When "Early Mobility" is Not the Answer: Challenges to the Effectiveness and Appropriateness of PT Intervention for Patients with Critical Illness

Amy Pawlik, PT, DPT, CCS
Sarah Harrison, PT, DPT
Saturday, February 7, 2015
Objectives

1) Identify medical conditions that may limit the effectiveness of physical therapy intervention in patients with critical illness

2) Identify medical conditions that may limit the safety and appropriateness of physical therapy intervention in patients with critical illness

3) Discuss strategies to initiate challenging conversations with the medical team regarding a patient's response, or lack of response, to physical therapy intervention
Why discuss this?

• Long term sequelae of critical illness
• Growing body of evidence supporting safety and effectiveness of intervention
• Barriers to our intervention
A problem…

Functional Disability 5 Years after Acute Respiratory Distress Syndrome

Margaret S. Herridge, M.D., M.P.H., Catherine M. Tansey, M.Sc., Andrea Matté, B.Sc., George Tomlinson, Ph.D., Natalia Diaz Granados, M.Sc., Andrew Cooper, M.D., Cameron B. Guest, M.D., C. David Mazer, M.D., Sangeeta Mehta, M.D., Thomas E. Stewart, M.D., Paul Kudlow, B.Sc., Deborah Cook, M.D., Arthur S. Slutsky, M.D., and Angela M. Cheung, M.D., Ph.D., for the Canadian Critical Care Trials Group

Acute Skeletal Muscle Wasting in Critical Illness

Zudin A. Puthucheary, MRCP; Jaikeyl Rawal, MRCS; Mark McPhail, PhD; Bronwen Connolly, BSc; Gamunu Ratnayake, MRCP; Pearl Chan, MBBS; Nicholas S. Hopkinson, PhD; Rahul Padhke, PhD; Tracy Dew, MSc; Paul S. Sidhu, PhD; Cristiana Velloso, PhD; John Seymour, PhD; Chibeza C. Agley, MSc; Anna Selby, PhD; Marie Limb, PhD; Lindsay M. Edwards, PhD; Kenneth Smith, PhD; Anthea Rowlerson, PhD; Michael John Rennie, PhD; John Moxham, PhD; Stephen D. R. Herridge, PhD; Nicholas Hart, PhD; Hugh E. Montgomery, MD

Published online October 9, 2013

Physical Complications in Acute Lung Injury Survivors: A Two-Year Longitudinal Prospective Study

Eddy Fan, MD, PhD1,2; David W. Dowdy, MD, PhD2,3; Elizabeth Colantuoni, PhD2,4; Pedro A. Mendez-Tellez, MD2,5; Jonathan E. Sevransky, MD, MHS6; Carl Shanholtz, MD7; Cheryl R. Dennison Himmelfarb, RN, PhD8; Sanjay V. Desai, MD9,10; Nancy Ciesla, DPT11; Margaret S. Herridge, MD, MPH1; Peter J. Pronovost, MD, PhD2,5,8,10,11; Dale M. Needham, MD, PhD2,9,11

Critical Care Medicine April 2014 Volume 42 Number 4

Challenges to PT Intervention in Critical Illness
Feasibility of physical and occupational therapy beginning from initiation of mechanical ventilation

Mark C. Pohiman, MD; William D. Schweickert, MD; Anne S. Pohiman, RN, MSN; Celerina Nigos, RN; Amy J. Pawlik, PT; Cheryl L. Esbrook, OTR/L; Linda Spears, PT; Megan Miller, OTR/L; Mietka Franczyk, PT; Deanna Deprizio, OTR/L; Gregory A. Schmidt, MD; Amy Bowman, RN, BSN; Rhonda Barr, PT; Kathryn McCallister, BS; Jesse B. Hall, MD; John P. Kress, MD

Crit Care Med 2010 Vol. 38, No. 11

Receiving Early Mobility During an Intensive Care Unit Admission Is a Predictor of Improved Outcomes in Acute Respiratory Failure

Peter E. Mortis, MD, Leah Griffin, MS, Michael Berry, PhD, Clif Thompson, RN, R. Duncan Hite, MD, Chris Winkelman, PhD, Ramona O. Hopkins, PhD, Amelia Ross, MSN, Luz Dixon, RN, Susan Leach, RN and Edward Haponik, MD

The American Journal of the Medical Sciences • 2011

The effect of increased mobility on morbidity in the neurointensive care unit

Clinical article


Early mobilization out of bed after ischaemic stroke reduces severe complications but not cerebral blood flow: a randomized controlled pilot trial

Karin Diserens, Tiago Moreira, Lorenz Hirt, Mohamed Faouzi, Jelena Grujic, Gilles Bieler, Philippe Vuadens and Patrik Michel

Clin Rehabil 2012 26: 451 originally published online 2 December 2011
Barriers?

Extending the Benefits of Early Mobility to Critically Ill Patients Undergoing Continuous Renal Replacement Therapy
The Michigan Experience

Cheryl L. Talley, RN; Robert O. Wonnacott, ADN; Janice K. Schuette, BSN, RN, CCRN; Jill Jamieson, RN; Michael Heung, MD

Safety and Efficacy of Mobility Interventions in Patients with Femoral Catheters in the ICU: A Prospective Observational Study

Christiane Perme, PT, CCS; Theresa Nalty, MS, PT, NCS, PhD; Chris Winkelman, RN, PhD, CCRN, FCCM; Ricardo Kenji Nawa, MS, PT; Faisal Masud, MD, FCCP, FCCM
Cardiopulmonary Physical Therapy Journal Vol 24 No 2 June 2013
Safety?

Expert consensus and recommendations on safety criteria for active mobilization of mechanically ventilated critically ill adults. *Critical Care* 2014, **18**:658
doi:10.1186/s13054-014-0658-y

- Great article that gives some guidance to when mobilizing a patient in bed or out of bed is recommended, should proceed with caution or may be contraindicated
- Very comprehensive considering vent settings, line presence, hemodynamic stability, etc
- However, does not consider those factors that may negatively impact the effectiveness of intervention

<table>
<thead>
<tr>
<th>Color</th>
<th>Description</th>
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<tbody>
<tr>
<td>Green</td>
<td>Low risk of an adverse event. Proceed as usual according to each ICU’s protocols and procedures.</td>
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<tr>
<td>Yellow</td>
<td>Potential risk and consequences of an adverse event are higher than green, but may be outweighed by the potential benefits of mobilization. The precautions or contraindications should be clarified prior to any mobilization episode. If mobilized, consideration should be given to doing so gradually and cautiously.</td>
</tr>
<tr>
<td>Red</td>
<td>Significant potential risk or consequences of an adverse event. Active mobilization should not occur unless specifically authorized by the treating intensive care specialist in consultation with the senior physical therapist and senior nursing staff.</td>
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<table>
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<th><strong>Cardiovascular Considerations</strong></th>
<th><strong>In-Bed Exercises</strong></th>
<th><strong>Out-of-Bed Exercises</strong></th>
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<td><strong>Blood pressure</strong></td>
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<tr>
<td>Intravenous antihypertensive therapy for hypertensive emergency&lt;sup&gt;a&lt;/sup&gt;</td>
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<tr>
<td><strong>MAP&lt;sup&gt;b&lt;/sup&gt;:</strong></td>
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<tr>
<td>Below target range and causing symptoms</td>
<td>![Diagram Symbol]</td>
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<tr>
<td>Below target range despite support (vasoactive and/or mechanical)</td>
<td>![Diagram Symbol]</td>
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<tr>
<td>Greater than lower limit of target range while receiving no support or low level support</td>
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<tr>
<td>Greater than lower limit of target range while receiving moderate level support</td>
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<tr>
<td>Greater than lower limit of target range on high level support</td>
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<td>![Diagram Symbol]</td>
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<tr>
<td>Known or suspected severe pulmonary hypertension</td>
<td>![Diagram Symbol]</td>
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</tbody>
</table>
Stop signs for Effectiveness?

Your Intervention May Not Be Working Because…???
Clarification

“Early mobility/mobilization”

versus

Physical therapy intervention

Rehabilitation in the ICU

Physical therapy intervention in critical illness
What to expect

- Series of case studies that address a few specific medical issues
- Some of the issues that may be a factor in rehabilitation
- Not all answers→initiate discussion on how we can begin to approach some of these topics
Possible barriers to effectiveness of PT intervention

• Nutrition
• Endocrine
• Myopathy/polyneuropathy
• Phos/Calcium/Magnesium
• Inflammatory process
• Worsening blood gases, mixed venous
• Mental status
• And more!
Case Studies

- Nutrition
- Endocrine
- Safety Concerns
Endocrine as a barrier?

- Mr Smith
- 64 yo male, IPF
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<td>Single Lung Transplant VV ECMO</td>
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<td>24</td>
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<td>RN note: moving all extremities</td>
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December 2013

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<th>NO weaned, sedation lightened</th>
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<td>PT and OT initial evaluation “no active movement extremities”</td>
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<tr>
<td>3</td>
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Challenges to PT Intervention in Critical Illness
We tried everything!!!!!!!

- Mobilization
- Bed to Chair
- NMES
- Weightbearing
- Tactile stimuli
- Increased frequency of sessions
- Decreased frequency of sessions
- Considered many possible medical explanations in an effort to help with frequency, intensity, rehab prognosis, etc.
The team tried everything!!!!

- Head CT 12/6-infarct, occipital lobe
- EEG 12/6-marked encephalopathy
- Spine CT-normal
- Nutrition-tube feeds started early
- Normalize Na, blood glucose,
- MORE PT and OT!!!!!!
<table>
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<tr>
<th>Date</th>
<th>Notes</th>
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<tr>
<td>5</td>
<td>NCV/EMG→Myopathy</td>
</tr>
<tr>
<td>6</td>
<td>“Will start growth hormone”</td>
</tr>
<tr>
<td>7</td>
<td>“Will add testosterone”</td>
</tr>
<tr>
<td>8</td>
<td>“TSH elevated, will discontinue synthroid”</td>
</tr>
<tr>
<td>9</td>
<td>Trace wrist, shoulder movements noted with OT</td>
</tr>
<tr>
<td>10</td>
<td>Trace knee extension L, 2-/5 knee extension R</td>
</tr>
<tr>
<td>11</td>
<td>Active movement B elbow flx/ext, hip rotators</td>
</tr>
<tr>
<td>12</td>
<td>3-/5 knee extension B</td>
</tr>
</tbody>
</table>

**January 2014**
EMG

- Revealed myopathy not polyneuropathy

LONG-TERM RECOVERY IN CRITICAL ILLNESS MYOPATHY IS COMPLETE, CONTRARY TO POLYNEUROPATHY

SUSANNE KOCH, MD,1 TOBIAS WOLLERSHEIM, MD,1 JEFFREY BIERBRAUER, MD,1 KURT HAAS, MD,1 RUDOLF MÖRGELI, MD,1 MARIA DEJA, MD,1 CLAUDIA D. SPIES, MD,1 SIMONE SPULER, MD,2 MARTIN KREBS, MD,1 and STEFFEN WEBER-CARSTENS, MD1

Endocrine Review

- Various glands throughout the body release hormones → specific effect on cells and organs
- Maintains homeostasis with the neural system: slower but longer duration
- 5 general functions
  - Differentiation of reproductive and CNS of the developing fetus
  - Simulation of sequential growth and development during childhood/adolescence
  - Coordination of male and female reproductive systems
  - Maintenance of optimal internal environment
  - Initiation of corrective and adaptive responses during emergencies
Hypothalamic Control
Response to stress

• Universal Response-FIGHT or FLIGHT-Sympathetic Nervous System
  – Response
    • CO increase
    • RR increase
    • Blood flow to brain and skeletal muscle
  – Activation of the hypothalamic-pituitary axis
    • Adrenal Cortex
      – Cortisol
        » Glucose increase-regulates metabolism of proteins, carbs, lipids
        » Energy-assists with increasing availability of amino acids to heal damaged tissues (delays anabolism)
        » Inflammation-inhibits (can cause poor wound healing)
      – Aldosterone
        » Intravascular fluid retention
    • Adrenal Medulla
      – Catecholamines increase (ionotopic and vasopressor response)
        » Heart-rate and force
        » Peripheral-increases BP
        » Glucose-increases liver and skeletal glycogenolysis
Acute vs Prolonged response

- **Acute Illness**
  - Cortisol remains elevated as compared to normal subjects

- **Prolonged critical illness (>10 days of ICU support)**
  - Reduced stimulation over time of cortisol
  - Prolonged hypercortisolemia can lead to:
    - Increased risk of infection
    - Impaired wound healing
    - Prolonged catabolism
    - myopathy
Growth Hormone

- Purpose
- Limitations to production
- Effects of deficit
Hyperthyroid

• Purpose
• Limitations to production/Elevated levels
• Effects of deficit
Testosterone

- Purpose
- Limitations to production
- Effects of deficit
Lessons Learned

Could this case have been managed differently?

– Awareness of impact of critical illness on endocrine function
– Suggestion to team of other possible lab tests?
– Achievable goals based on prognosis related to CIM
– Achievable goals based on prognosis related to endocrine dysfunction
– Utilize additional outcome measures to better show progress/lack of progress

Would he have had a different outcome?
Earlier PT and OT intervention?


- 222 survivors of ALI
- Multicenter, prospective study. Longitudinal follow-up at 3, 6, 12, 24 months
- Extremity, hand grip and respiratory muscle strength assessed; anthropometrics; 6MWT distance; SF=36 QOL
- Duration of bedrest was associated with decreased strength and function through 24 months of follow-up
- Cumulative doses of systemic CS and NMB were not associated with weakness
Other Considerations

Why else may he have been performing poorly?

• Infection, SIRS, sepsis
• Anoxia
• Psychological state
• Fluid overload
• Steroid induced myopathy
• Critical illness myo/neuropathy
• Immune suppression
• Inadequate nutrition

Why else may he have started making recovery?

• Medication, medical treatments
• Psychological state
• Other factors?
Nutrition as a barrier?

Critically ill already have an increased metabolic rate with muscle wasting as a known complication. 

Increasing evidence to support early physical therapy in the ICU setting.

Minimal evidence looking at the impact of poor nutrition on patient’s ability to participate in PT/OT.

Does inadequate nutrition impact a patient’s ability to progress with PT?

Should prescription of therapy intervention be adjusted in a mal/undernourished patient?
Purpose

Nutritional status may be considered if a patient has plateaued or is declining despite physical therapy intervention.
Review of Terms

• Metabolism
  – Catabolism: breaking down cell components as a source of energy
  – Anabolism: building new cellular components

• Catabolic state: Loss of lean body mass and muscle wasting

• Resting (Basal) Energy Expenditure (REE)
  – Strict resting state, no stimulation
  – kJ per hour / kg body mass
  – Multiplied by a stress/activity factor to estimate nutritional needs in the critically ill
Starvation vs. Stress

**Starvation Response**
- ↓ REE, ↓ metabolic demand
- muscle mass preserved

**Stress Response**
- ↑ REE
- Increased energy requirements
- ↑ metabolic demand
- → Catabolic state
- → Skeletal muscle breakdown
Markers of Nutritional Status

- **BMI**
  - Nutritional assessment/need
- **Albumin (3.5-5.7g/dL)**
  - Marker of long-term nutrition status (>3 weeks)
  - Can fluctuate based on fluid, not reliable
- **Prealbumin (Transthyretin/TTR: 21-41mg/dL)**
  - Good short-term marker of nutrition status
  - Correlates with ICU/hospital LOS
  - Predictive of outcome in critically ill patients (mortality)
- **C-Reactive Protein (<5mg/L)**
  - Inflammatory marker
  - Inverse relationship with Prealbumin
Literature Review

- Energy cost significantly increased with active exercise during early Physical Therapy in critically ill population
  - REE correlated with CRP (p=0.004)
- Premorbid nutritional status affects outcome
- Enhanced PT and nutrition rehab package trended toward increased activity and caloric/protein intake
- Muscle wasting occurs despite adequate nutrition
- Optimal amount of nutrition delivery generally unknown
- Also significant risks associated with overfeeding
  - Refeeding syndrome – electrolyte imbalances
Subject

• 46yo female admitted from rehab with hematemesis

• found to have GI bleed and respiratory failure requiring intubation and subsequent tracheostomy

• PMH: pulmonary veno-occlusive disease leading to pulmonary HTN, right HF

• s/p bilateral lung transplant at UCMC 25 days ago
  – transferred to rehab for 5 days prior to readmission
  – respiratory, kidney, liver involvement related to illness

• At d/c to rehab was min A to walk 200ft.
Participation in PT/OT

- Evaluated by PT/OT on day 3
- Able to mobilize with mod A, take steps
- Seen for 70 PT sessions over 140 days
  - *Additional 43 attempted sessions*
- Progressive decline in activity tolerance
- Progressive decline in functional ability
- Why spending more and more time in therapy and getting poorer results?
Hospital Course

• Body composition
  – BMI 17.9  \((\text{baseline} 19.6)\)
  – 108lbs \(\rightarrow\) 75lbs by day 20
• Surgeries & procedures requiring NPO/hold feeds
  – 6 surgeries  \((\text{admission days} 8-36)\)
  – 5 procedures  \((\text{admission days} 2-57)\)
• Inability to tolerate tube feeds
  – Ileus
  – C. difficile
  – Emesis
  – Ascites, abdominal distension
• Total 42 days of zero intake over hospitalization
• Additional 23 days with less than 200 ml intake
  – \textit{goal} 60-85ml per hour!
Modes of Nutrition Delivery
Correlation?

• Looked at whether nutritional status correlated with functional ability

  – Looked at nutrition markers however not enough information to draw a correlation
    • Admission Albumin 5.1
    • CRP as high as 61 mg/L
    • Pre-albumin as low as 12 mg/dL

  – Looked at volume of enteral feeds, TPN
Functional Status Score for the Intensive Care Unit

- FIM not sensitive enough, converted to FSS-ICU
- Provides measurement of change with well-established scale
- 5 domains (1, dependent – 7, independent as in FIM):
  - Rolling
  - Supine to sit
  - Unsupported sitting
  - Sit to stand
  - Gait
- Total possible score 35
FSS-ICU scores

Challenges to PT Intervention in Critical Illness
Lessons Learned

Could this case have been managed differently?

– Awareness of increased baseline energy needs
– Achievable goals based on prognosis related to nutrition
– Utilize additional outcome measures to better show progress
– Decrease therapy duration/frequency during times of high catabolism, minimal/no nutrition supplement

Would she have had a different outcome?
Other Considerations

Why else may she have been performing poorly?

- Infection, SIRS, sepsis
- Bleeding, low hemoglobin
- Psychological state
- Fluid overload
- Steroid induced myopathy
- Critical illness myo/neuropathy
- Immune suppression

Why else may she have started making recovery?

- Medication, medical treatments
- Fluid status, hematology
- Psychological state
- Other factors?
Take Home Messages-Changing the way we practice?

• Multi-disciplinary approach is key

• Question why your patient is not progressing, could nutrition status be a factor?
  – Correlate with CRP level for marker of REE
  – Prioritization of patients

• Alter treatment duration, intensity

• Plan of care, goals should reflect expectations based on whole patient picture, including nutritional status
Changing the way we practice?

- Communicate with your Registered Dietician
- Participate in multi-disciplinary Rounds
- Encouraging adequate intake as part of PT/OT intervention (when appropriate)
- Minimize holding tube feeds during therapy sessions
- Help nursing weigh the patient when indicated to optimize calculation of nutritional need
- Areas in EPIC to find more info on nutritional status:
  - Progress notes: FASTHUG assessment
  - Adult Nutrition tab in Doc Flowsheets
  - I/O tab in chart
Opportunities for Future Research

- Collaborative research with dietary/GI on metabolic demand with early physical/occupational therapy
- Do pre-albumin, CR-P levels impact a patient’s ability to participate/progress with therapy?
Finding the information

**ASSESSMENT & PLAN**

**FASTHUG ASSESSMENT**

- Feeding: No
- Analgesia: Yes
- Sedation: Yes
- Thromboembolic Prophylaxis: Yes
- Head of Bed Elevated: Yes
- Ulcer Prevention: Yes
- Glucose Control: Yes

**Neurological:**
- Fentanyl gt for sedation while intubated
- Sedation holiday daily

**Cardiovascular:**
- Septic shock
- Rec’d little volume resuscitation in setting of pulmonary edema
  -- norepinephrine weaned to off overnight
### Finding the Information

#### Intake/Output

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<th>Sep 25</th>
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<td>Intake: Water Flush (mL)</td>
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<td>Intake: Nutritional Supplement (mL)</td>
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<tr>
<td><strong>IV Piggyback</strong></td>
<td>1,050</td>
<td>1,400</td>
<td>1,000</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total Intake</strong></td>
<td>2,730.9</td>
<td>3,982.8</td>
<td>2,139.4</td>
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</tr>
</tbody>
</table>
Finding the information
### Laboratory Results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium Manual Ent...</td>
<td></td>
</tr>
<tr>
<td>Inorganic Phosphate</td>
<td>3.1</td>
</tr>
<tr>
<td>Magnesium</td>
<td>2.0</td>
</tr>
<tr>
<td>Total Protein</td>
<td>5.3</td>
</tr>
<tr>
<td>Albumin</td>
<td>3.1</td>
</tr>
<tr>
<td>Albumin Manual Ent...</td>
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</tr>
<tr>
<td>Bilirubin, Total</td>
<td>0.2</td>
</tr>
<tr>
<td>Bilirubin, Conjugated</td>
<td>0.1</td>
</tr>
<tr>
<td>Bilirubin, Unconju...</td>
<td>0.1</td>
</tr>
<tr>
<td>Alk Phos, Serum</td>
<td>153</td>
</tr>
<tr>
<td>AST (SGOT)</td>
<td>27</td>
</tr>
<tr>
<td>ALT (SGPT)</td>
<td>19</td>
</tr>
<tr>
<td>C-Reactive Protein</td>
<td>6</td>
</tr>
<tr>
<td>Lactic Acid</td>
<td></td>
</tr>
<tr>
<td>Metabolic Bone Dis...</td>
<td></td>
</tr>
<tr>
<td>25-Hydroxy Vitamin D</td>
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</tr>
<tr>
<td>Metals, Toxicology...</td>
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<tr>
<td>Tacrolimus</td>
<td>6.8</td>
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<tr>
<td>Test Information</td>
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<tr>
<td>This test was d...</td>
<td></td>
</tr>
<tr>
<td>This test was d...</td>
<td></td>
</tr>
<tr>
<td>VITAMINS &amp; NUTRITION</td>
<td></td>
</tr>
<tr>
<td>Pre Albumin</td>
<td>20</td>
</tr>
</tbody>
</table>
Some other causes of weakness

- **Hypophosphatemia**
  - 70% of patients mechanically ventilated in ICU
  - Signs and symptoms
    - Weakness (mimics critical illness myopathy)
    - Difficulty weaning from ventilator

- **Hypomagnesemia**
  - 20% of patients in ICU
  - Signs and symptoms
    - General muscle weakness
    - Tremors
    - Ventricular arrhythmias

- **Hypermagnesemia**
  - Signs and symptoms include muscle weakness

Magnesium is not routinely analyzed
A word on safety

- 55 yo female
- Admitted with IPF-progressing hypoxia
- Placed on VV ECMO, R IJ

- PaO2 50
- SpO2 86%
- Max Pressors
- Max ECMO

- Sit up at edge of bed????
How do we know

- What’s the problem?
- Can you do anything about it?

<table>
<thead>
<tr>
<th>Body Structure/Function (Impairment)</th>
<th>Activity (Functional Limitation)</th>
<th>Pathophysiology</th>
<th>Treatment Technique/PT Intervention?</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>

Challenges to PT Intervention in Critical Illness
Considerations

• Spectrum of support
  – Maxed?
  – Supplemental O2, BP, vent support, pressors, NO

• How beneficial will the session be for the patient
  – Mental status?
  – Current level of function
Communication

- Discussions with medical team
- Documentation
References


