Physical Therapy Management of the Patient with Critical Illness

Part 1: Assessment Skills & Tools for the ICU

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Objectives

• Identify standard components of a PT evaluation
  of the patient with critical illness
• Conduct an assessment of the patient’s sedation
  and delirium status in the ICU
• Identify common clinical assessment tools to
evaluate ICU-acquired weakness and neuromuscular
  dysfunction
• Discuss how to successfully synthesize medical
  information to assist with PT clinical decision
  making

Background

Impairments in Survivors of Critical Illness are Common

• Neuromuscular
• Physical Functioning
• Cognitive
• Psychological
• Ability to return to work
• Quality of life

Neuromuscular Outcomes

• Patients who survived ARDS (median age 44)
reported persistent functional impairments at
1 year post d/c
  – Muscle atrophy and weakness were significant
    contributing factors
  – Weight loss also a contributing factors (18% weight lost
    during hospitalization)
  – Only 71% returned to baseline weight at 1 year post-ICU
    discharge

Neuromuscular Outcomes

• 6 MWT limited in survivors of ARDS
  – 66% of predicted norms at 1 year
  – 76% of predicted norms at 5 years
  – Pulmonary function tests normal or near normal
• ICU-acquired weakness likely a significant
  limiting factor in long-term outcomes

Cognitive Outcomes

- Neurocognitive impairments are common in ICU survivors
  - Memory
  - Attention
  - Concentration
  - Executive function

- Cognitive deficits can be long-lasting (up to 6 years after hospital discharge), 7 permanent

- Some improvement occurs in the 1st 6 months to a year after ICU discharge. Little improvement after 1 year

Cognitive Outcomes

- 54 patients who had survived ARDS evaluated at 1 year post hospital discharge
  - 73% had cognitive deficits at hospital discharge
  - 46% had deficits that remained at 1 year

  - Short term memory most affected

- At 2 years follow-up post-ICU discharge
  - Little additional improvement over that seen at 1 year

Psychological Outcomes

- Anxiety and depression common in survivors of ARDS
  - Associated with longer hospital length of stay and longer periods of mechanical ventilation

- Multiple risk factors have been proposed
  - Altered sensory input
  - Sleep deprivation and nightmares
  - Hypoxemia and inflammation

Psychiatric Morbidity in ICU Survivors

- Delusional memories (nightmares, hallucinations) are also common in patients who are critically ill

- Trauma survivors who had delusional memories from their ICU stay had decreased QOL when compared to those who didn’t


Return to Work

- Survivors of critical illness often face challenges in returning to prior work status
  - Only 34-50% of survivors of ARDS returned to work 2 years following illness
  - Common limitations were persistent fatigue/weakness and poor functional status
- 545 patient prospective cohort study of ARDS survivors in 41 US ICUs
  - 52% returned to work @ 6 and 12 months

Improving long-term outcomes after discharge from intensive care unit: Report from a stakeholders’ conference

- Understand long-term outcomes of ICU patients and their families
- Identify stakeholders for sharing perspectives on scope and nature of long-term outcomes
- Identify strategies and funding sources to better patient and family needs
- Explore how stakeholders can contribute to improving long-term outcomes post hospital discharge


Influence of Bed Rest & Critical Illness Polyneuropathy

Consequences of bed rest

- Neuromuscular dysfunction is prevalent in critically ill patients, along with improve-
  - Neuromuscular dysfunction is prevalent in critically ill patients, along with improve-

Post Intensive Care Syndrome (PICS)

- Survivors (PICS)
  - Mental Health
  - Cognitive Impairments
  - Physical Impairments
- Family Members (PICS-F)
  - Mental Health


Patient Assessment: Level of Alertness and Cognition

Delirium & its impact on ICU patients

Liberation and animation for ventilated ICU patients: the ABCDE bundle for the back-end of critical care
**Patient Assessment: Level of Alertness**

Richmond Agitation-Sedation Scale (RASS)

10 Point Scale, ranging from -5 to +4

-5 = Unarousable to physical stimuli
0 = Alert and Calm
+4= Agitated and Combative, a danger to self/others

By EW et al., JAMA, 2003, 289, pp 2983-2991.

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**Prospective reliability and validity study of the RASS in the ICU**

**Setting:** Adult medical and coronary ICU

<table>
<thead>
<tr>
<th>Setting: Adult medical and coronary ICU</th>
<th>Reliability</th>
<th>Validity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>+/- mechanical ventilation + mechanical ventilation</td>
<td></td>
</tr>
<tr>
<td>Measures</td>
<td>Daily RASS by 2 RNs, MD, expert</td>
<td>Criterion: RASS vs. LOC by expert</td>
</tr>
<tr>
<td>Construct</td>
<td>Construct: RASS vs. 1. Attention screen 2. GCS 3. Quantity of sedatives/sedatives 4. Planned extubations 5. BIS-XP EEG</td>
<td></td>
</tr>
<tr>
<td>Results</td>
<td>ICC = 0.79 to 0.91</td>
<td>Discriminates LOC (Fig 1)</td>
</tr>
<tr>
<td></td>
<td>High correlations</td>
<td>+ survey results</td>
</tr>
</tbody>
</table>

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**Patient Assessment: Cognition**

- **Cognitive status**
  - Alert and oriented? Self, time, place, situation?

- **Communication**
  - Need to establish a mean of communication early on
  - Writing
  - Picture or letter board
  - Speaking valve
  - Use of technology (iPad, eye gaze systems)

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**Patient Assessment: Cognition**

- **Restlessness, confusion, or subtle behavioral changes may indicate inadequate oxygenation or rising CO₂**

- **Delirium Assessment**
  - CAM-ICU (Confusion Assessment Method for the ICU)

By EW et al. (2003). JAMA, 289: 2983-2991

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**Delirium is NOT “normal” for ICU patients**

Signs & symptoms:

- Abrupt onset & fluctuation during the day
- Change in level of consciousness
- Inattention
- Change in cognition &/or perception:
  - Impaired short-term memory, word finding, orientation
  - Hallucinations – often visual, but may be auditory or tactile

Adapted from DSM IV-TR, American Psychological Association 2000

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**Delirium is NOT “normal” for ICU patients**

Signs & symptoms:

- May have delusions, disorganized speech, emotional lability, sleep-wake disturbance
- Patients can be alert and following commands, but still delirious...need to assess specifically for delirium
- All in the absence of a psychiatric condition

Adapted from DSM IV-TR, American Psychological Association 2000

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Epidemiology of ICU Delirium

- 20 - 80% of ICU patients develop delirium at any point
- Frequently unrecognized or misdiagnosed by clinicians
- Typical onset in ICU patients: Day 2 ± 2 days
- Typical duration in ICU patients: 4 ± 2 days
- 50% and 10% of ARDS patients delirious @ ICU and Hospital d/c

Delirium and Patient Outcomes

- Independently associated with 2-3x increase in mortality
- Also associated with:
  - Increased MV duration (9 vs. 4 days)
  - Increased ICU length of stay (9 vs. 5 days)
  - Increased hospital length of stay (21 vs. 11 days)
  - Higher medical costs

Assessing for Delirium

- CAM-ICU (Confusion Assessment Method for the ICU)
  - Adapted for use in non-verbal ICU patients
  - Takes about 1 min to perform
  - Well validated and found to be reliable in the ICU population

CAM-ICU

CAM-ICU being performed:

http://www.icudelirium.org/videos/video_CAMICUvideo.html

CAM-ICU Website: Vanderbilt University
www.ICUdelirium.org

Prospective reliability and validity study of the CAM-ICU

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<th>Validity</th>
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<td>+ mechanical ventilation</td>
<td>+ mechanical ventilation</td>
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<tr>
<td>Measures</td>
<td>Daily CAM-ICU by 2 RNs, delirium experts</td>
<td>Criterion: CAM-ICU vs. DSM-IV by experts</td>
</tr>
<tr>
<td>Results</td>
<td>K = 0.96 [0.92, 0.99]</td>
<td>Accuracy: 98.4% [92, 100]</td>
</tr>
</tbody>
</table>

Ely EW et al., JAMA 2004;286:2703-2710.
Ely EW et al., Intensive Care Med 2001;27:1390-1396.
Lin SM et al., Crit Care Med 2006;34:2259-2263.
Milbrandt E et al., Crit Care Med 2004;33:950-962.
Patient Assessment: Chart Review

- HPI
- Hospital Course
- PMH
  - Events, procedures, exam findings
  - How long immobile?
  - Why in the ICU?
- Allergies/Restrictions/Precautions

Recent Events/HPI

- Anything that would set off a “red flag”?
  - Recent episodes of hemodynamic instability
  - Recent evidence of respiratory instability
  - Acute DVT/PE
  - Concern for spinal stability
  - Current bleeding
  - etc, etc...

Things to Consider....

- Overall appearance
- Recent events/HPI
- Recent Labs (current and trends)
- Vitals/ECG (current and trends)
- Meds/Infusions

Overall Appearance

- “Quick look”
- ? Alert
- Breathing pattern/rate
- Skin color
- Pertinent life support equipment
- Current Vitals/ vent settings

“Quick Look”

- Alert?
- In any distress?
- What type of equipment?
- Mechanically ventilated?
- Current Vitals?
- Overall Appearance
Vitals/ECG (current and trends)

- Vitals and ECG should be within parameters for that patient
  - BP
  - MAP
  - HR (rate and rhythm)
  - O₂ sats
  - Resp rate

Lab Values (current and trends)

- Consider acute vs. chronic findings
- Consider risk vs. benefit

> Great resource: Acute Care Section's Lab value interpretation resources.
Find at...

Meds/Infusions

- IV infusions
  - Vasopressors / Inotropes
  - Vasodilators
  - Sedation
  - Analgesia
  - Paralytics / Neuromuscular blockers
  - Insulin drips

Meds/Infusions

- Pressors:
  - Single vs. multiple agents
  - Recent trends (up, down, same...)
- Insulin drips
  - Be aware if holding tube feeds for treatment
- Consider meds that may cause changes in hemodynamics, coagulation status, immune function, electrolyte balance and fluid balance, etc.

Medical Stability Guidelines

Team discussion about appropriateness of mobilization of patients with the following scenarios:

Poor oxygenation:
- Pulse oximetry <88% (with supplemental O₂), OR
- FiO₂ > 0.6 and PEEP>10 cmH₂O

Tachypnea: respiratory rate >45 bpm
Acidosis: recent arterial pH <7.25
Acute PE/DVT

Medical Stability Concerns

Hemodynamic Instability
- New or increased vasopressor or vasodilator support in the past 2 hours
- Evidence of new dysrhythmias
- Evidence of cardiac ischemia
- Significant bleeding

Certain Medical Equipment
- IABP (intra-aortic balloon pump)
- ECMO (femorally cannulated)

Active Mobilization for Mechanically Ventilated Patients: A Systematic Review

Results

• 17 studies:
  • 11 ICU, 6 high dependency unit
  • Sample size 17 - 510
  • 10 Effectiveness (7 RCTs, 3 non-randomized)
  • 10 Safety (2 RCTs, 1 cohort, 7 case series)
  • Clinically heterogeneous – not pooled
  • Risk of bias assessment (Effectiveness)
    • 7/10 randomized clinical trials
    • 4/7 reported allocation concealment
    • 4/10 outcome assessors blinded


Active Mobilization for Mechanically Ventilated Patients: A Systematic Review

Purpose: As effectiveness & safety of active mobilization in pts MV ≥ 24h

Population: Adults >18 y

Intervention: In-bed exs, bed mobility, transfers, ambulation (excluded passive therapies – range of motion, electrical muscle stimulation)

Comparison: Any (or none)

Outcomes: Primary: Efficacy; Secondary: Adverse events, LOS, mechanical ventilation

Study designs: RCTs, cohort studies, retrospective studies, case series (safety only)


ABG Interpretation

• Measures effectiveness of alveolar ventilation & role of respiratory system in acid-base balance

• Norms
  - pH 7.35-7.45
  - PaO₂ 70-100 mmHg
  - PaCO₂ 35-45 mmHg
  - HCO₃⁻ 22-26 mEq/L

ABG Analysis

- Look at pH 1st…
  - Normal?
  - Acidotic (<7.35)?
  - Alkalotic (>7.45)?

- Next look at PaCO₂ - Is it consistent with a change in pH? If inverse relationship exists, change in pH is likely respiratory in origin.
  - Increased PaCO₂ = hypoventilation
  - Decreased PaCO₂ = hyperventilation

Patient Assessment: Skin

- Skin integrity
  - Overall appearance
  - Areas of pressure or wounds?
  - Temperature
  - Color
  - Moisture

Patient Assessment: Pulmonary

- Breath sounds (anterior and posterior?)
- Breathing patterns
  - Equal?
  - Use of accessory muscles?
- Secretions
  - Thick? Bloody? Color?

Patient Assessment: Pulmonary

- PaO₂
  - Keep in mind that you need to consider what FiO₂ the patient is on when you are interpreting the PaO₂
  - Expected norms of 70-100 mmHg is with room air (21% or FiO₂ .21). When supplemental O₂ is provided, the PaO₂ would rise well above 100 mmHg in someone with normal healthy lungs

Lastly, look at HCO₃⁻. There is a direct relationship between pH and HCO₃⁻ when HCO₃ increases, pH will usually as well
- Usually a metabolic cause
Patient Assessment: Equipment

- Mechanical vent? Settings?
  - Mode/Rate
  - PEEP
  - FiO₂
  - Tidal Vol
- Other equipment (IVs, CVVHD, warming/cooling blankets, O₂ delivery systems, etc.)
- Lines/Tubes/Drains

Patient Assessment: Neurological

- Musculoskeletal and Neurological Assessments
  - Sensation
  - Tone
  - Joint ROM
  - Strength

Patient Assessment: Strength

- Manual Muscle Testing
- Hand grip dynamometry
- Medical Research Council Scale (MRC Scale) for testing of 6 muscle groups
  - 3 Upper extremity (shoulder abduction, elbow flex, wrist ext)
  - 3 Lower extremity (hip flex, knee ext, ankle dorsiflexion)

What is the Medical Research Council Sumscore?

**Table 2.** MRC scale with full figures only. The patient is investigated in sitting posture and/or lying supine.

<table>
<thead>
<tr>
<th>Score</th>
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<tbody>
<tr>
<td>0</td>
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<tr>
<td>1</td>
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<tr>
<td>2</td>
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<tr>
<td>3</td>
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<tr>
<td>4</td>
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<tr>
<td>5</td>
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</table>

**MRC sumscore** = Σ manual muscle test score for each muscle group tested

- Originally developed for ventilated patients with Guillain-Barré syndrome
- 6 muscle groups - max score of 30
- Tested bilaterally - max score of 60

Prospective 9-month follow-up study of 95 mechanically ventilated patients

- Setting: 5 French ICUs (2 surgical, 3 medical)
- Population: Adult patients mechanically ventilated >7 d
- Outcomes: ICU-Acquired Weakness: MRC SS (<48/60)
- Results: Incidence of ICUAW = 25.3% (16.9, 35.2)

MMT in ICU patients is reliable

- 19 trainees vs. 1 gold standard rater
- Multistep training
  - Photo-illustrated instruction manual
  - Didactic teaching
  - Supervised training
- Individual assessment compared to gold standard
- 13 muscle groups (6 upper, 7 lower); abbreviated
- Inter-rater reliability
  - Sumscore, >80% sumscore (ICUAW)

JAMA. 2002;288:2859-67
MMT in ICU patients is reliable

<table>
<thead>
<tr>
<th>Author</th>
<th>Population (N)</th>
<th>MRC Sum Score (0-60) ICC</th>
<th>ICUAW (Kappa [95%])</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fan et al. 2010</td>
<td>ICU survivors/simulated patients (19)</td>
<td>1.0 [0.99, 1.0]</td>
<td>1.0 [0.55, 1.0]</td>
</tr>
<tr>
<td>Hough et al. 2011</td>
<td>ICU patients/survivors (30)</td>
<td>0.83 [0.67, 0.93]</td>
<td>0.76 [0.44, 1.0]</td>
</tr>
<tr>
<td>Hermans et al. 2012</td>
<td>ICU patients (75)</td>
<td>0.95 [0.92, 0.97]</td>
<td>0.68 ± 0.09*</td>
</tr>
</tbody>
</table>

*standard error

Hough et al. Critical Care 2011, 18:43

ICU Acquired Weakness

- Prevalence of ICU-AW in the literature varies depending on patient population, diagnostic method, and timing of examination
  - Clinical exam in patients receiving > 7 days of MV (25-30%)
  - Use of EP studies leads to higher estimates (50-60%)
  - Patients with sepsis/multi-organ failure (50-100%)

Systematic review looking at all studies where patients were evaluated by clinical exam and electrophysiological testing

Systematic review

Neuromuscular dysfunction acquired in critical illness: a systematic review

- Critical illness neuromuscular dysfunction diagnosed in 46% of adult ICU patients
- Highest incidence in patients with sepsis, multi-organ dysfunction, and prolonged mechanical ventilation

Stevens RD et al., Intensive Care Med 2007;33:1876-1891.

Clinical Presentation

- Subtle signs may be present
  - Weakness in withdrawal to noxious stimuli (Facial grimacing will be intact)
  - Decreased spontaneous movements
  - May have decreased or absent reflexes, but normal reflexes does not rule out
  - Weakness is symmetric and ranges from mild paresis to quadriplegia

Clinical Presentation

- ICUAW diagnosed in 2 different ways:
  - Prolonged wean from mechanical ventilation
  - Profound weakness in an awake ICU patient

- Neuromuscular deficits are usually detected after the recovery of other organ systems

Schweickert WD and Hall J. Chest 2007;131:1541-1549
Critical Illness Neuromuscular Dysfunction

- Critical illness polyneuropathy (CIP)
- Critical illness myopathy (CIM)
- CIP and CIM often co-exist

Critical Illness Polyneuropathy (CIP)

- Physical exam:
  - Distal sensory deficits
  - Distal weakness
  - Preserved or decreased deep tendon reflexes
  - Mainly affects distal muscles

Critical Illness Myopathy (CIM)

- Physical Exam:
  - No sensory deficits
  - Proximal muscle weakness
  - Preserved or decreased DTRs

Patient Assessment: Strength

- Hand grip dynamometry
  - May serve as an alternate and more simple way to test for ICUAW

Reliability of Hand grip measures in the ICU

N=46, 2 raters
ICC:
R: 0.93 [0.86, 0.97]
L: 0.97 [0.94, 0.98]

Lower hand grip strength in the ICU is independently associated with hospital mortality

Setting: 5 academic MICUs; N=174 (136 examined)
Population: Adult patients mechanically ventilated >5 d

Results:
MMT ICUAW=26.7%
Hand grip ICUAW=?
Mortality odds ratio (adjusted):
MMT ICUAW: 7.8 [2.4, 25.3]
Hand grip ICUAW: 4.5 [4.5, 13.6]
How much relative strength is 11kg & 7kg?

Ali et al. cohort average age=57; assume R dominant:
- **Males 11kg** = 24.2 lbs = 25% average
- **Females 7kg** = 15.4 lbs = 23% average

**Caution: above values from convenience samples**

Hand-held dynamometry – key principles

- Position the patient similarly
- Position the dynamometer at the same place on the patient
- Standardize instructions to the patient
- Assessor – position yourself to have the best mechanical advantage

**Perspective: Pre-JHH MICU QI**

 Setting: Academic MICU; N=32
 Population: Adult patients mechanically ventilated ≥ 4 d

<table>
<thead>
<tr>
<th>Clinical Course</th>
<th>ICU Admission</th>
<th>ICU Discharge</th>
<th>Hospital Discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Assessment</strong></td>
<td>4 Days MICU</td>
<td>PICU</td>
<td>MICU discharge</td>
</tr>
<tr>
<td><strong>Measures</strong></td>
<td>- ROM (contracture index)</td>
<td>- Unsupported sitting</td>
<td>Ambulation</td>
</tr>
</tbody>
</table>

**Results:**
- 72% referrals; Rx on 12% ICU days/patient
- Minimal physiologic effects, no safety events
- L/E ROM limitations
- ↑ MMT, unsupported sitting, ambulation

**Setting:** Academic MICU; N=32
**Population:** Adult patients mechanically ventilated ≥ 4 d

**Assessment @ hospital d/c**


**Physical Function ICU Test (PFIT)**

Tool to assess endurance, strength, cardiovascular capacity and functional status in the ICU patient
- Strength (shoulder flex and knee ext)
- Mobility assistance (sit to stand transfers)
- Marching in place (steps per min)

### Physical Therapy Management of the Patient with Critical Illness

Part 2: Treatment options across the activity continuum in the ICU

Michelle Kho, PT, PhD  
Jennifer M. Zanni, PT, DScPT  
Julie M. Skrzat, PT, DPT

### Objectives

- Identify PT treatment strategies across the continuum for the patient with critical illness
- Critically appraise the evidence for PT treatment interventions for the patient with critical illness
- Discuss how to successfully synthesize medical information, including vital signs, mechanical ventilation, and pharmacological therapies, to assist with physical therapy clinical decision making for treatment strategies for patients with critical illness.

### Optimal Treatment Planning: Strategies and Considerations

- Complex patient population - need for high level of clinical decision-making and ability to integrate many variables in a hectic environment
- Successful intervention requires pre-planning, flexibility, and team coordination
- Teamwork is a must!!!

### Optimal Treatment Planning

- Work as a team on modifying those barriers that may limit a patient’s ability to work with PM&R
- Sedation, delirium, and sleep are areas that need to be addressed by all ICU team members to allow max patient participation with rehab activities

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**Treatment Principles**

- Need to assess a patient’s “readiness” to participate in activity
  - Cognitive status allows for patient participation (ideal, but not required)
  - Stable hemodynamics and resp status
- Clinical decision-making on optimal type of activity based on medical status

**Treatment Progression**

- Start slow, progress activity in stages and monitor a patient’s response
- May begin with bed activities and progress to sitting at the edge of the bed, standing, pre-gait activities, and transfer to the chair
- Ambulation can be initiated when pts are able to weight bear and demonstrate stable hemodynamics and resp function


**Continuum of physical activity**

- HOB elevation/ chair position
- Continuous lateral rotational therapy
- Tilt table/ tilt bed
- Dangling
- Out of bed (OOB)
- Ambulation

Bourett RD et al. Intensive and Critical Care Nursing (2012); 28; 88-97

**Progressive Mobilization**

- Each treatment is really an evaluation and assessment of a patient’s tolerance to activity—this may change each session
- Goal is to ensure that the physiological demands of the activity do not exceed what the patient’s ability to respond to those demands
- Consider using rating of perceived exertion (RPE) to assess pt’s perceptions

Treatment Considerations

- Consider the need for increased FiO₂ or vent support prior to mobilizing a pt in order to maximize their pulmonary status.
- Communicate with medical team to discuss optimal settings
- Consider reason for resp failure?
  - Failure to oxygenate?
  - Failure to ventilate?
  - Both?

Guidelines to Stop or Modify Treatment

- Drop in O₂ sats below 88% which is persistent despite increased FiO₂
- Significant increased work of breathing/accessory muscle use
- Evidence of hemodynamic instability
  - ↓BP/MAP
  - Change in EKG rhythm
  - Chest pain

Guidelines to Stop or Modify Treatment

- HR greater than age predicted max
- Increased resp rate >20 bpm over resting
- Pt reports significant pain or fatigue
- Patient requests to stop

Mechanical Ventilation

- Patients who are slow to liberate from the vent pose a special challenge for planning rehabilitation activities around weaning from mech vent
- Mobilization activities may interfere with spontaneous breathing trials and the assessment for ability to extubate

Mechanical Ventilation

- Patients weaning from mechanical ventilation
  - Consider each patient’s case and determine their ability to tolerate both spontaneous breathing trials (SBTs) and rehab sessions
  - May be optimal to treat prior to SBT or after they are rested
  - Consider mobility and strengthening 1st, then weaning

Treatment Considerations - Equipment

- Less portable pieces of equipment
  - Continuous dialysis
  - Some high flow nasal cannula systems
  - ECMO (extracorporeal membrane oxygenation)
- Lines that may potentially limit mobility
  - Pedal lines
  - Femoral hemodialysis (HD) lines with CRRT
Femoral Lines & Continuous Renal Replacement Therapy (CRRT)

- 30 pts, 156 activity events of sitting edge of bed or greater
- No adverse events
  - Bleeding
  - Dislodgement
  - Non-functioning
  - Acute limb ischemia in 24 hours

Perma C et al. JACPT. 2011, 21(1), Spring. 32-36

Femoral Arterial Lines

- 30 pts, 156 activity events of sitting edge of bed or greater
- No adverse events
  - Bleeding
  - Dislodgement
  - Non-functioning
  - Acute limb ischemia in 24 hours

Perma C et al. JACPT. 2011, 21(1), Spring. 32-36

Safety and feasibility of femoral catheters during physical rehabilitation in the intensive care unit

- Prospective evaluation of consecutive patients admitted to MICU with fem lines (venous, arterial, & HD)
- 1,074 total patients, 239 (22%) received a femoral line(s)
- 101 patients with femoral lines received PT, seen for a total of 253 PT sessions
  - 67% also receiving mech vent


Safety and efficacy of mobility interventions in patients with femoral catheters in the ICU: A Prospective Observational Study

- Types of activities:
  - 49 (23%) standing activities or ambulation
  - 57 (27%) sitting
  - 25 (12%) cycle ergometry
  - 79 (38%) in-bed exercises
- No femoral catheter-related adverse events in 253 PT sessions


Safety and feasibility of femoral catheters during physical rehabilitation in the intensive care unit

- Evaluated for complications post rx
  - Non-functioning line
  - Dislodgement
  - Bleeding
  - Acute limb ischemia within 24 hrs


Types of activities:
- 49 (23%) standing activities or ambulation
- 57 (27%) sitting
- 25 (12%) cycle ergometry
- 79 (38%) in-bed exercises
- No femoral catheter-related adverse events in 253 PT sessions


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

- Prospective, observational study of patients with various femoral catheters
- 77 pts, 92 femoral catheters
  - 50 arterial
  - 15 central
  - 27 HD

Continuous Phys Ther Journal. 2011, June. Vol 24(2), 12-17
Safety and Efficacy of Mobility Interventions in Patients with Femoral Catheters in the ICU: A Prospective Observational Study

- 210 PT sessions, 630 mobility activities
  - 57 walking activities
- No femoral line complications
  - Including bleeding, hematoma, line dislodgement or loss of function, or evidence of vascular compromise

Mobility and Continuous Renal Replacement Therapy (CRRT)

- Results:
  - 72% on vasopressors
  - 60% had jugular access
  - 16% had femoral access
  - 89% Able to perform Phase 0 Activities
  - 9% Able to perform Phase 1 Activities
  - 2% Able to perform Phase 2 Activities

Recent Systematic Reviews on Early PT in the ICU

- 85 new studies since 2000 (55 clinical)
- Adult intubated and mech vented pts
- RCTs demonstrate early progressive mobilization is safe and feasible
- Improved functional outcomes
- May translate into decreased hosp and ICU LOS

Recent Systematic Reviews on Early PT in the ICU

- Findings suggest that early progressive rehabilitation and mobilization should be a prioritized and implemented in all adult ICU patients
Physical Therapy for the Critically Ill in the ICU: A Systematic Review and Meta-Analysis

Gerrita Kayambu, BSc Phys (Hons); Robert Boots, PhD; Jennifer Parsi, PhD

• Findings:
  – Improvements in quality of life (QOL), physical function, peripheral and resp muscle strength
  – Changes in LE strength (as measured by hand held dynamometry (HHD)) correlates with ability to ambulate
  – No significant effect of PT on hand grip strength

Results

<table>
<thead>
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<th>Description</th>
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<tbody>
<tr>
<td>SAFETY</td>
<td>14/1,449 activity sessions -&gt; .9%</td>
</tr>
<tr>
<td>Muscle Strength</td>
<td>Scores did not significantly improve in the ICU, but did improve by the time of hospital discharge.</td>
</tr>
</tbody>
</table>
| Functional Mobility | Time to mobilization milestones was reduced.  
The FIM and Barthel Index scores improved in the intervention group. |
| QOL/Patient Sx    | Neuropsychological impairments are negatively impacted by prolonged mechanical ventilation and ICU duration. |

Active Mobilization for Mechanically Ventilated Patients: A Systematic Review

Results

- 17 studies:
  - 11 ICU, 6 high dependency unit
  - Sample size 17 - 510
  - 10 Effectiveness (7 RCTs, 3 non-randomized)
  - 10 Safety (2 RCTs, 1 cohort, 7 case series)
- Clinically heterogeneous – not pooled
- Risk of bias assessment (Effectiveness)
  - 7/10 randomized clinical trials
  - 4/7 reported allocation concealment
  - 4/10 outcome assessors blinded


Active Mobilization for Mechanically Ventilated Patients: A Systematic Review

<table>
<thead>
<tr>
<th>Outcome</th>
<th>#</th>
<th>Active Mobilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety</td>
<td>10</td>
<td>No serious adverse events requiring life-saving measures</td>
</tr>
</tbody>
</table>

*ADLs = Activities of Daily Living


Interventions to Improve the Physical Function of ICU Survivors

A Systematic Review

- 14 studies met inclusion criteria
- Described interventions were exercise/physical therapy, parenteral nutrition, nurse led follow up, intensive insulin therapy, spontaneous awakening and breathing trials, absence of sedation during mechanical ventilation, and early tracheotomy.
- The only effective intervention to improve long-term PF in critically ill patients is exercise/PT, its benefit may be greater if started earlier

CHEST 2013; 144(5):1469–1480

Exercise Prescription and Protocols
**Early intensive care unit mobility therapy in the treatment of acute respiratory failure**

Peter E. Morris, MD; Amanda Savo, RN, Clifford Thompson, RN; Karin Taylor, MPT; Barbara Hirsy, MPT; John Pavacich, MD; Andrea Ross, RN, MS; Laura Anderson; Shirley Baker; Mary Sanchez; Jennifer Porter; April Howard, RN, LC, E, Susan Leach, RN, Howard Smal, MSN, D; Dennis Hie, MD; Edward Hapsel, MD

- **ICU Mobility Team (RN, PT, nursing asst)**
- **Mobility protocol initiated by ICU mobility team within 48 hrs of intubation vs. usual care PT**
- **Mobility protocol started with PROM until patients were awake and then progressed systematically with active exercises, sitting, standing, and transfer to a chair**

**RCT of early PT/OT in the ICU**

*N=49

| Early physical and occupational therapy in mechanically ventilated, critically ill patients (randomized controlled trial) |
|---|---|
| Medical ICU | R |
| Daily interruption of sedation + Early OT/PT | 59% (29/49) |
| Daily interruption of sedation + Standard care OT/PT | 35% (19/55) |
| p=0.02 |

Schweickert et al., Lancet. 2009. 373: 1874-82.

**It’s about receiving therapy while on mechanical ventilation**

- **Primary Outcome:** Independent functional status @ hospital discharge (composite) (6 ADLs + independent walking)

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROM -&gt; AAROM -&gt; AROM -&gt; Bed Mobility -&gt; Transfers (sitting) -&gt;</td>
<td>Sitting balance -&gt; ADLs -&gt; Transfers (standing) -&gt; Ambulation</td>
</tr>
<tr>
<td>N=49</td>
<td>N=55</td>
</tr>
<tr>
<td>Median time to start therapy (d)</td>
<td>1.5 [1.0 to 2.1]</td>
</tr>
</tbody>
</table>

0.32 h/d = 19.2 minutes

Schweickert et al., Lancet. 2009. 373: 1874-82.

**Patients receiving early rehab had less ICU and hospital delirium**

<table>
<thead>
<tr>
<th></th>
<th>Intervention N=49</th>
<th>Control N=55</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICU delirium (days)</td>
<td>2.0 [0.0 to 6.0]</td>
<td>4.0 [2.0 to 7.0]</td>
<td>0.03</td>
</tr>
<tr>
<td>Time in ICU with delirium (%)</td>
<td>33% [0 to 58]</td>
<td>57% [33 to 69]</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Schweickert et al., Lancet. 2009. 373: 1874-82.

**Exercise rehabilitation for patients with critical illness: a randomized controlled trial with 12 months of follow-up**

- **Intensive PT, begun after day 5 in ICU**
- **Exercise program continued daily on the ward**
- **Followed up with 2x/weekly outpatient visits for 8 weeks after d/c**
- **Compared to “usual care”**
- **Follow up at 3, 6, and 12 months**
- **Primary outcome: 6MWT**
- **Secondary outcomes: TUG, phys fxn, QOL**

Results:
- 150 pts randomized to usual care or intervention
  - 92% required mech vent, 55% still vented at time of enrollment
  - No adverse events
  - No significant differences in outcomes at 12 months

Thoughts on outcomes:
- Higher level of PT involvement already in usual care
- Rate of improvement in 6 MWT was better in the intervention group, but no difference at 12 mos.
- Poor outpatient attendance (41%)

Safety and Feasibility of an Exercise Prescription Approach to Rehabilitation Across the Continuum of Care for Survivors of Critical Illness

- Patients (74) participating in a 12 month RCT with ICU and outpatient programs
- Rehab approach based on exercise prescription (PFIT or 6MWT) to achieve physiological training response
- No adverse outcomes

Treatment Strategies:
Neuromuscular Electrical Stimulation
What is NMES?

**Neuromuscular Electrical Stimulation**

Also known as:
- **Electrical Stimulation “E-stim”**
- **Functional Electrical Stimulation “FES”**

To-date, NMES in the published ICU literature is completely non-volitional.

Pflugers Arch. 1983;398(2):139-141.

---

Selected contraindications to NMES

- Any pacemaker (e.g., cardiac, diaphragm) or implanted cardiac defibrillator
- Infected tissues, tuberculosis or wounds with underlying osteomyelitis
- Over confirmed / suspected malignancy
- Area of untreated DVT
- Areas of uncontrolled bleeding
- Damaged or at-risk skin
- OK in intact skin overlying implants containing metal, plastic, or cement

Full issue dedicated to Electrophysical Agents & Contraindications (NMES ch.4): Physiotherapy Canada. 2010. 62(5).

---

Current evidence supporting NMES in mechanically ventilated patients

- 9 unique randomized controlled trials
- Populations
  - Chronic mechanical ventilation
  - COPD, pneumonia, or sepsis
  - Comparisons
  - Routine care, sham, contralateral side

---

Current evidence: NMES parameters and Outcomes

- NMES intervention parameters varied
  - Visible contraction (most); max tolerable
  - Daily duration: 30 min BID to ~60 min OD
  - Number of days per week: 4 – 7
- Outcomes
  - Body structure: microcirculation, muscle circumference/ area/ volume/ thickness
  - Body function: muscle strength
  - Activity: time to transfer from bed to chair
  - None measured beyond ICU awakening


---

NMES: Selected results

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Patients</th>
<th>NMES</th>
<th>No NMES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muscle strength</td>
<td>Chronic</td>
<td>3.8/5.0</td>
<td>3.1/5.0</td>
</tr>
<tr>
<td>Transfer from bed to chair</td>
<td>Chronic</td>
<td>11 days</td>
<td>14 days</td>
</tr>
<tr>
<td>Quadriceps muscle volume</td>
<td>Acute</td>
<td>-20%</td>
<td>-16%</td>
</tr>
<tr>
<td>ICU-acquired weakness at awakening</td>
<td>Acute</td>
<td>13%</td>
<td>39%</td>
</tr>
<tr>
<td>Leg muscle strength</td>
<td>Acute</td>
<td>29/30</td>
<td>25/30</td>
</tr>
</tbody>
</table>

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3 Routsi et al., Critical Care. 2010. 14:874.
Is NMES ready for clinical use?

**Strengths**
- Can be initiated in sedated patients
- Can occur in supine
- Single person implementation
- Provides "something"

**Limitations**
- Completely non-volitional modality
- Impaired current delivery: obesity, edema
- Opportunity cost of limited therapist time
- No outcomes beyond ICU awakening (yet)

---

### Treatment Strategies: Cycle Ergometry

**RCT of cycling in the ICU**

<table>
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<tr>
<th>Group</th>
<th>N</th>
<th>Treatment</th>
<th>Primary outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (5d/wk)</td>
<td>26</td>
<td>Respiratory PT</td>
<td>143 m [37-226m]</td>
</tr>
<tr>
<td>Control (5d/wk)</td>
<td>32</td>
<td>A/PROM U/L/E</td>
<td>196 m [126-329m]</td>
</tr>
</tbody>
</table>

Burtin et al., Crit Care Med. 2009. 37(9): 2499-2505.

**Results**

<table>
<thead>
<tr>
<th></th>
<th>Control (5d/wk)</th>
<th>Treatment (5d/wk)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>45 randomized</td>
<td>45 randomized</td>
</tr>
<tr>
<td>N complete data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary outcome</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6MWT @ hospital d/c</td>
<td>143 m [37-226m]</td>
<td>196 m [126-329m]</td>
</tr>
</tbody>
</table>

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### Treatment Strategies: Cognitive Therapy and PT

**Purpose**: Develop and implement a cognitive therapy protocol that could be implemented early during critical illness

**Setting**: MICU and SICU at Vanderbilt University Medical Center

**Participants**: Adults (> 18 y.o.) being treated for respiratory and/or septic, cardiogenic, or hemorrhagic shock

Feasibility and safety of early combined cognitive and physical therapy for critically ill medical and surgical patients: the Activity and Cognitive Therapy in ICU (ACT-ICU) trial

**Protocol:**

1: Usual Care  
N=22

2: Early Once Daily PT  
N=22

3: Early Once Daily PT + Cognitive Therapy  
N=43

**Results**

Cognitive, functional, and health-related QOL outcomes did not differ between groups at 3-month follow-up (pilot study)

**Objective:** Examine safety & feasibility of a commercially-available videogame (Nintendo Wii™) in the ICU

IRB-approved observational study:

- Adults admitted to 16-bed MICU from 9/2009 – 8/2010
- Videogames as part of routine PT treatment

**Data collection:**

- Severity of illness - APACHE II
- Indications & types of Wii™ activities

**Prospective evaluation of safety events:**

- Line or tube removal
- Cardiovascular / respiratory complications
- Other complications (e.g., fall)

Of 410 MICU PT patients, 22 had total of 42 PT sessions including videogames.

Age, median years [IQR]  
52 [24, 64]

Male, N (%)  
14 (64)

APACHE II Score, median [IQR]  
17 [14, 22]

ICU admission diagnosis, N (%)  
Respiratory failure 15 (68)

Received mechanical ventilation during MICU stay, N (%)  
14 (64)

MICU length of stay, median [IQR] days  
8.5 [2.8, 28.8]

Hospital length of stay, median [IQR] days  
30.5 [8.9, 52.3]

Days from initial PT to videogame therapy, median [IQR]  
3.0 [1.0, 7.3]

Average no. videogame therapy sessions, median [IQR]  
1.0 [1.0, 2.0]

Common indications for the 42 videogame therapy sessions included balance and endurance.

<table>
<thead>
<tr>
<th>Indication</th>
<th>% Patients</th>
</tr>
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<tbody>
<tr>
<td>Balance</td>
<td>53</td>
</tr>
<tr>
<td>Endurance</td>
<td>45</td>
</tr>
<tr>
<td>Range of Motion</td>
<td>7</td>
</tr>
<tr>
<td>Other</td>
<td>24</td>
</tr>
</tbody>
</table>

**Therapeutic Indications**

**Other** includes therapeutic exercise (14%), neuromuscular re-education (5%), strengthening (2%), and posture (2%)

The most common videogame activities included boxing, bowling, and use of the balance board.

<table>
<thead>
<tr>
<th>Activity</th>
<th>% Patients</th>
</tr>
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<tbody>
<tr>
<td>Boxing</td>
<td>38</td>
</tr>
<tr>
<td>Bowling</td>
<td>24</td>
</tr>
<tr>
<td>Tennis</td>
<td>21</td>
</tr>
<tr>
<td>Golf</td>
<td>7</td>
</tr>
<tr>
<td>Wii Fit Exercise</td>
<td>6</td>
</tr>
<tr>
<td>Wii Fit Skiing</td>
<td>2</td>
</tr>
<tr>
<td>Wii Fit Bowling</td>
<td>2</td>
</tr>
<tr>
<td>Wii Fit Soccer</td>
<td>2</td>
</tr>
<tr>
<td>Wii Fit Football</td>
<td>1</td>
</tr>
</tbody>
</table>
Of 42 videogame therapy sessions over 35 hours, 45% occurred on mechanical ventilation.

No safety events occurred: 0% events (95% upper confidence limit = 8.4%)

<table>
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<tr>
<th>Airways</th>
<th>% patients</th>
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<td>0</td>
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<td>Tracheostomy</td>
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