 2015;6:70-83.
18. Carson JL, Guyatt G, Heddle NM, et al. Clinical Practice Guidelines From the AABB: Red Blood Cell Transfusion Thresholds and Storage. *JAMA.* 2016;316:2025-2035.
19. Peterson M. The Impact of Low Hemoglobin on the Percentage of Adverse Events During Physical Therapy in the Acute Care Setting: A Retrospective Study. *JACPT.* 2015;6:29-34.
20. Paz J, West M. *Acute care Handbook for Physical Therapists*. 3rd ed. St. Louis: Saunders Elsevier; 2009.
21. Malone DJ, Lindsay KLB. *Physical therapy in acute care : a clinician's guide*. Thorofare, NJ: Slack; 2006.
22. Lindner G, Funk GC. Hypernatremia in critically ill patients. *J Crit Care.* 2013;28:216 e211-220.
23. Verbalis JG, Goldsmith SR, Greenberg A, et al. Diagnosis, evaluation, and treatment of hyponatremia: expert panel recommendations. *Am J Med.* 2013;126:S1-42.
24. Association AD. Standards in Medical Care in Diabetes-2016. *Diabetes Care.* 2016;39.
25. Dean E, Ross J. Discordance between cardiopulmonary physiology and physical therapy. Toward a rational basis for practice. *Chest.* 1992;101:1694-1698.
26. Herridge MS, Cheung AM, Tansey CM, et al. One-year outcomes in survivors of the acute respiratory distress syndrome. *N Engl J Med.* 2003;348:683-693.
27. Stiller K. Safety issues that should be considered when mobilizing critically ill patients. *Crit Care Clin.* 2007;23:35-53.
28. Hess CE, Nichols AB, Hunt WB, Suratt PM. Pseudohypoxemia secondary to leukemia and thrombocytosis. *N Engl J Med.* 1979;301:361-363.
29. Ream AK, Reitz BA, Silverberg G. Temperature correction of PCO2 and pH in estimating acid-base status: an example of the emperor's new clothes? *Anesthesiology.* 1982;56:41-44.
30. Williams AJ. ABC of oxygen: assessing and interpreting arterial blood gases and acid-base balance. *BMJ.* 1998;317:1213-1216.

31. DeSanti L. Involuntary weight loss and the nonhealing wound. *Adv Skin Wound Care.* 2000;13:11-20.
32. Luca A, Angermayr B, Bertolini G, et al. An integrated MELD model including serum sodium and age improves the prediction of early mortality in patients with cirrhosis. *Liver Transpl.* 2007;13:1174-1180.
33. Kim WR, Biggins SW, Kremers WK, et al. Hyponatremia and mortality among patients on the liver-transplant waiting list. *N Engl J Med.* 2008;359:1018-1026.
34. Biselli M, Gitto S, Gramenzi A, et al. Six score systems to evaluate candidates with advanced cirrhosis for orthotopic liver transplant: Which is the winner? *Liver Transpl.* 2010;16:964-973.
35. Organ Procurement and Transplantation Network. In: Services UDoHaH, ed2016.
36. Stone NJ, Robinson JG, Lichtenstein AH, et al. 2013 ACC/AHA guideline on the treatment of blood cholesterol to reduce atherosclerotic cardiovascular risk in adults: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. *Circulation.* 2014;129:S1-45.
37. Goldman L. *Disorders of lipid metabolism*. 25th ed. Philadlphia, PA: Saunders Elsevier; 2016.
38. Oden A, Fahlen M, Hart RG. Optimal INR for prevention of stroke and death in atrial fibrillation: a critical appraisal. *Thromb Res.* 2006;117:493-499.
39. Guyatt GH, Akl EA, Crowther M, et al. Executive summary: Antithrombotic Therapy and Prevention of Thrombosis, 9th ed: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines. *Chest.* 2012;141:7S-47S.
40. Vandiver JW, Vondracek TG. Antifactor Xa levels versus activated partial thromboplastin time for monitoring unfractionated heparin. *Pharmacotherapy.* 2012;32:546-558.
41. Hillegass E, Puthoff M, Frese EM, et al. Role of Physical Therapists in the Management of Individuals at Risk for or Diagnosed With Venous Thromboembolism: Evidence-Based Clinical Practice Guideline. *Phys Ther.* 2016;96:143-166.
42. Wells PS, Anderson DR, Rodger M, et al. Evaluation of D-dimer in the diagnosis of suspected deep-vein thrombosis. *N Engl J Med.* 2003;349:1227-1235.
43. Tanindi A, Cemri M. Troponin elevation in conditions other than acute coronary syndromes. *Vasc Health Risk Manag.* 2011;7:597-603.
44. Thygesen K, Alpert JS, White HD, Joint ESCAAHAWHFTFftRoMI. Universal definition of myocardial infarction. *Eur Heart J.* 2007;28:2525-2538.
45. Thygesen K, Mair J, Katus H, et al. Recommendations for the use of cardiac troponin measurement in acute cardiac care. *Eur Heart J.* 2010;31:2197-2204.
46. Maisel AS, Krishnaswamy P, Nowak RM, et al. Rapid measurement of B-type natriuretic peptide in the emergency diagnosis of heart failure. *N Engl J Med.* 2002;347:161-167.
47. Lee SC, Stevens TL, Sandberg SM, et al. The potential of brain natriuretic peptide as a biomarker for New York Heart Association class during the outpatient treatment of heart failure. *J Card Fail.* 2002;8:149-154.
48. Palazzuoli A, Antonelli G, Quatrini I, Nuti R. Natriuretic peptides in heart failure: where we are, where we are going. *Intern Emerg Med.* 2011;6:63-68.
49. Palazzuoli A, Gallotta M, Quatrini I, Nuti R. Natriuretic peptides (BNP and NT-proBNP): measurement and relevance in heart failure. *Vasc Health Risk Manag.* 2010;6:411-418.
50. Apple FS, Quist HE, Doyle PJ, Otto AP, Murakami MM. Plasma 99th percentile reference limits for cardiac troponin and creatine kinase MB mass for use with European Society of Cardiology/American College of Cardiology consensus recommendations. *Clin Chem.* 2003;49:1331-1336.
51. Huerta-Alardin AL, Varon J, Marik PE. Bench-to-bedside review: Rhabdomyolysis -- an overview for clinicians. *Crit Care.* 2005;9:158-169.
52. Sinert R, Kohl L, Rainone T, Scalea T. Exercise-induced rhabdomyolysis. *Ann Emerg Med.* 1994;23:1301-1306.

Appendix A: Point-of-Care Document

Complete Blood Count (CBC)

White Blood Cells — REFERENCE VALUES: 5.0-10.0 10^9/L

	Causes		Presentation		Clinical Implications
Trending Upward *(leukocytosis)* **> 11.0 10^9/L**	Infection Leukemia Neoplasm Trauma/surgery	Obesity Inflammation Connective tissue disease	Fever Malaise Lethargy Dizziness	Bleeding Bruising Weight loss	Symptoms-based approach when determining appropriateness for activity, especially in the presence of fever. Consider timing of therapy session due to early-morning low level and late-afternoon high peak. Neutropenic precautions (dependent on facility guidelines).
Trending Downward *(leukopenia)* **< 4.0 10^9/L**	Infections Chemotherapy Aplastic anemia	Autoimmune disease Hepatitis	Anemia Weakness Fatigue	Headache Dyspnea Fever	
Trending Down *(neutropenia)* **< 1.5 10^9/L**	Stem cell disorder	Viral/bacterial infection Radiation	Fever Skin abscesses	Sore mouth Pneumonia symptoms	

Platelets — REFERENCE VALUE: 140-400 k/uL

	Causes		Presentation		Clinical Implications
Trending Upward *(thrombocytosis/thrombocythemia)* **> 450 k/uL**	Splenectomy Inflammation Cancer Stress	Iron deficiency Infection Hemorrhage	Weakness Headache Dizziness	Chest pain Tingling in hands/feet	Symptoms-based approach when determining appropriateness for activity; monitor symptoms; collaborate with interprofessional team. Elevated levels can lead to venous thromboembolism. In presence of severe thrombocytopenia (< 20 k/uL): Symptoms-based approach when determining appropriateness for activity; collaborate with interprofessional team (regarding possible need for/timing of transfusion prior to mobilization). Fall risk awareness (risk of spontaneous hemorrhage).
Trending Downward *(thrombocytopenia)* **< 150 k/uL**	Infection Leukemia Radiation/ chemotherapy	Malignancy Liver disease Aplastic anemia	Petechiae Ecchymosis Fatigue Risk for bleeding	Jaundice Splenomegaly	

Hemoglobin

REFERENCE VALUES: Men: 14-17.4 g/dL Women: 12-16 g/dL CRITICAL VALUES: < 5-7 g/dL or > 20 g/dL

**NOTE:* *Values are slightly decreased in elderly.*

	Causes		Presentation		Clinical Implications
Trending Upward *(polycythemia)*	Congenital heart disease Dehydration	CHF Severe burns COPD	Orthostasis Dizziness Arrhythmias	Seizure TIA-symptoms Chest pain	Low critical values (< 5-7 g/dL) can lead to heart failure or death. High critical values (> 20 g/dL) can lead to clogging of capillaries as a result of hemoconcentration. Symptoms-based approach when determining appropriateness for activity, monitor symptoms, collaborate interprofessional team. Monitor vitals including SpO2 to predict tissue perfusion. May present with tachycardia and/or orthostatic hypotension. Medical team might monitor patients with pre-existing cerebrovascular, cardiac, or renal conditions for ineffective tissue perfusion related to decreased hemoglobin. < 8 g/dL: Symptoms-based approach when determining appropriateness for activity; collaborate with interprofessional team (regarding possible need for/timing of transfusion prior to mobilization). Consultation with the interprofessional team as while as monitoring of signs and symptoms is imperative since hemoglobin levels and blood transfusions is individualized. • hospitalized patients who are hemodynamically stable and asymptomatic may transfuse at 7 g/dL • post-surgical cardiac or orthopedic patients and those with underlying cardiovascular disease may transfuse at 8 g/dL. • patients with hematological disorders, oncological disorders and severe thrombocytopenia ,or chronic transfusion-dependent anemia: no transfusion threshold recommendation is available.
Trending Downward *(anemia)*	Anemia/blood loss Nutrition Neoplasia Lymphoma Systemic lupus erythematosus Splenomegaly	Sarcoidosis Kidney disease Sickle cell anemia Stress to bone marrow RBC destruction	Anemia Decreased endurance	Pallor Tachycardia Decreased activity	

Hematocrit

REFERENCE VALUES: Men: 42-52% Women: 37-47% Critical Values: < 15-20% or > 60%

***NOTE:** Values are slightly decreased in elderly.*

	Causes		Presentation		Clinical Implications
Trending Upward *(polycythemia)*	COPD Burns Eclampsia	CHF High altitude Dehydration	Fever Headache Dizziness	Weakness Fatigue Bruising/bleeding	Low critical value (< 15-20%): cardiac failure or death. High critical value (> 60%): spontaneous blood clotting. Symptoms-based approach when determining appropriateness for activity; monitor symptoms; collaborate with interprofessional team. Patient might have impaired endurance; progress slowly with activity. Monitor vitals including SpO2 to predict tissue perfusion. Might present with tachycardia and/or orthostatic hypotension. Medical team might monitor patients with pre-existing cerebrovascular, cardiac, or renal conditions for ineffective tissue perfusion related to decreased hematocrit. < 25%: Symptoms-based approach when determining appropriateness for activity; collaborate with interprofessional team (regarding possible need for/timing of transfusion prior to mobilization).
Trending Downward *(anemia)*	Leukemia Multiple myeloma Pregnancy High altitude	Hyperthyroid Cirrhosis Rheumatoid Arthritis Hemorrhage	Pale skin Headache Dizziness	Chest pain Arrhythmia Dyspnea	

Electrolyte Reference Values

Sodium (Na)

REFERENCE VALUES: 134-142 mEq/L

	Causes		Presentation		Clinical Implications
Trending Upward *(hypernatremia)*	Increased sodium intake Severe vomiting CHF	Renal insufficiency Cushing's syndrome Diabetes	Irritability Agitation Seizure Coma	Hypotension Tachycardia Decreased urinary output	Impaired cognitive status. Seizure precautions for patient with past medical history.
Trending Downward *(hyponatremia)* **Sodium level < 130 mEq/L**	Diuretic use GI loss Burns/wounds	Hypotonic IV use Cirrhosis	Headache Lethargic Decreased reflexes Nausea and diarrhea	Seizure Coma Orthostatic hypotension Pitting edema	Impaired cognitive status. Monitor vitals secondary to risk for orthostatic hypotension.

Potassium (K)

REFERENCE VALUES: 3.7-5.1 mEq/L

	Causes		Presentation		Clinical Implications
Trending Upward *(hyperkalemia)*	Renal failure Metabolic acidosis DKA	Addison's disease Excess potassium supplements Blood transfusion	Muscle weakness/paralysis Paresthesia Bradycardia	Heart block V-fib Cardiac arrest	> 5 mEq/L: Patient at risk for cardiac issues Use symptoms-based approach when determining appropriateness for activity. Might exhibit muscle weakness during intervention.
Trending Downward *(hypokalemia)*	Diarrhea/vomiting Diuretics Cushing's syndrome	Malnutrition Restrictive diet ETOH abuse	Extremity weakness Decreased reflexes Paresthesia Leg cramps	EKG changes Cardiac arrest Hypotension Constipation	Symptoms-based approach when determining appropriateness for activity. Severe hypokalemia < 2.5 mEq/L: Collaborate with interprofessional team.

Calcium (Ca)

REFERENCE VALUES: Adult: 8.6-10.3 mg/dL

	Causes		Presentation		Clinical Implications
Trending Upward *(hypercalcemia)*	Excessive calcium supplements Antacids Bone destruction Tumor	Excessive vitamin D Cancer Renal failure Immobilization Fracture Renal failure	Ventricular dysrhythmias Heart block Asystole Coma	Decreased DTR Constipation N/V Lethargy Muscle weakness	Symptoms-based approach, when determining appropriateness for activity.
Trending Downward *(hypocalcemia)*	ETOH abuse Poor dietary intake	Pancreatitis Laxative use Limited GI absorption	Anxiety/confusion Agitation Seizure EKG changes	Fatigue Numb/tingling Hyperreflexia Muscle cramps	May have impaired cognitive abilities. Symptoms-based approach when determining appropriateness for activity.

Chloride (Cl)

REFERENCE VALUES: 98-108 mEq/L

	Causes		Presentation		Clinical Implications
Trending Upward *(hyperchloremia)*	High salt, low water diet Hypertonic IV	Metabolic acidosis Renal failure	Lethargy Decreased level of consciousness Tachycardia	Weakness Edema Tachypnea HTN	Determine if appropriate for treatment if exhibiting decreased level of consciousness.
Trending Downward *(hypochloremia)*	Low salt diet Water intoxication Diuresis	Excessive diarrhea/vomiting	Agitation Irritability Hypertonicity	Increased reflexes Cramping Twitching	Monitor level of consciousness and motor function.

Phosphate (PO_4)

REFERENCE VALUES: 2.3-4.1 mg/dL

	Causes		Presentation		Clinical Implications
Trending Upward *(hyperphosphatemia)*	Bone destruction Tumor Immobilization Fracture	Excessive vitamin D Cancer Renal failure	Ventricular Dysrhythmia Heart block Asystole Coma	Muscle weakness Decreased reflexes Constipation N/V Lethargy	Symptoms-based approach when determining appropriateness of activity.

Phosphate (PO_4) (cont.)

REFERENCE VALUES: 2.3-4.1 mg/dL

	Causes		Presentation		Clinical Implications
Trending Downward *(hypophosphatemia)*	Poor dietary intake Poor GI absorption	Pancreatitis Laxative use ETOH abuse	Anxiety/confusion Agitation Seizure EKG changes	Fatigue Numb/tingling Increased reflexes Muscle cramps	Might have impaired cognitive abilities. Symptoms-based approach when determining appropriateness for activity.

Magnesium (Mg)

REFERENCE VALUES: 1.2-1.9 mEq/L

	Causes		Presentation		Clinical Implications
Trending Upward *(hypermagnesemia)*	Increased intake in antacids/magnesium citrate	Renal failure Leukemia Dehydration	Diaphoresis N/V Drowsiness Lethargy Weakness	Flaccidity Decreased reflexes Hypotension Heart block	Symptoms-based approach when determining appropriateness for activity.
Trending Downward *(hypomagnesemia)*	ETOH abuse Eating disorders	Diuresis DKA Medications	Increased reflexes Tremors Spasticity Seizures	EKG changes (premature ventricular contraction [PVC] → v-tach →v-fib) Emotional lability	Symptoms-based approach when determining appropriateness for activity.

Serum Viscosity	
INTERNATIONAL NORMALIZED RATIO (INR) NORMAL RANGE: 0.8-1.2	
Therapeutic Range (VTE, PE, patients with atrial fibrillation)	2.0 to 3.0
Therapeutic Range for Stroke Prophylaxis	2.0-2.5
Therapeutic Range for Patients at Higher Risk (prosthetic heart valves)	2.5-3.5
Therapeutic Range for Patients with Lupus Anticoagulant	3.0-3.5
Patient at Higher Risk for Bleeding	> 3.6
activated Partial Thromboplastin Time aPTT (Heparin)	
Normal Range	21-35 seconds > 70 seconds increased risk of spontaneous bleeding
Therapeutic for Effectiveness of Anticoagulant	2-2.5 times normal range (60-109 seconds) Variability in reagents
Prothrombin Time (Coumadin)	
Normal Range	11-13 sec
High Risk for Bleeding into Tissue, Utilize Caution and Discuss with Interprofessional team	> 25 sec
Anti-Factor Xa Assay (Unfractionated Heparin [UH] and Low Molecular Weight Heparin [LMWH])	
Therapeutic ranges of: **LMWH** **UH**	 0.5-1.2 IU/mL 0.3-0.7 IU/mL
Prophylactic ranges of: **LMWH** **UH**	 0.25-0.5 IU/mL 0.1-0.4 IU/mL

Troponin Normal <0.03 ng/mL

Trend is most important in decision to provide physical therapy.

B-Type Natriuretic Peptide (BNP)

BNP Level	NYHA Classification	Treatment Implications
< 100 pg/mL	Indicates no heart failure.	
100–300 pg/mL	**Class I** – Cardiac disease, but no symptoms and no limitation in ordinary physical activity, e.g. no shortness of breath when walking, climbing stairs etc.	Symptoms-based approach when determining appropriateness for activity.
> 300 pg/mL	**Class II** – Mild symptoms (mild shortness of breath and/or angina) and slight limitation during ordinary activity.	
> 600 pg/mL	**Class III** – Marked limitation in activity due to symptoms, even during less-than-ordinary activity, e.g. walking short distances (20–100 m). Comfortable only at rest.	
> 900 pg/mL	**Class IV** – Severe limitations. Experiences symptoms even while at rest.	

Creatinine Kinase (CK)

REFERENCE VALUES: Normal = 30-170 U/L Males: 52-336 U/L Females: 38-176 U/L

CK Isoenzymes	Treatment Implications
CK1-BB Brain Tissue	Rarely present but described as a marker for adenocarcinoma of the prostate, breast, ovary, colon, and gastrointestinal tract, and for small-cell anaplastic carcinoma of lung. BB has been reported with severe shock and/or hypothermia, infarction of bowel, brain injury, and stroke.
CK2-MB Cardiac Muscle	Commonly elevated in myocardial infarction within 3-6 hours of cardiac injury and then returns to normal within 2-3 days (peaks 18-24 hours). Useful for diagnosing re-infarction. Might be elevated in cases of carbon monoxide poisoning, pulmonary embolism, hypothyroidism, crush injuries, and muscular dystrophy. Sensitivity and specificity are not as high as troponin levels.
CK3-MM Skeletal Muscle	> 15 and 20K following strenuous exercise but not considered rhabdomyolysis[51,52]. Intramuscular injection can increase.

Acid-Base Disorders

REFERENCE VALUES: Normal = pH: 7.35-7.45 PaO_2: 80-95 mmHg $PaCO_2$: 37-43 mmHg HCO_3:20-30 mmol/L

	Cause		Symptoms		Implications
Respiratory Alkalosis **pH >7.45** **$PaCO_2$ <35mmHg**	Sedatives COPD Pain Anxiety Fever	CHF CVA PE Meningitis Psychosis	Dizziness Paresthesia Chest pain	Confusion Seizure	May need to coordinate treatments around ventilation. Expect somnolence and fatigue.
Respiratory Acidosis **pH <7.35** **$PaCO_2$ >45mmHg**	Dec ventilation Depression of central respiratory center (drugs vs. cerebral disease)	Neuromuscular disease (ALS, GBS, MD) Asthma/chronic obstructive pulmonary disease (COPD)	Confusion Fatigue/lethargy	SOB Somnolence	May need to coordinate treatments around ventilation. Expect somnolence and fatigue.
Metabolic Alkalosis **pH >7.45** **HCO_3 >30mmol/L**	Severe vomiting Diarrhea Severe dehydration (diuretics) Retention of bicarbonate	Decreasing ventilation Causing increasing hypercapnia Cystic fibrosis Chloride-resistant	CO2 retention Decreasing ventilation		May need to coordinate treatments around ventilation. Expect somnolence and fatigue.
Metabolic Acidosis **pH <7.35** **HCO_3 <24mmol/L**	Increased acid production Decreased renal acid excretion	Laxative abuse Thiazide diuretics Massive diuresis	Lactic acidosis Ketoacidosis Kidney disease Cardiac Arrhythmia W/ pH <7.1	Diarrhea or other intestinal losses Anxiety related to hypoxia	May need to coordinate mobility around dialysis (CVVHD vs HD). Expect increased fatigue levels/somnolence. Consider risk of arrhythmias with mobility.

Liver Function/Hepatic Panel

Serum Albumin (Half-Life of 21 Days) & Serum Pre-Albumin (Half-Life of 2 Days)

REFERENCE VALUES:
Serum Albumin = 3.5-5.2g/dL Serum Pre-Albumin = 19-39 mg/dL

	Causes		Presentation	Clinical Implications
Trending Upward	Severe infections Congenital disorders Severe dehydration Chronic inflammation	Tuberculosis Overdose of cortisone meds CHF Renal disease Cancer Hepatitis	Clinical features are dependent on the cause (i.e. renal, cardiac, TB, etc.)[21]	Assess integumentary daily. Collaborate with the interprofessional team regarding nutrition.
Trending Downward	Nutritional compromise Infection Inflammation Liver disease Crohn's disease	Burns Malnutrition Thyroid disease	Peripheral edema Non-healing wound Hypotension	Assess integumentary daily. Collaborate with the interprofessional team regarding nutrition. Low levels occur with prolonged hospital stay. Serum Albumin: < 3.0 g/dL nutritionally compromised; < 2.8 g/dL generalized symmetrical peripheral edema, poor wound healing, potential drug toxicity Serum Pre-Albumin: < 10 g/dL significant nutritional risk, poor wound healing, generalized edema

Serum Bilirubin (Total Bilirubin)

REFERENCE VALUES: 0.3-1.0 mg/dL CRITICAL VALUE: > 12 mg/dL[13]

	Causes		Presentation	Clinical Implications
Trending Upward	Cirrhosis Hepatitis Hemolytic Anemia Jaundice	Transfusion reaction Bile duct occlusion Chemotherapy	Patients with severe disease might have fatigue, anorexia, nausea, fever, and, occasionally, vomiting. Might have loose fatty stools.	Symptoms-based approach when determining appropriateness for activity. Adapt education if decreased cognition. Patients with advanced disease are at risk for osteoporosis and bleeding due to deficiencies of fat soluble vitamins.

Kidney Function Reference Values

Blood Urea Nitrogen (BUN)

REFERENCE VALUES: 6-25 mg/dL

	Causes		Presentation		Clinical Implications
Trending Upward	High protein diet Renal failure Decreasing volume CHF	GL Bleed Fever Increased protein Catabolism	HTN Fluid retention Fatigue Poor appetite Nausea/vomiting	Itchy/dry skin Decreasing cognition Dyspnea Bone pain	Decreased tolerance to activity. Symptoms-based approach when determining appropriateness for activity.
Trending Downward	Hepatic disease Malnutrition		Uncommon; usually not a concern.		

Serum Creatinine

REFERENCE VALUES: Male: 0.7-1.3 mg/dL Female: 0.4-1.1 mg/dL

	Causes		Presentation		Clinical Implications
Trending Upward	Renal disease Muscular dystrophy Rhabdomyolysis Dehydration		Decreasing urine output Dark colored urine Edema Back pain Dyspnea	Fatigue Low fever Loss of appetite Headache Confusion	Decreased tolerance to activity. Symptoms-based approach when determining appropriateness for activity.
Trending Downward	Age Low muscle mass	Liver disease Low protein diet Pregnancy	Fatigue; this is uncommon can be precursor to autoimmune disease.		

Glucose **REFERENCE VALUES: 70-100 mg/dL HEALTHY OLDER ADULTS: FASTING PLASMA GLUCOSE (FPG) 90–130 mg/dL**					
	Causes		**Presentation**		**Clinical Implications**
Trending Upward *(hyperglycemic)* **> 200 mg/dL** **Criteria for the Diagnosis of Diabetes FPG > 126 mg/dL *OR* 2-Hour Plasma Glucose > 200 mg/dL**	Diabetes mellitus[21] Sepsis Brain tumors	Certain medication IV glucose After a meal Pancreatitis	DKA Severe Fatigue		Decreased tolerance to activity Symptoms-based approach to appropriateness of activity.[21]
Trending Downward *(hypoglycemic)* *< 70 mg/dL*	Excess insulin Brain injury Pituitary deficiency	Malignancy Addison's disease	Lethargy Irritability Shaking	Extremity weakness Loss of consciousness	May not tolerate therapy until glucose level increased. A glucose target between 140-180 mg/dL is recommended for most patients in noncritical care units while hospitalized.
Hgb A1C **REFERENCE VALUES: Normal = <5.7%**					
Pre-Diabetes Mellitus: 5.7 - 6.4% **With Diabetes Mellitus: > 6.5%** *(poor glucose control)*	Diabetes mellitus		Eye disease Heart disease Kidney disease Nerve damage	Stroke Gum disease Non-traumatic amputations[24]	Monitor vitals if poorly controlled diabetes. Educate importance of exercise for blood sugar control. Consider for wound care management.

Thyroid Function Reference Values

		Presentation		Clinical Implications
Thyroxine (T4) **REFERENCE VALUES:** **Total: 4.5-11.5 µg/dL** **Triiodothyronine (T3)** **REFERENCE VALUES:** **80-200 ng/dL** **Thyroid-Stimulating Hormone (TSH)** **REFERENCE VALUES:** **0.3-3.0 U/mL** ***Note: Increased** TSH **AND decreased** T4 = thyroid disease* ***Decreased** TSH = pituitary disease*	Hyperthyroidism Increased T3 and/or T4	Tremors Nervousness/lability Weakness/muscle atrophy Increased reflexes Fatigue Tachycardia Increased cardiac output	Arrhythmias (a-fib) Hypotension Chronic periarthritis Proximal weakness Also affects: integumentary, gastrointestinal and genitourinary systems	Decreased exercise tolerance – both strength and capacity. Monitor heart rate and blood pressure. Patient at risk for arrhythmias during exercise. Patient in hypermetabolic state will deplete nutrients quickly with exercise.
	Hypothyroidism Increased TSH Decreased T3 and/or T4	Slow speech/hoarseness Slow mental function Ataxia Proximal muscle weakness Carpal tunnel syndrome Prolonged reflexes Paresthesia	Muscular/joint edema Back pain Bradycardia CHF Poor peripheral circulation Hyperlipidemia Hypertension Also affects: integumentary, gastrointestinal and genitourinary systems	Hypothyroidism – frequently accompanied by myalgia and CK elevation. More prone to skin tears. Activity intolerance – should improve with treatment of hypothyroidism. Rhabdomyolysis, although rare, can appear in the presence of heavy exercise, alcohol, or medications. Monitor heart rate – bradycardia.