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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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Henry Ford Hospital, Detroit, MI
July 26, 2017 * PhysicalTherapy.com

Objectives

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

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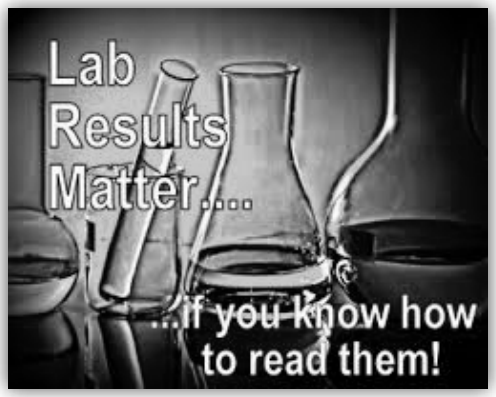

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Introduction

- 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

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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.

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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."

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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 is important for professional exchange.

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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.

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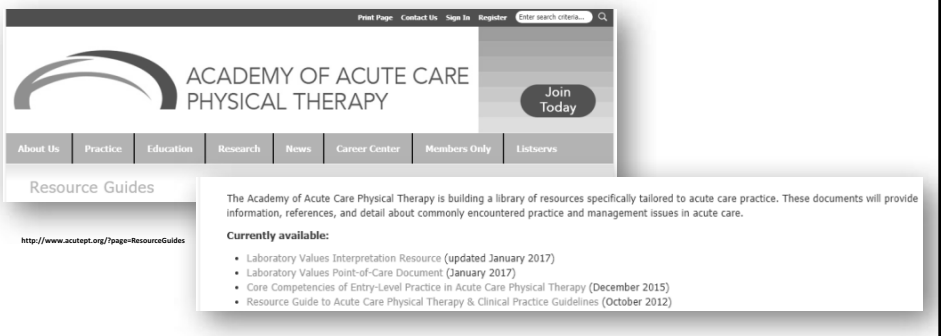
Introduction

Abnormal values and appropriateness for rehab intervention is based on:

- APTA AACPT Lab Value Resource – 2011, updated 2013, updated 2017



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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 a 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

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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.

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Documentation

- Always document rationale for treatment, the patient's response to treatment and any modifications made during the treatment session.

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Vital Signs

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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.

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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

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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

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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)

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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.

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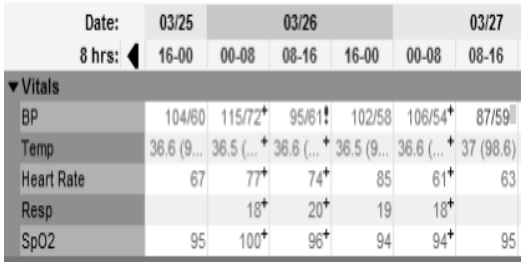
Clinical Example



Date:	03/25	03/26			03/27	
8 hrs:	16-00	00-08	08-16	16-00	00-08	08-16
▼Vitals						
BP	104/60	115/72	95/61	102/58	106/54	87/59
Temp	36.6 (9...	36.5 (...	36.6 (...	36.5 (9...	36.6 (...	37 (98.6)
Heart Rate	67	77	74	85	61	63
Resp		18	20	19	18	
SpO2	95	100	96	94	94	95

Considerations :

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

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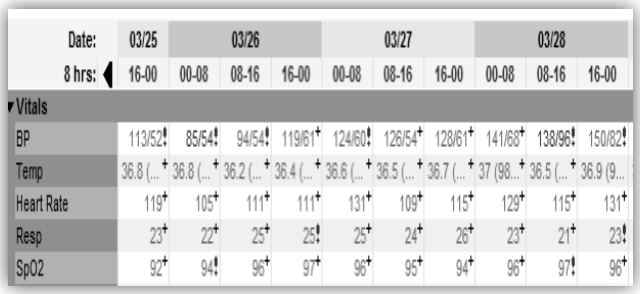
Clinical Example



Date:	03/25	03/26			03/27			03/28		
8 hrs:	16-00	00-08	08-16	16-00	00-08	08-16	16-00	00-08	08-16	16-00
▼Vitals										
BP	113/52	85/54	94/54	119/61	124/60	126/54	128/61	141/68	138/96	150/82
Temp	36.8 (...	36.8 (...	36.2 (...	36.4 (...	36.6 (...	36.5 (...	36.7 (...	37 (98...	36.5 (...	36.9 (9...
Heart Rate	119	105	111	111	131	109	115	129	115	131
Resp	23	22	25	25	25	24	26	23	21	23
SpO2	92	94	96	97	96	95	94	96	97	96

Considerations :

- HR/BP is fluctuating; likely taken at rest by RN
- Most recent is greater than 120 at rest, Tachypnea also

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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.

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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.

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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

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Vital Signs: Questions?

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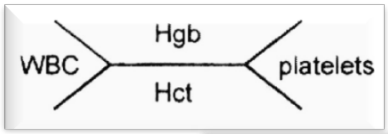
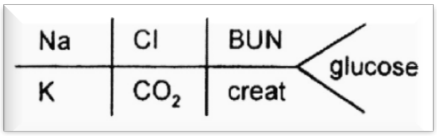


Lab values



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Hemoglobin

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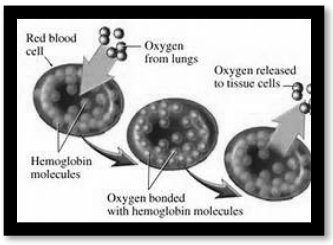
Hemoglobin

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



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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

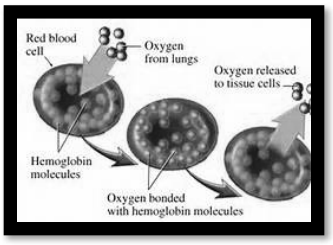

Image: www.webmd.com

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Causes of Low Hemoglobin

Macrocytic anemia
- Liver disease
- Hypothyroidism
- Vitamin B_{12} deficiency
- Folate deficiency
- Myelodysplasia

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

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

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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.

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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 is individualized.

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HFH Hemoglobin Guidelines

Value	HFH Hemoglobin Guidelines
Hgb < 7 gm/dL:	No Occupational or Physical Therapy that day*

Hgb 7.1 – 7.9 gm/dL:	• Activity orders must be clarified with the patient's primary physician
	• The patient's heart rate and blood pressure must be monitored pre-, mid- and post-treatment.
	• Oxygen saturation levels must be ≥90% prior to treatment.
	• Treatment will be terminated if any of the following symptoms are observed:
	  • Dizziness not resolved within 60 seconds of obtaining upright
	  • Increase 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

Hgb > 8gm/dL	Routine Occupational and Physical Therapy

*exception: Persons who decline blood transfusions for religious reasons

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Blood Transfusion

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

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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

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Hematocrit

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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%

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Hematocrit

INCREASED IN:

Hemoconcentration
- Dehydration
- Burns
- Vomiting

Polycythemia (erythrocytosis)

Extreme physical exercise

DECREASED IN:

Same as Hemoglobin

Macrocytic anemia (liver disease, hypothyroidism, vitamin B_{12} 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

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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

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PaO_2

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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**

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Oxygen, Partial Pressure (PO_2)

INCREASED IN:	DECREASED IN:
Oxygen therapy	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.

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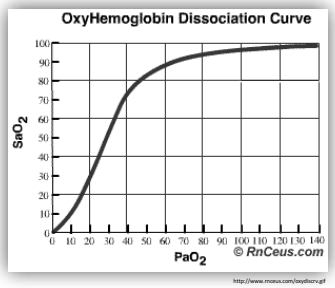
HFH Guidelines for PO_2

- No PT or OT intervention with PaO_2 < 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.



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Hemoglobin, Hematocrit, PaO2
Questions?

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Potassium

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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

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Potassium K+

INCREASED IN:	DECREASED IN:
Massive hemolysis	Low potassium intake
severe tissue damage	Prolonged vomiting or diarrhea
Rhabdomyolysis	Cushing syndrome
Acidosis	Osmotic diuresis (eg, hyperglycemia)
Dehydration	Alkalosis, (hypokalemic)
Acute or chronic renal failure	Trauma (transient),
Addison disease	Subarachnoid hemorrhage,
Medications	Diuretics

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Potassium K+

Definitions

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

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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.

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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.

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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.

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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

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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

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Validation of Safe Physical and Occupational Therapy Intervention with Potassium Levels 3.1-5.9 mmol/L

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Michael Hudson, MD, Dept of Cardiology, Jerry Yee, MD, Dept of Nephrology
Henry Ford Hospital, Detroit, MI

BACKGROUND

The current standard of practice for provision of PT and OT services for patients at Henry Ford Hospital with K+ levels 3.1-5.9 mmol/L is based on expert recommendation. No significant adverse events in the treatment of these patients have been reported in greater than 10 years. This study will provide verification and validation of the safety of this practice and provide evidence that is critically lacking in the literature.

METHODS

380 hospitalized patients were enrolled in this study
* 68 in an ICU * 256 on a GPU * 58 on a cardiology telemetry unit

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

Patients with hypo/hyperkalemia had heart rate and blood pressure monitored pre-, mid- and post- treatment

Exclusion Criteria

- K+ <3.0 mmol/L & >6.0 mmol/L
- Resting heart rate <50 or >120 bpm
- Resting systolic blood pressure <80 or >180 mmHg
- Resting diastolic blood pressure <40 or >110 mmHg
- Resting oxygen saturation levels </=90%
- Hemoglobin </=7.0 g/dl
- Blood Glucose <70 or >300 mg/dL
- Troponin I- new onset increase >0.2 ng/mL or elevation 0.05-0.2 within 24 hours prior to treatment

Criteria for Termination of Treatment

-Numbness or tingling in any body part
-Dizziness not resolved/improved within 60 seconds of obtaining upright positioning
-Nausea/vomiting
-Blurred vision
-Heart rate increase >30 bpm over resting
-Systolic blood pressure change >/= 30 mmHg
-Diastolic blood pressure change >/= 10 mmHg
-Anginal pain
-Shortness of breath

STATISTICAL ANALYSIS

Baseline clinical characteristics and adverse outcomes were compared between patients with normal and abnormal potassium levels. A two-group, large-sample normal approximation test of proportions was used with a one-sided significance level of 0.05 and 80% power to reject the null hypothesis. This method was used to reject the null hypothesis that the abnormal-potassium group and the normal-potassium group have equivalent rates of adverse events.

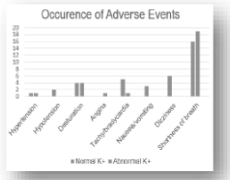
RESULTS

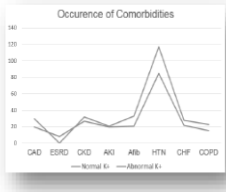
Of the 380 subjects, 37% had abnormal potassium levels at the time of their rehabilitation session. 25.5% had hypokalemia, and 14.2% had hyperkalemia.

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

Eight 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= 0.029).

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





	Normal K+	Abnormal K+
% of patients who had adverse reactions	15.48%	16.43%
% terminated treatment sessions	3.00%	0.00%

CONCLUSION

No deaths or cardiopulmonary arrest requiring resuscitation during rehabilitation occurred in any study patient with normal or abnormal K+ 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 abnormal 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 K+ levels 3.1-3.4 and 5.1-5.9 than in a population with normal K+ levels.

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

ACKNOWLEDGEMENTS

Jessica Demski, Kathy Neckrook, Don Frega, HFH Rehab staff

KEY

Physical Therapy (PT)
Occupational Therapy (OT)
Potassium (K+)
Beats per minute (bpm)
Intensive Care Unit (ICU)

Hypokalemia: 3.1-3.4 mmol/L
"Normal" K+: 3.5-5.0 mmol/L
Hyperkalemia: 5.1-5.9 mmol/L

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Sodium

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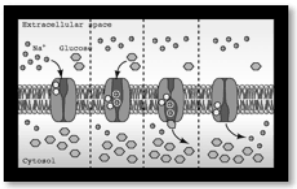
Sodium (Na)

- 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



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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

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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

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Glucose

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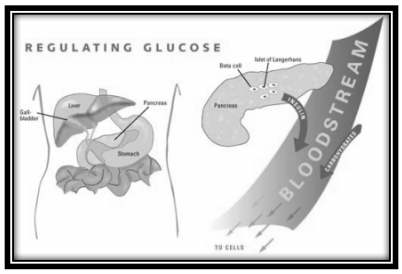
Glucose

- 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.

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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

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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

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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

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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

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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.

65

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.

66

Potassium, Sodium or Glucose Questions?

67

White Blood Cells

68

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

70

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

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Platelets

72

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

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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 (eg, HIV)

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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

75

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.

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WBC or Platelet Questions?

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Cardiac Markers

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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.

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CPK

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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)

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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

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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.

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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

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Troponin

85

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.

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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

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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)

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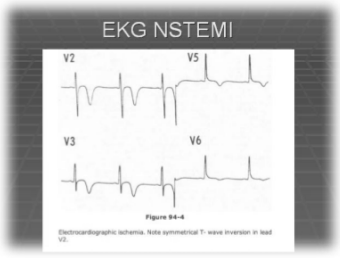
HFH Guidelines - Troponin

- **Troponin Levels >0.2:** Positive for Myocardial Damage.
  - New onset increases: no treatment.
  - 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.

89

Troponin

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



http://www.hcmw.com/lectures/pci_2_6_08/img48.jpg

90

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

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Clinical Example: Troponin

82 year old male admit with chest pain.

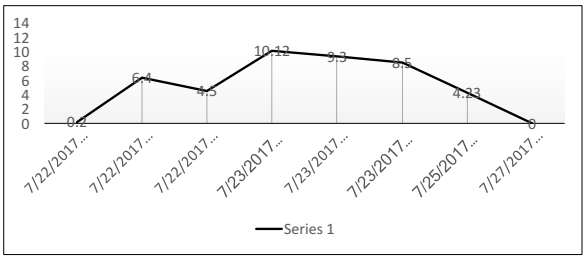
BP 168/72 HR 92-108 SaO2 94% on 4 L NC

Troponin levels:

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

92

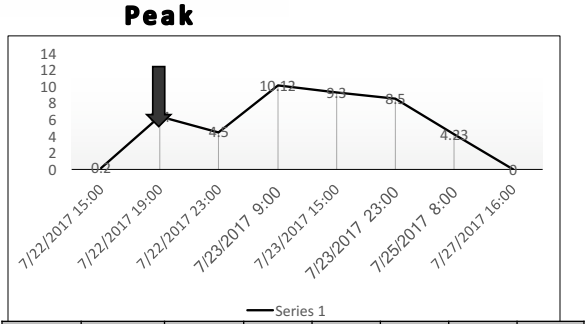
Troponin Example



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

93

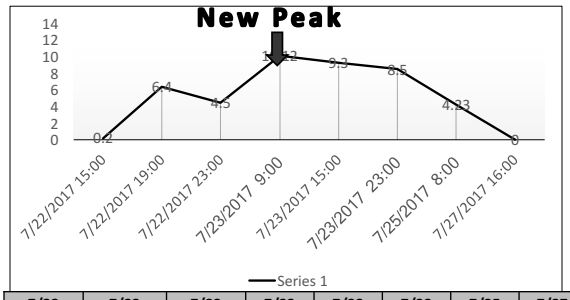
Troponin Example



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

94

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

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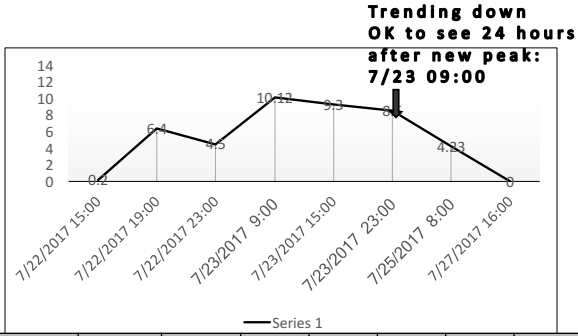
Troponin Example



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

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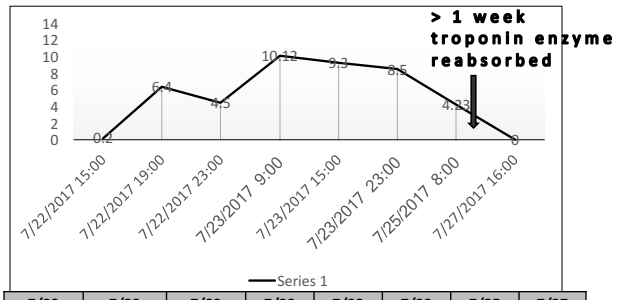
Troponin Example



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

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Cardiac Markers: Questions?

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Lab Values associated with DVT

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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

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PTT

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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.

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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

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Prothrombin Time

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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

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INR

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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

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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

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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 does of Lovenox such as TKA/THA and diagnosed with DVT, a therapeutic dose must be given

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APTA AACPT Guidelines: Known DVT

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

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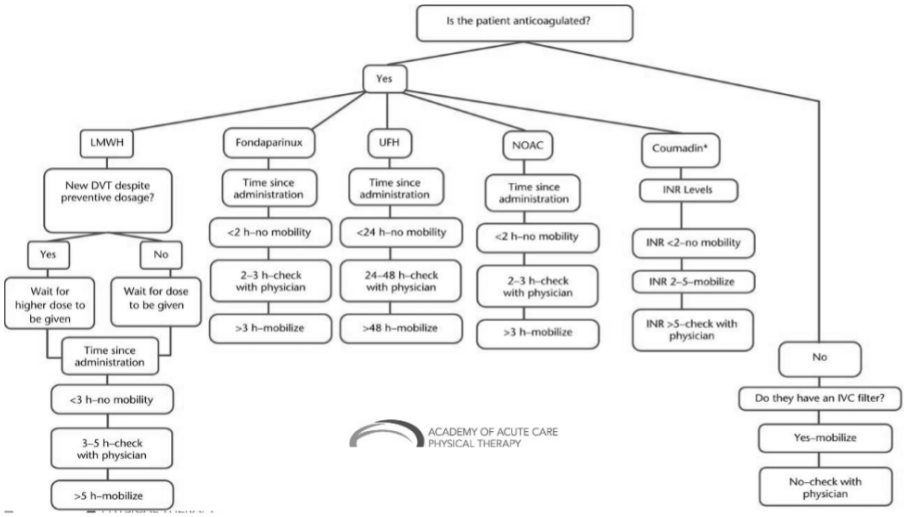
Algorithm for Mobilizing Patients with Known Lower-Extremity Deep Vein Thrombosis

DVT = deep-vein thrombosis | **LMWH** = low molecular weight heparin | **UFH** = unfractionated heparin | **NOAC** = novel oral anticoagulants
INR = international normalized ratio | **IVC** = inferior vena cava



111

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.

http://www.exactradiology.com.au/images/inferior-vena-cava-doppler-technology.jpg

112

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.

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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.

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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

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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.

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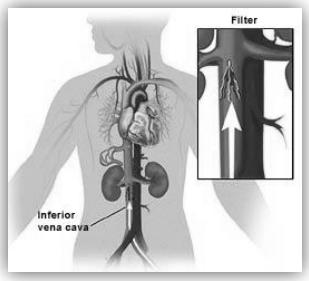
IVC Filters



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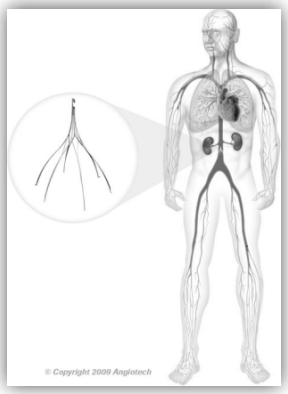

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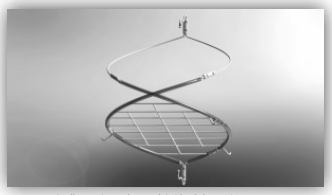

http://www.angiologist.com/wp-content/uploads/2012/07/Crue-IVC-Filter.jpg

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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

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DVT: Questions?

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Other
Lab Values

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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 Electrolyte panel: Calcium, Chloride, Phosphate, Magnesium
- B-Type Natriuretic Peptide (BNP)
- APTA AACPT: Symptom Based Approach; See resource manual for additional information

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Quick Reference Guide

Lab Value	Normal Value	Rehab Guideline Quick Reference
Hemoglobin Hgb	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 K+	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 >300 no routine PT/OT refer to guideline
Platelets Plts	150,000 -450,000 cells/microL	>50,000 amb as tol, bike OK 20-50,000 ambulate, light resist 5-20,000 AROM, walk in room, light activities <5,000/<1 wk. transfers <5,000/>1 wk. same as 5-20,000
Prothrombin PT	9.5-13 sec. (18-30 Coumadin)	
Partial Thromboplastin PTT	22-36 sec. (64-109 Heparin)	>200 considering holding, check with MD +DVT: anticoag tx must be started prior to tx Greenfield filter (IVC)=ok
International Normalized Ratio INR	2-3: std. dose 2.5-3.5: high dose	>6 Check with MD
Troponin-I cTnI	<0.2	TROPONIN >0.2 New onset increases = NO TX. 0.05-0.2: indeterminate for Myocardial Damage: See Guidelines +MI = Tx. after 24 hrs. if hemodynamically stable
BNP		100-300 pg/mL suggest heart failure is present (I) above 300 pg/mL indicate mild heart failure (II) above 600 pg/mL indicate moderate heart failure (III) above 900 pg/mL indicate severe heart failure (IV)
Sodium **Na**	135-145	Risk for mental status changes, intracranial hemorrhage, coma

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Questions?

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Clinical Cases

124

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

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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

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Clinical Case #1 of 6 — Mr. J.

Lab Value	7/26
Glucose	250
HCT	42%
HGB	9.9
K+	3.6
Na	138

	08:00	09:00	10:00	11:00
BP	145/72	162/78	179/75	168/98
HR	100	102	110	90
SaO_2	99	98	100	99
Oxygen Therapy	2L NC	2L NC	2L NC	2L NC

Is this patient appropriate for intervention based on above labs/vitals?

Why or Why Not?

127

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)

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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

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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.

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Clinical Case #2 of 6

Mr. D.

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

	7/24	7/25	7/26
Glucose	79	89	60
HCT	40%	42%	42%
HGB	11.9	9.8	8.2
K+	3.4	3.3	3.6
Na	135	136	137
Troponin	0.04	0.04	0.04
WBC	8500	9000	8800
PTT	30	36	34

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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:

	7/24	7/25	7/26
Glucose	110	150	114
HCT	44	42	40
HGB	12.1	11.5	10.8
K+	3.4	3.3	3.1
Na	125	132	135

- Can intervention be initiated?
- What would you monitor?

Yes, K+ is within treatable range; NA above 130

Vital Signs and Physiologic response

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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

133

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:

1400: Troponins <0.04

2000: Troponin 0.08

2400: Troponin 0.08

Current Vital Signs taken at 0800:

BP 140/82 HR 98 SaO_2 94% on 2L O_2

Would you initiate treatment with Mrs. R?

Yes, troponins are indeterminate, history of CHF

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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 and why might the level 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)

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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

Why might this patient's CPK be elevated?

Injury to skeletal muscle can cause CPK to be elevated

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Questions?

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References

139

References

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