



# Lab Values

Capstone Project by Caroline Ballard, SPT

# Considerations before interpretation

- Trends
- Acute vs. chronic abnormal values
- Race and genetic heterogeneity
- Gender
- Age
- Ultimate judgement by clinician

# Complete Blood Count



White Blood Cells:  
5.0-10.0  $10^9/L$

## Leukocytosis

- $>11.0 \times 10^9/L$
- Causes: infection, leukemia, neoplasm, surgery, stress, smoking, obesity
- Symptoms: fever, lethargy, dizziness, bleeding, lymphadenopathy
- PT: Monitor symptoms, consider systemic cause and evaluate for appropriateness

## Leukopenia

- $<4.0 \times 10^9/L$
- Causes: viral infection, chemotherapy, autoimmune disease, hepatitis
- Symptoms: anemia, weakness, fatigue, fever, headache, SOB
- PT: Monitor symptoms, consider systemic cause and evaluate for appropriateness

## Neutropenia

- $<1.5 \times 10^9/L$
- Causes: stem cell disorder, infection, radiation
- Symptoms: Low grade fever, skin abscesses, pneumonia-like presentation
- PT: Neutropenic precautions

Platelets:  
140-400 k/ $\mu$ L

## Thrombocytosis

- $>450$  k/ $\mu$ L
- Causes: splenectomy, inflammation, neoplasm, stress, iron deficiency, hemorrhage, trauma, strenuous exercise
- Symptoms: weakness, headache, dizziness, chest pain
- PT: watch for signs of venous thromboembolism

## Thrombocytopenia

- $<150$  k/ $\mu$ L
- Causes: viral infection, malnutrition, leukemia, chemotherapy, liver disease, premenstrual and postpartum
- Symptoms: petechiae, ecchymosis, fatigue, jaundice, risk for bleeding
- PT: severe ( $<20$  k/ $\mu$ L) may need transfusion before mobilization, falls risk reduction

# Hemoglobin

## Gender specific norms

- Male: 14-17.4 g/dL
- Female: 12-16 g/dL
- Values may be lower in older adults

## Polycythemia

- Causes: congenital heart disease, severe dehydration, COPD, CHF, severe burns
- Symptoms: orthostasis, arrhythmias, angina
- PT: Monitor SpO<sub>2</sub> and vitals, >20 g/dL can clog capillaries

## Anemia

- Causes: hemorrhage, neoplasia, lymphoma, SLE, renal disease
- Symptoms: decreased endurance and activity tolerance, pallor, tachycardia
- PT: Monitor SpO<sub>2</sub> and vitals, consult with team about mobility <8 g/dL, critically low values 5-7 g/dL can lead to heart failure or death

# Hematocrit

## Gender specific norms

- Male: 42-52%
- Female: 37-47%
- Values may be lower in older adults

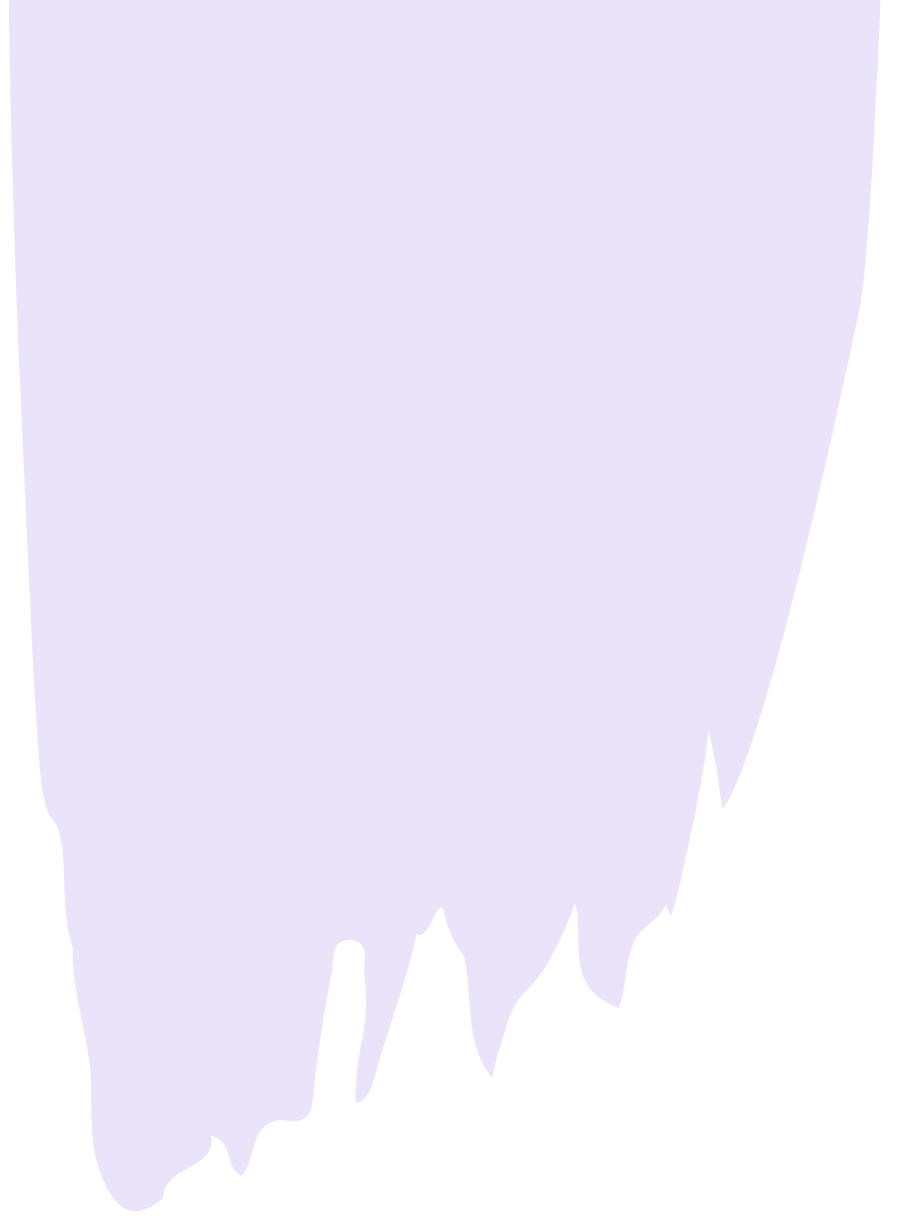
## Polycythemia

- Causes: burns, eclampsia, severe dehydration, erythrocytosis, chronic hypoxia
- Symptoms: fever, headache, dizziness, weakness, fatigue, easy bruising or bleeding
- PT: Monitor vitals and symptoms, >60% can cause spontaneous blood clots

## Anemia

- Causes: leukemia, multiple myeloma, dietary deficiency, pregnancy, hyperthyroidism, RA, hemorrhage
- Symptoms: pale skin, headache, dizziness, chest pain, arrhythmia, SOB
- PT: Monitor vitals and symptoms, progress activity slowly, if <25% consult with medical team before mobilizing

# Basic Metabolic Panel





Sodium:  
134-142  
mEq/L

## Hypernatremia

- > 145 mEq/L
- Causes: increased sodium intake, severe vomiting, CHF, renal insufficiency, Cushing's syndrome, diabetes
- Symptoms: irritability, agitation, seizure, coma, hypotension, tachycardia, decreased urine output
- PT: Potential for impaired cognition, seizure precautions for patients with PMH

## Hyponatremia

- <130 mEq/L
- Causes: diuretic use, GI impairment, burns/wounds, cirrhosis
- Symptoms: headache, lethargy, decreased reflexes, nausea/vomiting, diarrhea, seizure, coma, orthostatic hypotension, pitting edema
- PT: Potential for impaired cognition, monitor vitals especially with position changes

Potassium:  
3.7-5.1  
mEq/L

## Hyperkalemia

- $>5.5$  mEq/L
- Causes: renal failure, metabolic acidosis, diabetic ketoacidosis, excess supplements, blood transfusion
- Symptoms: muscle weakness or paralysis, paresthesia, bradycardia, heart block, ventricular fibrillation, cardiac arrest
- PT: Risk for cardiac event in at-risk patients when  $>5.0$  mEq/L (consult with team), muscle weakness may impact intervention

## Hypokalemia

- $<3.5$  mEq/L
- Causes: Diarrhea, vomiting, diuretics, Cushing's syndrome, malnutrition, ETOH abuse
- Symptoms: extremity weakness, decreased reflexes, paresthesia, leg cramps, EKG changes, cardiac arrest, hypotension, constipation
- PT: severe ( $<2.5$  mEq/L) consult with team, monitor vitals

Calcium:  
8.6-10.3  
mg/dL

## Hypercalcemia

- Causes: excessive calcium supplements or antacids, bone tumor, immobilization, fracture, excessive Vit D, renal failure
- Symptoms: Ventricular dysrhythmias, coma, lethargy, muscle weakness, decreased reflexes, constipation, nausea, vomiting
- PT: Monitor symptoms

## Hypocalcemia

- Causes: ETOH abuse, poor dietary intake, limited GI absorption, pancreatitis, laxative use
- Symptoms: Anxiety, confusion, agitation, seizure, EKG changes, fatigue, numbness/tingling, increased reflexes, muscle cramps
- PT: Monitor cognitive status and symptoms

Chloride:  
98-108  
mEq/L

## Hyperchloremia

- Causes: high salt diet, metabolic acidosis, renal failure
- Symptoms: lethargy, decreased level of consciousness, weakness, edema, tachypnea, hypertension, tachycardia
- PT: Decreased level of consciousness may cause a hold on treatment

## Hypochloremia

- Causes: low salt diet, water intoxication, diuresis, excessive vomiting or diarrhea
- Symptoms: agitation, irritability, hypertonicity, increased reflexes, cramping, twitching
- PT: Monitor level of consciousness and motor function

Blood Urea  
Nitrogen:  
6-25  
mg/dL

## Elevated levels

- Causes: high protein diet, renal failure, CHF, GI bleed, fever, increased protein catabolism
- Symptoms: hypertension, fluid retention, fatigue, poor appetite, nausea, vomiting, itchy/dry skin, decreased cognition, dyspnea, bone pain
- PT: Patient will likely have decreased activity tolerance, monitor symptoms

## Reduced levels

- Causes: Hepatic disease, malnutrition
- Very uncommon, usually not a concern

# Serum Creatinine

## Gender Specific Norms

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

## Elevated levels

- Causes: renal disease, muscular dystrophy, rhabdomyolysis, dehydration
- Symptoms: reduced urine output, dark colored urine, edema, back pain, fatigue, low fever, loss of appetite, headache, confusion, dyspnea
- PT: Expect low activity tolerance, monitor symptoms

## Reduced levels

- Causes: age, pregnancy, low muscle mass, liver disease, low protein diet
- Symptoms: fatigue
- Uncommon condition, can precede autoimmune disease

Glucose:  
70-100  
mg/dL (90-  
130 mg/dL  
fasting)

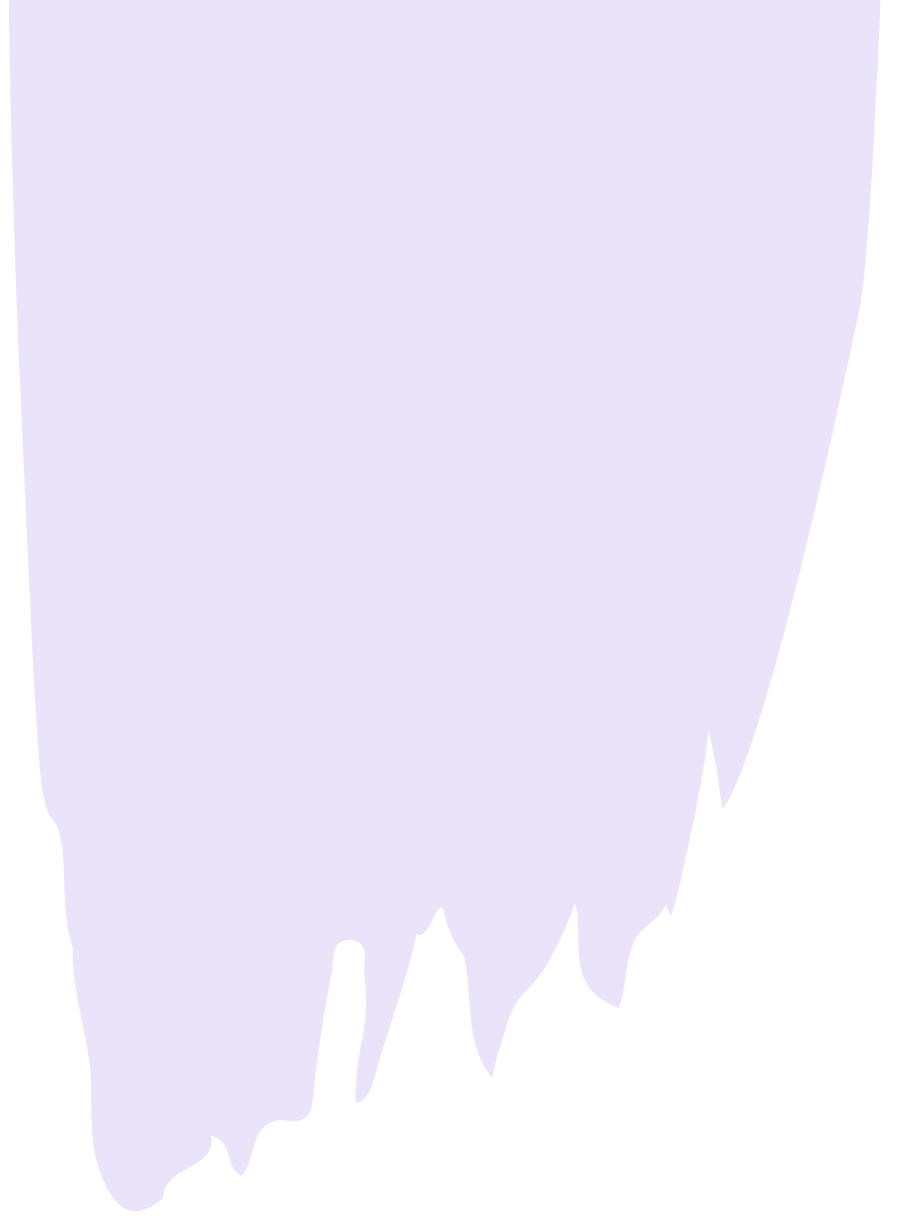
## Hyperglycemic

- >200 mg/dL
- Causes: diabetes mellitus, sepsis, brain tumor, after a meal, pancreatitis
- Symptoms: severe fatigue, coma, diabetic ketoacidosis
- PT: Patient will have decreased activity tolerance, progress activity slowly and monitor symptoms

## Hypoglycemic

- <70 mg/dL
- Causes: excess insulin, brain injury, pituitary deficiency, malignancy, Addison's disease
- Symptoms: lethargy, irritability, shaking, extremity weakness, loss of consciousness
- PT: May not tolerate activity until glucose level increased

# Acid-Base Disorders





Arterial  
Blood Gases:  
Reference  
Values

pH: 7.35-7.45

PaO<sub>2</sub>: 80-95 mmHg

PaCO<sub>2</sub>: 37-43 mmHg

HCO<sub>3</sub>: 22-26 mmol/L

# Respiratory Acid-Base Disorders

## Respiratory Alkalosis

- $\text{pH} \geq 7.45$ ,  $\text{PaCO}_2 \leq 35$  mmHg
- Causes: COPD, pain, fever, CHF, CVA, psychosis
- Symptoms: dizziness, paresthesia, chest pain, confusion, seizure

## Respiratory Acidosis

- $\text{pH} \leq 7.35$ ,  $\text{PaCO}_2 \geq 45$  mmHg
- Causes: decreased ventilation, depression of central respiratory center, neuromuscular disease, COPD
- Symptoms: confusion, fatigue, SOB, somnolence

PT: Expect somnolence and fatigue, may need to coordinate therapy around ventilation treatments

# Metabolic Acid-Base Disorders

## Metabolic Alkalosis

- $\text{pH} \geq 7.45$ ,  $\text{HCO}_3^- > 26$  mmol/L
- Causes: severe vomiting, diarrhea, dehydration, retention of bicarbonate, decreased ventilation and hypercapnia, cystic fibrosis
- Symptoms:  $\text{CO}_2$  retention

## Metabolic Acidosis

- $\text{pH} \leq 7.35$ ,  $\text{HCO}_3^- < 22$  mmol/L
- Causes: increased acid production, decreased renal acid excretion, laxative abuse, diuretics
- Symptoms: lactic acidosis, ketoacidosis, kidney disease, diarrhea

PT: Expect somnolence and fatigue, may need to coordinate therapy around ventilation or dialysis treatments

# Lipid Panel



# High-Density Lipoprotein

## Gender Specific Guidelines

- Males:  $\geq 40$  mg/dL
- Females:  $\geq 50$  mg/dL

Higher levels can reduce incidence of CAD

## Low-Density Lipoprotein

Desired:  $< 100$  mg/dL

Borderline high: 130-159 mg/dL

High: 160-189 mg/dL

Very high:  $\geq 190$  mg/dL

# Triglycerides

Normal:  $< 150$  mg/dL

Borderline high: 150-199 mg/dL

High: 200-499 mg/dL

Very high:  $\geq 500$  mg/dL

# Total Cholesterol

Desired level:  $< 200$  mg/dL

Borderline high: 200-239 mg/dL

High:  $\geq 240$  mg/dL

**PT implications of Lipid Panel: recognize risk factors for cardiovascular disease and ischemic events**



# Serum Viscosity



# International Normalized Ratio

Normal range: 0.8-1.2

Therapeutic range for stroke prophylaxis: 2.0-2.5

Therapeutic range (VTE, PE, atrial fibrillation): 2.0-3.0

Therapeutic range for higher risk patients: 2.5-3.5

Patient at high risk for bleeding: >3.6

Anti-Factor Xa  
Assay:  
Unfractionated  
Heparin and  
Low Molecular  
Weight Heparin

## Therapeutic Ranges

- LMWH: 0.5-1.2 IU/mL
- UH: 0.3-0.7 IU/mL

## Prophylactic Ranges

- LMWH: 0.25-0.5 IU/mL
- UH: 0.1-0.4 IU/mL

# Cardiovascular Biomarkers



## Troponin I (cTnI) and T (cTnT)

Indicator of congestive heart failure

Released when injury occurs (6 hours to 3 days after)

> 0.10 ng/mL is sufficient to diagnose MI

PT: Be mindful of activity limitations with NYHA Classification

# B-Type Natriuretic Peptide

Indicator of congestive heart failure

BNP	NYHA Classification
BNP <100 pg/mL <sup>48</sup>	Indicates no heart failure
BNP 100–300 pg/mL <sup>48</sup>	<b>Class I</b> – 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. <sup>1,20,21</sup>
BNP > 300 pg/mL <sup>48</sup>	<b>Class II</b> – Mild symptoms (mild shortness of breath and/or angina) and slight limitation during ordinary activity. Symptoms-based approach when determining appropriateness for activity. <sup>1,20,21</sup>
BNP > 600 pg/mL <sup>48</sup>	<b>Class III</b> – 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. <sup>1,20,21</sup>
BNP > 900 pg/mL <sup>48</sup>	<b>Class IV</b> – Severe limitations. Experiences symptoms even while at rest. Symptoms-based approach when determining appropriateness for activity. <sup>1,20,21</sup>

PT:Be mindful of activity limitations with NYHA Classification

# Creatine Kinase

Different enzymes are released with brain, cardiac and skeletal muscle injury

CK2-MB is specific to cardiac muscle

Gender specific norms

- Males: 52-336 U/L
- Females: 38-176 U/L

Elevated 3-6 hours after MI and peaks at 18-24 hours

Returns to normal in 2-3 days

PT: Important to follow trend and monitor for cardiac symptoms