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The Role of Lab Values in clinical decision making and patient safety for the acutely ill patient.

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Objectives

1. Discuss why lab values and vital signs are essential clinical tools to determining appropriateness of acute care rehab intervention.
2. List the normal values for BP, HR, SaO2, Hemoglobin, Potassium, Glucose, Platelets, Troponin, CPK and other lab values.
3. Describe the effects of abnormal lab values and discuss precautions and monitoring techniques.
4. Recognize when to implement, modify or hold rehab interventions based on assessment of lab values and vital
Introduction

- Laboratory diagnostic tests are one factor in determining the overall health of our patients.
- Lab tests evaluate the kidneys, liver, thyroid, and heart and other aspects of health.
- In acute care, most common blood tests include Complete Blood Count (CBC) and Differential and Basic Metabolic Profile or Routine Chemistry.
- Normal values are typically determined based on 95 percent of healthy people in a certain group. For many tests, normal ranges vary depending on your age, gender, race, and other factors.
Introduction

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.”

As critical values might evolve quickly in the acute care setting, frequent reassessment is required for safe and effective patient management.

Introduction

Pawlik et al. states in a 2013 article that patients with acute illness “require timely and accurate assessment and modification of activity by the intervening PT (or OT) and titration of activity in response to changes in physiological status.”
Introduction

- Basic understanding of normal Lab Values, Vitals Signs and the physiologic response are essential.
- Individual physicians may have guidelines based on their own clinical research or preference.
- Discussions with the physicians at your facility are important for professional exchange.

Introduction

- Abnormal values and appropriateness for rehab intervention is based on:
  - Evidence based literature
  - Expert physician recommendations
  - At Henry Ford Hospital, a Lab Values Manual was created in 1996, revised in 2007, 2011 and 2015; reviewed every 2 years to assist PT, OT, PTA and COTAs in clinical decision making.
Introduction

- Abnormal values and appropriateness for rehab intervention is based on:
  - APTA AACPT Lab Value Resource – 2011, updated 2013, updated 2017

Clinical Decision Making

- To begin or continue interventions on patients whose lab values are outside of normal ranges or guidelines, clinical decision making based on the following is key:
  - Thorough medical record review
  - Graph trends of labs or vitals
  - Clinical discussion with medical team
  - Ability to monitor clinical signs and hemodynamics during intervention
Clinical Decision Making

Considerations:
- potential drug interactions
- the patient’s recent meals
- significance of trends in the values over time
- Electrolyte panels might change with intravenous infusions, medications, and diet
- 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.

Documentation
- Always document rationale for treatment, the patient’s response to treatment and any modifications made during the treatment session.
Vital Signs

- Important to understand normal values for vital signs in order to monitor patients with abnormal lab values
- Abnormal resting vitals signs may also be an indicator for modifying or deferring intervention on a given day.
Vital Signs Guidelines

- Resting Values
  - Heart Rate (HR) 50-120 bpm
  - Systolic Blood Pressure (SBP): 80-180
  - Diastolic Blood Pressure (DBP): 40-110 mmHg
  - SaO2: ≥ 90%
  - Respiratory rate: 12-20 bpm

Vital Signs Guidelines

- If you mobilize a patient whose vital signs fall outside of the “normal” parameters, treatment should be terminated if any of the following symptoms are observed:
  - Dizziness not resolved within 60 seconds of obtaining upright
  - ↑ in patient’s heart rate of 30 bpm over baseline
  - A change in the patient’s systolic blood pressure of 30 mmHg or a change in the diastolic blood pressure of 10 mmHg
  - Blurred vision
  - Dilated pupils
  - Anginal pain
  - Shortness of breath
Vital Signs Guidelines

- Values for Resting rates outside of the listed guidelines, do not mean automatically defer treatment.

- Consider the following:
  - What has been the trend over the last 24 hours?
  - Is the patient asymptomatic?
  - Are other factors involved (i.e., pain, ↓ hemoglobin, sepsis, medications)?
  - Interventions provided by nursing may help with evaluation and treatment (i.e., pain meds, BP meds, suctioning, position change, anti-anxiety meds).

Vital Signs Guidelines

- Vitals may fall within the normal values, but you may decide to modify or defer treatment based on the following:
  - What has been the trend over the last 24 hour? Has it been consistent?
  - Have trends in the first 24 hours significantly changed from baseline measures?
    - For example: SBP is 120/80 in the a.m. and 140/90 – 180/100 over the next few readings. Although the values are within our guidelines, the patient’s BP is gradually trending up so treatment may be deferred. This may also happen if there is a sudden, significant change (↑ or ↓) in the values.
Clinical Example

- **Considerations:**
  - What position was patient tested in?
  - When were BP meds given?

<table>
<thead>
<tr>
<th>Date</th>
<th>03/25</th>
<th>03/26</th>
<th>03/27</th>
<th>03/28</th>
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<tr>
<td><strong>8 hrs:</strong></td>
<td>16:00</td>
<td>00:08</td>
<td>08:16</td>
<td>15:00</td>
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<td><strong>Vitals</strong></td>
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<td>BP</td>
<td>104/60</td>
<td>115/72</td>
<td>95/61</td>
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<td>36.5 (9...)</td>
<td>36.6 (9...)</td>
<td>36.5 (9...)</td>
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<tr>
<td>Heart Rate</td>
<td>67</td>
<td>77+</td>
<td>74+</td>
<td>85</td>
</tr>
<tr>
<td>Resp</td>
<td>16+</td>
<td>20+</td>
<td>19</td>
<td>18+</td>
</tr>
<tr>
<td>SpO2</td>
<td>95</td>
<td>100+</td>
<td>96+</td>
<td>94</td>
</tr>
</tbody>
</table>

Clinical Example

- **Considerations:**
  - HR/BP is fluctuating; likely taken at rest by RN
  - Most recent is greater than 120 at rest, Tachypnea as well
Vital Signs Tips

- Choose the manual BP machine for patients with significantly low or high blood pressure readings.
- Electronic BP machines tend to over read at low BP and under read at very high BP.
- Have stethoscope ear pieces rotated forward, following the direction of your ear canals.
- Choose the right cuff size. Too small of a cuff on a large arm will register an inaccurately high BP.

Vital Signs Tips

- Try to keep the patients arm at the level of the heart to avoid hydrostatic and gravitational forces in the blood vessels.
- Instruct the patient to not move or talk. Electronic cuffs are especially sensitive to any motion in arm/hand.
- Wait 1-2 minutes before re-inflating the cuff so that blood trapped in the vessels can be released.
Orthostatic Hypotension

- Defined as a decrease in SBP of 20 mmHg or more; DBP of 10 mmHg or more within 3 minutes of standing up
- Instructions:
  Measure and document HR and BP with 2-3 minutes between position changes:
  - Supine
  - Sitting
  - Standing

Vital Signs: Questions?

- If you have a question, Please use the button for raising your hand so I know a question is coming in, and go ahead and begin typing.

- If I move on before answering your question, I will return to answer the question after the next section. Thanks.
Lab values

Hemoglobin
**Hemoglobin**

- Red, iron-based pigment in the blood that carries oxygen.
- Major protein of erythrocytes that transports oxygen from the lungs to peripheral tissues.

[Image](http://cox.org/content/coll14961.6/)

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**Hemoglobin**

- **NORMAL RANGES**
  - 12 - 16 Gm/dL for women
  - 14 - 17.4 Gm/dL for men
- Values differ in men and women due to body size and muscle mass.
- Values are slightly decreased in elderly
Causes of Low Hemoglobin

- Macrocytic anemia
  - Liver disease
  - Hypothyroidism
  - Vitamin B₁₂ deficiency
  - Folate deficiency
  - Myelodysplasia

- Normocytic anemia
  - Early iron deficiency
  - Anemia of chronic disease
  - Hemolytic anemia
  - Acute hemorrhage s/p surgery or trauma
  - Bone marrow infiltrates

- Microcytic anemia
  - Iron deficiency
  - Sickle Cell Anemia
  - Hemodilution (increased IV fluids or plasma)

Physiological Impact of Low Hgb

- Decreased exercise tolerance
- Increased fatigue
- Tachycardia
- When the blood has low oxygen-carrying capacity, there are limited levels of oxygen available to the tissues.
- To get oxygen to the tissues, heart rate and cardiac output will increase, thus causing increased work on the myocardium.
APTA AACPT Hemoglobin guidelines

- Monitor vitals including SpO2 to predict tissue perfusion. May present with tachycardia and/or orthostatic hypotension.
- 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).
- Consultation with the interprofessional team as while as monitoring of signs and symptoms is imperative since hemoglobin levels and blood transfusions are individualized.

**HFH Hemoglobin Guidelines**

<table>
<thead>
<tr>
<th>Value</th>
<th>HFH Hemoglobin Guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hgb &lt; 7 gm/dL:</td>
<td>No Occupational or Physical Therapy that day*</td>
</tr>
<tr>
<td>Hgb 7.1 – 7.9 gm/dL:</td>
<td>• Activity orders must be clarified with the patient’s primary physician&lt;br&gt;• The patient’s heart rate and blood pressure must be monitored pre-, mid- and post-treatment.&lt;br&gt;• Oxygen saturation levels must be &gt;90% prior to treatment.&lt;br&gt;• Treatment will be terminated if any of the following symptoms are observed:&lt;br&gt;  • Dizziness not resolved within 60 seconds of obtaining upright&lt;br&gt;  • Increase in patient’s heart rate of 30 bpm over baseline&lt;br&gt;  • A change in the patient’s systolic blood pressure of 30 mmHg or a change in the diastolic blood pressure of 10 mmHg&lt;br&gt;  • Blurred vision&lt;br&gt;  • Dilated pupils&lt;br&gt;  • Anginal pain&lt;br&gt;  • Shortness of breath</td>
</tr>
<tr>
<td>Hgb &gt; 8gm/dL</td>
<td>Routine Occupational and Physical Therapy</td>
</tr>
</tbody>
</table>

*Exception: Persons who decline blood transfusions for religious reasons*
Blood Transfusion

- Typically general medicine patients who are hemodynamically stable and asymptomatic may receive transfusion at 7 g/dL.
- Note: For hematological disorders, oncological disorders and severe thrombocytopenia, or chronic transfusion dependent anemia, there are no standard transfusion threshold recommendations available.
- Post surgical, cardiac or orthopedic patients, and those with underlying cardiovascular disease may transfuse at 8 g/dL.

HFH Blood Transfusion Guidelines

- No mobilization/treatment during the first 30 minutes of the transfusion for each bag of blood.
  - Nursing is monitoring for transfusion reaction every 5 minutes
- Patient’s hemoglobin must be at least 7.1g/dL
- If the patient’s hemoglobin levels fall between 7.1 and 7.9, refer to the above guidelines.
Hematocrit

- Represents the percentage of whole blood volume composed of erythrocytes.
- Assesses blood loss and fluid balance
- Normal ranges
  - Males: 42–52%
  - Females: 37–47%
Hematocrit

Increased in:
- Hemoconcentration
  - Dehydration
  - Burns
  - Vomiting
- Polycythemia (erythrocytosis)
- Extreme physical exercise

Decreased in:
- Same as Hemoglobin
- Macrocytic anemia (liver disease, hypothyroidism, vitamin B₁₂ deficiency, folate deficiency, myelodysplasia), normocytic anemia (early iron deficiency, anemia of chronic disease, hemolytic anemia, acute hemorrhage, bone marrow infiltrates), and microcytic anemia (iron deficiency, sickle cell).
- Hemodilution

APTA AACPT Guidelines: Hematocrit

- Low critical value (<15-20%) cardiac failure or death
- High critical value (>60%) spontaneous blood clotting
- Less than normal: Monitor vitals to predict tissue perfusion
- <25%: Symptoms based approach when determining appropriateness; collaborate with interprofessional team regarding need for / timing of transfusion prior to mobilization
Oxygen, Partial Pressure (PO$_2$)

- Measures oxygen tension (partial pressure) in arterial blood.
- Determines tissue oxygen supply, along with hemoglobin and blood supply.

- Normal ranges > 80 mmHg
Oxygen, Partial Pressure (PO₂)

Increased in:
- Oxygen therapy

Decreased in:
- Ventilation/perfusion mismatching (asthma, COPD, atelectasis, pulmonary embolism, pneumonia, interstitial lung disease, airway obstruction by foreign body, shock)
- Alveolar hypoventilation (kyphoscoliosis, neuromuscular disease, head injury, stroke)
- Drugs: barbiturates, opioids.

HFH Guidelines for PO₂
- No PT or OT intervention with PaO₂ < 60 mmHg
- Once the PaO₂ reaches 60 mm Hg the curve is almost flat, indicating there is little change in saturation above this point. So, PaO₂ of 60 or more is usually considered adequate.
Hemoglobin, Hematocrit, PaO2 Questions?

Potassium
Potassium K+

- Potassium is predominantly an intracellular ion whose plasma level is regulated by renal excretion.
- Plasma potassium concentration determines neuromuscular irritability. Elevated or depressed potassium concentrations interfere with muscle contraction and cardiac conductivity.

**NORMAL VALUES**
- Merck manual: 3.5 - 5.0 mEq/L
- APTA reference: 3.7-5.1 mEq/L

Potassium K+

**Increased in:**
- Massive hemolysis
- Severe tissue damage
- Rhabdomyolysis
- Acidosis
- Dehydration
- Acute or chronic renal failure
- Addison disease
- Medications

**Decreased in:**
- Low potassium intake
- Prolonged vomiting or diarrhea
- Cushing syndrome
- Osmotic diuresis (e.g. hyperglycemia)
- Alkalosis, (hypokalemic)
- Trauma (transient)
- Subarachnoid hemorrhage
- Diuretics
Potassium K+

Definitions
- Hyperkalemia: > 5.5 mEq/L
- Hypokalemia: < 3.5 mEq/L

APTA AACPT Guidelines: Potassium K+

Potassium Trending Up:
- Patients at risk for cardiac issues > 5 mEq/L: Use symptoms-based approach when determining appropriateness for activity
- Might exhibit muscle weakness during intervention

Potassium Trending down:
- Symptoms-based approach when determining appropriateness for activity.
- Severe hypokalemia < 2.5 mEq/L: collaborate with interprofessional team.
HFH Potassium K+ Guidelines

- Patients with potassium levels <3.0m Eq/L or >6.0 Eq/L will not receive any Physical or Occupational Therapy for that day.

<table>
<thead>
<tr>
<th></th>
<th>&lt; 3.0</th>
<th>3.1-3.4</th>
<th>3.5-5.0</th>
<th>5.1-5.9</th>
<th>&gt; 6.0</th>
</tr>
</thead>
</table>

HFH Potassium K+ Guidelines

- The following guidelines will be observed for patients whose potassium levels are 3.0-3.4 and 5.1-6.0:
  - Review chart and note any orders for cardiac workup. If cardiac workup is pending or completed, follow departmental guidelines for troponin.
HFH Potassium K+ Guidelines

- The following guidelines will be observed for patients whose potassium levels are 3.0-3.4 and 5.1-6.0:
  - Vital Signs within normal resting values
  - Vitals monitored pre, mid and post treatment
  - Oxygen saturation levels must be ≥ 90% prior to treatment.

<table>
<thead>
<tr>
<th></th>
<th>&lt; 3.0</th>
<th>3.1-3.4</th>
<th>3.5-5.0</th>
<th>5.1-5.9</th>
<th>&gt; 6.0</th>
</tr>
</thead>
</table>

HFH Potassium K+ Guidelines

- The following guidelines will be observed for patients whose potassium levels are 3.0-3.4 and 5.1-6.0:
  - Treatment will be terminated with the onset or increase in any of the following:
    - Dizziness not resolved/improved within 60 seconds of obtaining upright
    - Increase in the patient’s heart rate of 30 bpm over baseline or Bradycardia or arrhythmia
    - Change in the patient’s systolic blood pressure of 30 mm Hg or a change in the diastolic blood pressure of 10 mm Hg or orthostatic hypotension
    - Nausea/Vomiting
    - Paresthesia
    - Anginal pain

|   | < 3.0 | 3.1-3.4 | 3.5-5.0 | 5.1-5.9 | > 6.0 |
Validation of Safe Physical and Occupational Therapy Intervention with Potassium Levels 3.1-5.9 mmol/L

BACKGROUND

The current standard of practice for provision of PT and OT services for patients at Henry Ford Hospital with IV levels 3.1-5.9 mmol/L, is based on expert recommendation. No significant research has been conducted to support the practice. This study will provide verification and validation of the safety of this practice and practice evidence that is critically lacking in the literature.

METHODS

300 hospitalized patients were enrolled in this study.
- 88 in an ICU, 204 are a OPD. 80 in a Cardiology/recovery unit

Intervention - Standard PT and OT services designed to address patient-specific impairments in musculoskeletal, neuromuscular, integumentary, cardiorespiratory, pulmonary, or cognitive systems causing limitations in mobility or restrictions in activities of daily living.

Results: Of the 300 subjects, 36% had abnormal potassium levels at the time of their rehabilitation session. 20.8% had hypokalemia, and 14.2% had hyperkalemia.

No deaths or cardiopulmonary arrest requiring resuscitation during rehabilitation occurred in any study patient with normal or abnormal fiv levels.

Eights rehabilitation sessions were terminated prematurely due to patient instability or deterioration. All of these adverse events occurred in patients with normal potassium values, which was significant (p-value 0.033).

Shortness of breath was found to be a significantly higher occurring factor in subjects with abnormal vs. normal K+.

CONCLUSION

No deaths or cardiopulmonary arrest requiring resuscitation during rehabilitation occurred in any study patient with normal or abnormal fiv levels.

Rates of adverse outcomes did not differ significantly between normal and abnormal potassium groups. There was a non-significant numerically higher rate of adverse events in normal vs. normal potassium groups. There were no significant results that suggested the provision of standard PT and OT services are less safe in a population with fiv levels 3.1-5.9 and 5.1-5.9 than in a population with normal fiv levels.

This study supports the current standard of practice for the Rehabilitation Department at Henry Ford Hospital regarding provision of standard PT and OT services for patients with fiv concentration levels 3.1-5.9.

ACKNOWLEDGEMENTS

Jessica Dement, Kathy Hackett, Don Forte, HHVI Rehab staff

KEY

- Physical Therapy (PT)
- Occupational Therapy (OT)
- Potassium (K+)
- Normal: 3.5-5.0 mmol/L
- Hypokalemia: 3.1-3.4 mmol/L
- Hyperkalemia: 5.1-5.9 mmol/L

Sodium
Sodium (Na)
- Maintains cell membrane potential; acid-base balance
- Promote neuromuscular, renal and adrenal functions
- Values show hydration state of patient
- The brain is most susceptible to changes in sodium.
- NORMAL VALUES
  - 134 – 142 mEq/L

Sodium (Na)

Increased due to:
- Dehydration (excessive sweating, severe vomiting, or diarrhea)
- Polyuria (diabetes mellitus, diabetes insipidus)
- Hyperaldosteronism
- Impaired renal function
- Inadequate water intake (coma, hypothalamic disease).
- Drugs: steroids, licorice, oral contraceptives.

Decreased due to:
- Decreased food intake
- Increased water intake
- Diuretic therapies
- Burns
- Chronic Renal Failure
- Diarrhea
- Adrenal insufficiency
- Drugs: insulin, ethanol, propranolol and other oral hypoglycemic agents
APTA ACCPT Guidelines: Sodium (Na)

- Sodium Trending Up >155 mEq/L
  - Impaired cognitive status
  - Seizure precautions for patients with past medical history
- Sodium Trending Down >130 mEq/L
  - Impaired cognitive status
  - Monitor vitals secondary to risk for orthostatic hypotension

Glucose
Glucose
- Measures blood glucose at the time sample obtained
- NORMAL RANGE
  - 80 – 120 mg/dL
  - Some sources report normal range is 70–100 mg/dL

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Glucose

**Increased in:**
- Diabetes mellitus
- Cushing syndrome (10–15%)
- Chronic pancreatitis (30%)
- Sepsis
- Brain Tumors
- Medications such as corticosteroids, estrogen, thiazides.
  - After a meal
  - After IV glucose

**Decreased in:**
- Excess insulin
- Brain damage
- Pituitary deficiency
- Addison’s disease
- Malignancy (adrenocortical, stomach, fibrosarcoma),
- Drugs: insulin, ethanol, propranolol; sulfonylureas, and other oral hypoglycemic agents.
APTA ACCPT Guidelines: Glucose

- Glucose Trending Up > 200 mg/dL:
  - Diabetic Ketoacidosis, severe fatigue
  - Symptom based appropriate to appropriateness of activity
- Glucose Trending Down < 70 mg/dL
  - Lethargy, irritability, shaking, loss of consciousness
  - May not tolerate therapy until glucose increased

HFH Glucose Guideline

- Important to monitor in all patients, not just those with diabetes.
- Patients with glucose levels below 70 will NOT receive routine Occupational or Physical Therapy. Consider requesting updated value with glucometer.
- Patients with glucose levels above 300 will not receive routine OT or PT. Rather, based on trends and in collaboration with physician, delivery of care may be modified based on clinical decision making. Patient’s vitals and signs/symptoms will be monitored and treatment terminated as appropriate.
Glucose >300mg/dL

- If glucose is >300mg/dL = severe hyperglycemia
- If glucose >300 and ketones are present, exercise could cause diabetic ketoacidosis (DKA) Cells lack their energy source to function
- May have severe fatigue
- Patient in need of insulin

Glucose < 70mg/dL

- Hypoglycemia is usually defines as < 70 mg/dL
- May demonstrate:
  - Confusion or delirium
  - Lightheadedness or dizziness
  - Seizures
  - Lack of coordination
  - Weakness or fatigue
  - Blurred/impaired vision
Clinical example #1 : Glucose only

- 54 year old admit with dehydration s/p chemo for stomach cancer.
- 0700 blood glucose is 65
- Breakfast due at 0800
- OT initiated for morning ADLs at 0730
- After walk to bathroom and ADLs standing at sink, patient becomes confused, complains of dizziness, and blurred vision.
- RN notified; metered glucose = 45
- Likely due to diagnosis, pre-breakfast and energy expenditure.

Clinical example #2 : Glucose only

- 43 year old female admit with uncontrolled diabetes.
- Glucose levels range from 350-600 for the last several days
- Patient fatigues easily but is ready for discharge and MD writes order for PT to evaluate despite glucose 300+
- PT assessment includes activities to assess for safe discharge home only; vitals monitored and response documented.
Potassium, Sodium or Glucose Questions?

White Blood Cells
White Blood Cells

- A marker for disease process
- Monitors body's response to infectious disease processes.
- Routinely tested to identify the presence of infection, inflammation or allergens

**NORMAL RANGE**
- 450,000 – 1,060,000 cells/mm3
- Also reported as 5.0-10.0 $10^9$/L

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White Blood Cells

**Increased in:**
- Parasitic infections
- Bacterial infections
- Inflammation
- Tissue injury/necrosis
- Leukemia/Lymphoma
- Allergic reactions
- Hypersensitivity reactions
- Stress
- Smoking
- Corticosteroids

**Decreased in:**
- Viral infections
- Chemotherapy/Radiation
- Bone marrow transplant
- Immune compromise
- Neutropenia
- Myelodysplasia
- Alcoholism
APTA AACPT Guidelines: White Blood Cells

- Trending upward: > 11.0 \(10^9/L\) or 11,000 cells/mm3
  - Fever, lethargy, dizziness, painful joints
  - Symptom based approach to appropriateness; consider timing of session due to early morning low level or late afternoon high peak
- Trending downward: <4.0 \(10^9/L\) Leukopenia
  - Anemia, weakness, fatigue, headache, SOB, fever
  - Symptom based approach to appropriateness especially in presence of fever
- Trending downward: <1.5 \(10^9/L\) Neutropenia
  - Low-grade fever, skin abscesses, sore mouth, symptoms of pneumonia
  - Symptom based approach to appropriateness especially in presence of fever

Platelets
Platelets

- Initiate clotting sequence & plugging of damaged blood vessels.
- Platelets are released from megakaryocytes in bone marrow and are important for normal hemostasis.
- NORMAL RANGE
  - 150,000 – 450,000 mcL
  - Also reported as 140-400 k/uL

Platelets

Increased in:

- Myeloproliferative disorders (polycythemia vera, chronic myeloid leukemia, essential thrombocythemia, myelofibrosis),
- Acute blood loss
- Reactive thrombocytosis secondary to inflammatory disorders
- Infection
- Tissue injury
- Iron deficiency
- Some Malignancies

Decreased in:

- Leukemia/lymphoma
- Other Cancers
- Bone marrow suppression or replacement/infiltration
- Post-bone marrow transplant
- Myelodysplasia,
- Chemotherapy
- Drugs, Alcohol
- Infection (ie. HIV)
APTA AACPT Guidelines: Platelets

- Trending upward: > 450 k/uL
  - Weakness, headache, dizziness, chest pain, tingling in hands/feet
  - Symptom based approach to appropriateness
- Trending downward: < 150 k/uL
  - Fatigue, jaundice, splenomegaly, risk of bleeding
  - Symptom based approach to appropriateness
- Trending downward: < 20 k/uL
  - Fall risk awareness secondary to risk of spontaneous hemorrhage
  - Symptom based approach to appropriateness

HFH Guidelines - Platelets

- >50 k/uL - can ambulate as tolerated do bike and moderate resistance strength training.
- 20k - 50 k/uL - can do ambulation and light resistance training.
- 5- 20 k/uL - can do active ROM, ambulation in room, light daily activities.
- < 5 k/uL for less than 1 week - can do transfers.
- < 5 k/uL for greater than 1 week - can do same as for 5,000 - 20,000 range.
WBC or Platelet Questions?

Cardiac Markers
CARDIAC MARKERS

- When damage occurs to myocardial tissue, there is a loss of cellular integrity and intracellular cardiac enzymes are released into the circulation at variable rates.
- These enzymes include Creatinine Phosphokinase (CPK) and Troponins.
Creatinine Phosphokinase (CPK)

- Found in cardiac muscle as CPK-MB (released after MI, cardiac injury)
- Found in skeletal muscle as CPK - MM (released after trauma, with muscular dystrophy)
- Found in brain tissue as CPK - BB (released after brain injury, with severe shock)

CPK

- Normal values: 30-170 U/L
- To be positive for an MI, >5% of the total CPK levels must be in the CPK-MB form (cardiac muscle)
- CPK-MB begins to rise at 4-6 hours
- Peaks in 12-24 hours
- Returns to normal within 48-72 hours
HFH Guidelines - CPK

- Be aware that CPK-MB can also be elevated after surgery or after cardiopulmonary resuscitation especially with defibrillation.

- Note: at HFH, Troponin I has been found to have greater sensitivity and specificity in the diagnosis of MI over CK-MB.

Clinical Example: CPK

- 77 year old woman s/p fall at home, found down after 2 days, no loss of consciousness reported.
- X-rays + right wrist fracture, CT head negative
- CPK = 400 U/L (CPK-MB is 15 U/L)
- CPK-MB is 3.8% of total CPK
- Vitals stable, Troponin negative
- Diagnosis: Rhabdomyolysis
Troponin

- Found in striated muscle cells.
- 3 isoforms
  - 2 cardiac muscle (TnC and TnI)
  - 1 skeletal muscle.
- Cell necrosis leads to the release of troponins into the circulation.
- TnC and TnI are only expressed from cardiac muscle and are the only 2 that are tested during severe ischemia and infarction.
Troponin

- Normal Range: less than 0.04
- Troponin enzyme begins to rise at 8 hours
- Peak Time: 12-16 hours
- Typical lab orders are for Troponin x 3, series 8 hours apart
- Returns to normal within one week

HFH Guidelines - Troponin

- **Troponin Levels < 0.04**: Negative for myocardial damage
  - No restrictions

- **Troponin Levels 0.05 to 0.2**: Indeterminate for Myocardial Damage
  - **Guidelines**: Review chart to ascertain why troponin was ordered; check to see if it is a one time order; look for any notes that may indicate that a cardiac component is NOT suspected for the troponin elevation (Cardiology notes or other MD notes in chart after the troponin became positive.).
HFH Guidelines - Troponin

- **Troponin Levels >0.2**: Positive for Myocardial Damage.
  - Once it has been determined that a patient has had an MI, therapy can usually be initiated within 24 hours of the diagnosis if the patient is hemodynamically stable.

Troponin

- Always look for the trend since a NEW peak indicates further cardiac damage.
Troponin Leak

- Conditions commonly associated with cardiac troponin elevation in absence of Acute Myocardial Infarction:
  - Acute PE or pulm. htn.
  - Acute pericarditis
  - Acute or severe heart failure
  - Myocarditis
  - Sepsis and/or shock
  - COPD
  - Renal failure
  - False-positive troponin
  - Stroke or subarachnoid hemorrhage
  - Hypertensive emergency

Clinical Example: Troponin

- 82 year old male admit with chest pain.
- BP 168/72 HR 92-108 SaO2 94% on 4 L NC
- Troponin levels:

<table>
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<tr>
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<th>Value</th>
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<tbody>
<tr>
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Troponin Example

7/22  7/22  7/22  7/23  7/23  7/23  7/25  7/27
15:00 19:00 23:00 09:00 15:00 23:00 08:00 08:00
0.20  6.4  4.5  10.12  9.3  8.5  4.23  0.04

Troponin Example

Peak

7/22  7/22  7/22  7/23  7/23  7/23  7/25  7/27
15:00 19:00 23:00 09:00 15:00 23:00 08:00 08:00
0.20  6.4  4.5  10.12  9.3  8.5  4.23  0.04
Troponin Example

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</tr>
<tr>
<td>7/27</td>
<td>08:00</td>
<td>0.04</td>
</tr>
</tbody>
</table>

> 1 week troponin enzyme reabsorbed

Cardiac Markers: Questions?
Lab Values associated with DVT

- Serum Viscosity/Bleeding Ratio
- Based on the type of anticoagulation medication
- PTT = Partial Thromboplastin Time
- PT = Prothrombin Time
- INR = International Normalized Ratio
PTT = Partial Thromboplastin Time

- An intrinsic clotting factor used to monitor the effectiveness of Heparin therapy and for screening for bleeding disorders.
- Increased PTT levels will occur following thrombolytic or Heparin infusion causing an increased time for blood to clot and subsequently, an increased chance of bleeding or bruising.
PTT = Partial Thromboplastin Time

- Monitors effectiveness of Heparin therapy (IV anticoagulation)
- NORMAL RANGE = 21 - 35 seconds
  - No anticoagulation medication

- THERAPEUTIC RANGE IF ON HEPARIN = 2-3 times the normal range
  - Approximately 60-109 seconds

Prothrombin Time
PT = Prothrombin Time

- Monitors effectiveness of Coumadin or Warfarin therapy (Oral anticoagulation)
- NORMAL RANGE = 11 - 13 seconds
- Therapeutic Range = 2-3 times the normal range
  - Appropriately > 25 seconds
INR = International Normalized Ratio

- **NORMAL RANGE = 0.8 – 1.20**
- Therapeutic ranges:
  - Stroke prophylaxis: 2.0-2.5
  - VTE, PE, patients with atrial fibrillation: 2.0 to 3.0
  - Patients at higher risk (prosthetic heart valves): 2.5-3.5
  - Patients with lupus anticoagulant 3.0-3.5
  - Patient at higher risk for bleeding > 3.6

Anti-Factor Xa Assay

- **Unfractionated Heparin (UH) and Low Molecular Weight Heparin [LMWH]**
  - 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
Lovenox

- No lab test are associated with subcutaneous injections of low molecular weight Heparin such as Lovenox
- Therefore, therapy is typically initiated > 3 hours post anticoagulation
- For patients on prophylactic doses of Lovenox such as TKA/THA and diagnosed with DVT, a therapeutic dose must be given

APTA AACPT Guidelines: Known DVT

- Algorithm for Mobilizing Patients with Known Lower-Extremity Deep Vein Thrombosis
HFH Guidelines related to DVT

- Patients in which a DVT or PE is suspected will NOT be mobilized by PT/OT until testing (UE/LE Venous Doppler, CT scan, and/or V/Q scan) has been completed to rule out DVT or PE.

- For patients with suspected DVT (red/swollen/painful extremities, +Homan’s test) PT/OT will notify MD and defer mobility or modify activity to avoid aggravation of symptoms.
HFH Guidelines related to DVT

- In 2011, HF Medical Group Physicians decided that the risks of delayed mobilization and PT/OT prior to reaching therapeutic doses outweighed the risk of complications or embolism.

New HFH Guidelines

- Patients diagnosed with ACUTE UE DVT, LE DVT, and/or PE will be mobilized by PT/OT without restrictions once anticoagulation (Heparin, Lovenox) has been started.

- No minimum time period between anticoagulation initiation and mobilization by PT/OT is required. No minimum PTT and/or INR values need to be reached prior to mobilization by PT/OT after anticoagulation initiation.
HFH PTT and INR GUIDELINES

- For patients with INR >6 or PTT >200, PT/OT will confer with the patient's physician to determine appropriate activity level prior to initiating treatment. PT/OT will document physician recommendations in the patient's chart.
  - Due to increased risk of bleeding

IVC Filters

- Patients with ACUTE LE DVT and/or PE who cannot be anticoagulated due to medical reasons may have an Inferior Vena Cava (IVC) filter placed. In this case, the patient can be mobilized without restrictions once the IVC filter has been placed.
IVC Filters

HFH Guidelines related to DVT

- For the small percentage of patients who fall outside the guidelines or who do not qualify for anticoagulation, PT/OT will confer with the patient’s medical team prior to initiating mobility/exercise to determine appropriate activity level.

- Document medical team recommendations for mobilization/exercise in the patient’s chart.

- Monitor vitals
DVT: Questions?

Other Lab Values
Other Lab Values

- Kidney Function: Blood Urea Nitrogen; Serum Creatine
- Acid Base Disorders: Respiratory and Metabolic Alkalosis and Acidosis
- Liver Function: Serum Albumin, Pre-Albumin
- Other Electolyte panel: Calcium, Chloride, Phosphate, Magnesium
- B-Type Natriuretic Peptide (BNP)
- APTA AACPT: Symptom Based Approach; See resource manual for additional information

Quick Reference Guide

<table>
<thead>
<tr>
<th>Lab Value</th>
<th>Normal Value</th>
<th>Rehab Guideline Quick Reference</th>
</tr>
</thead>
</table>
| Hemoglobin  | Men 13.5-17 g/dl;
Women 12-15 g/dl                  | 8-10 g/dl ↑↓ exercise tolerance, tachycardia; <8 follow guidelines; 7 or less no tx.             |
| Potassium   | 3.5-5.0                                          | <3.0 or >6.0 mmol/L: NO TX due to possibility of tetany or dysrhythmia; Follow policy guidelines for 3.0 - 6.0 levels |
| Glucose     | 80-120                                           | <70 NO TX, or <30 no routine PT/OT refer to guideline                                             |
| Platelets   | 150,000 - 450,000 cells/microL                    | >50,000 amb as tol., bike OK 20-50,000 ambulate, light resist 5-20,000 ARDM, walk in room, light activities <5,000/<1 wk. transfers |
| Prothrombin | 5.5-13 sec. (18-30 Coumadin)                      | >200 considering holding, check with MD 4/DV anticoag tx must be started prior to tx Greenfield filter (IVC) ok |
| Partial     | 22-36 sec. (64-109 Heparin)                       | >6 Check with MD                                                                                   |
| Thromboplastin PTIM  | 2.3-3.5: std dose 2.3-3.5: high dose        |                                                                                                    |
| Troponin    | <0.2                                             | TROPOININ >0.2 New onset increases = NO TX. 0.05-0.2: indeterminate for Myocardial Damage; See Guidelines  
| cTnl        |                                                   | +MI = Tx. after 24 hrs. if hemodynamically stable                                                    |
| BNP         | 100-350 pg/mL, suggest heart failure is present (I) 
above 300 pg/mL indicate mild heart failure (II)   |
| Sodium      | 135-145                                           | Risk for mental status changes, intracranial hemorrhage, coma                                      |
Questions?

Clinical Cases
Clinical Case #1 of 6  Mr. J.

Mr. J. is admitted to the nephrology general unit with kidney failure and is having an exacerbation of gouty arthritis. He received his morning medications within the last hour. He is NPO for TEE this am.

- His PMH is as follows:
  - Hypertension
  - Diabetes
  - Arthritis, Gout
  - Previous MI
  - Renal Failure

Clinical Case #1 of 6  Mr. J.

Mr. J. is admitted to the nephrology general unit with kidney failure and is having an exacerbation of gouty arthritis. He received his morning medications within the last hour. He is NPO for TEE this am.

- In reviewing his Medication Administration Record, these are the medications he received:
  - Lisinopril for lowering blood pressure
  - Insulin on a sliding scale
  - Ibuprofen for joint pain
Clinical Case #1 of 6

Mr. J.

<table>
<thead>
<tr>
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<tr>
<td>HGB</td>
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<tr>
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<tr>
<td>Na</td>
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<tr>
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<td>162/78</td>
<td>179/75</td>
<td>168/98</td>
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<tr>
<td>HR</td>
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<td>102</td>
<td>110</td>
<td>90</td>
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<tr>
<td>SaO₂</td>
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<tr>
<td>Oxygen Therapy</td>
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<td>2L NC</td>
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</table>

- Is this patient appropriate for intervention based on above labs/vitals?
- Why or Why Not?

Clinical Case #1 of 6

Mr. J.

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<tr>
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<tr>
<td>HGB</td>
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<td>2L NC</td>
<td>2L NC</td>
<td>2L NC</td>
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</tbody>
</table>

- Is this patient appropriate for intervention based on above labs/vitals?
- Why or Why Not?
  - Yes, vitals are stable, though BP is high; glucose is high but WNL
Clinical Case #1 of 6  Mr. J.

- Upon sitting up, Mr. J reports that he feels dizzy and like he might faint. What issues might be causing these symptoms?
  - Orthostatic hypotension
  - Increased glucose OR decreased glucose 2° NPO and receiving insulin
  - Medications (Lisinopril for lowering blood pressure, insulin)

Clinical Case #1 of 6  Mr. J.

- What would you monitor? What would you do in this situation?
  - Monitor HR, BP, SpO2
  - See if symptoms resolve within 1-2 minutes
  - Lie patient back down
  - Recheck vitals
  - Communicate with RN/MD
Clinical Case #2 of 6 Mr. D.

Mr. D has been in the hospital for 4 days following a total shoulder replacement.

He has had a complicated hospital stay with increased pain, decreased PO intake, and increased UE swelling.

He was given Lovenox prophylactically starting on post op day 1.

On post op day 3 he was diagnosed with a left UE DVT.

Heparin therapy was initiated to treat the clot.

---

Mr. D’s Lab Values are:

- According to his Lab Values, can treatment be initiated?
  - Not at this time: glucose 60

- Are you concerned that Mr. D has had an MI?
  - No, troponin less than 0.04

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<tr>
<td>WBC</td>
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<td>9000</td>
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<tr>
<td>PTT</td>
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Clinical Case #3 of 6

Mr. Z.

- Mr. Z. is a 46 year morbidly obese male with new onset ESRD s/p dialysis MWF. His Lab Values are as follows:

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<th>7/25</th>
<th>7/26</th>
</tr>
</thead>
<tbody>
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<td>K+</td>
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<td>3.1</td>
</tr>
<tr>
<td>Na</td>
<td>125</td>
<td>132</td>
<td>135</td>
</tr>
</tbody>
</table>

- Can intervention be initiated? Yes, K+ is within treatable range; NA above 130
- Why or why not? Vital Signs and Physiologic response
- What would you monitor?

Clinical Case #3 of 6

Mr. Z.

- Treatment will be terminated with the onset or increase in any of the following:
  - Dizziness not resolved/improved within 60 seconds of obtaining upright
  - Increase in the patient’s heart rate of 30 bpm over baseline or Bradycardia or arrhythmia
  - Change in the patient’s systolic blood pressure of 30 mm Hg or a change in the diastolic blood pressure of 10 mm Hg or orthostatic hypotension
  - Nausea/Vomiting
  - Paresthesia
  - Anginal pain
Clinical Case #4 of 6  Mrs. R.
Mrs. R is an 80 year old female admitted to the hospital with a CHF Exacerbation. She has a PMH of DM and HTN and a SxH of 3 Vessel CABG 5 years ago. Vital Signs have been stable; however, troponins x 3 were ordered yesterday at 1400. The results were as follows:

- 2000: Troponin 0.08
- 2400: Troponin 0.08
- 1400: Troponins <0.04

Current Vital Signs taken at 0800:
- BP 140/82
- HR 98
- SaO₂ 94% on 2L O₂

Would you initiate treatment with Mrs. R?
Yes, troponins are indeterminate, history of CHF

Clinical Case #5 of 6  Mrs. T
Mrs. T is admitted s/p NSTEMI. Therapy has been consulted for initiation of Cardiac Rehab after she has been in the hospital for 2 days. Her Troponin level peaked at 5.0 in the Emergency Department; current Troponin level is 2.0. BP is 130/85, HR is 80, SaO₂ is 95% on Room Air. Dr. N. wants her to go home today.

What indicates that Mrs. T. had an actual heart attack?
- Troponin level

Why might her Troponin levels still be high after 2 days?
- Troponins remain in bloodstream for a week

Does her Troponin level indicate initiation of therapy for Cardiac Rehab today?
- **YES**, it has been more than 24 hours since troponin peak, hemodynamically stable
Clinical Case #6 of 6  Mr. X.

Mr. X comes into the hospital after being involved in an MVA. He has a large, infected wound on his left leg, which is being treated with IV antibiotics. He also has a broken left femur. He has been in the ICU for 3 days, and PT and OT services have been requested to mobilize him out of bed and begin working on gait and ADL’s.

His lab values are as follows:
Hemoglobin = 8.4
WBC count = 12,000
PTT = 30
CPK = 340 (CPK-MB is less than 5% of total CPK)

Clinical Case #6 of 6  Mr. X.

What issues might the therapist have to deal with when treating this patient because of his Hemoglobin level of 8.4?

- Increased fatigue
- Mental status changes
- Low exercise tolerance
- Tachycardia
- Dizziness
- Orthostatic hypotension

Why might his WBC count be elevated (12 10^9/L)?

WBC Increases with bacterial infections and most illnesses

What is the normal range for this patient for PTT levels.

Why might this patient’s CPK be elevated?  22-36 seconds

Injury to skeletal muscle can cause CPK to be elevated
Questions?

- AMYSZEN1@hfhs.org

References
References

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