Improving Patient Outcomes,
One Move at a Time

MICU Resident Lecture Series
Updated July 2015
Bryan J. McVerry, MD
Deconditioning is a common complication of critical illness

- Healthy adults experience decreased strength and lean body mass after 10 days in bed
- Acquired muscle weakness has been reported in as many as 75% of patients with severe sepsis and has been associated with mortality
  - Predisposing factors in the ICU include inactivity, inflammation, drugs (corticosteroids, sedatives, neuromuscular blockers)
- Loss of muscle mass most pronounced during the first 2-3 weeks of immobilization / ICU stay
- Functional limitation may be prolonged

Curtin et al Crit Care Med 2009; 37: 2499
Kortebein et al JAMA 2007; 297: 1772
Musculoskeletal Consequences of Immobility

- Skeletal muscle mass declines 1-1.5% per day in strict bed rest patients
  - Muscle weakness/ reduced protein synthesis
  - Joint contractures (Hip/knee flexion)
  - Poor endurance, proximal muscle weakness
  - Osteoporosis
  - Impaired balance → fall risk
  - Muscle atrophy, sarcopenia


Image credit: www.medpreps.com
Cardiovascular Consequences of Immobility

- Immobility results in notable reductions in
  - VO2 max
    - Decline of 12% in 10 days of bed rest
  - Cardiac output
    - Stroke volume
    - Venous return
      - Orthostatic hypotension
        → FALL RISK
- Predisposition to DVT

Image credit: Blue Cross Blue Shield
Neuropsychological Consequences of Immobility

• Immobility contributes to
  – Delirium
  – Depression/Anxiety/Emotional lability
  – Cognitive deficits: disorientation, memory, attention, concentration, executive function
  – Sleep/wake dysregulation
  – Critical illness polyneuropathy

Image credit: http://newsatjama.jama.com/
Why are consequences of immobility important for critical care docs?

- More people are surviving critical illness in the 21st century
- These data demonstrate control group mortality from the major ARDS trials since 1987

Control Group Fatality Rate

- Steroids (1987)
- PGE1 (1989)
- Surfactant (1996)
- ARMA (2000)
- FACTT (2006)
- B Agonist (2011)
Survivors frequently rate health poorly one year after prolonged mechanical ventilation

<table>
<thead>
<tr>
<th>Health Status</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>7.7</td>
</tr>
<tr>
<td>Very Good</td>
<td>17.4</td>
</tr>
<tr>
<td>Good</td>
<td>38.1</td>
</tr>
<tr>
<td>Fair</td>
<td>25.8</td>
</tr>
<tr>
<td>Poor</td>
<td>11</td>
</tr>
</tbody>
</table>

- 25% of patients rated their health worse one year after prolonged mechanical ventilation than prior
Survivors of ARDS remain functionally limited 5 years after discharge

<table>
<thead>
<tr>
<th>Outcome</th>
<th>One Year (n=83)</th>
<th>Five Years (n=64)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Median</td>
<td>% Pred</td>
</tr>
<tr>
<td>Six minute walk (meters)</td>
<td>422</td>
<td>66</td>
</tr>
<tr>
<td>SF-36 Score</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical Functioning</td>
<td>60</td>
<td>67</td>
</tr>
<tr>
<td>General Health</td>
<td>52</td>
<td>68</td>
</tr>
<tr>
<td>Vitality</td>
<td>55</td>
<td>81</td>
</tr>
<tr>
<td>Social Functioning</td>
<td>63</td>
<td>72</td>
</tr>
<tr>
<td>Emotional Role</td>
<td>100</td>
<td>119</td>
</tr>
<tr>
<td>Mental Health</td>
<td>72</td>
<td>92</td>
</tr>
</tbody>
</table>

Return to Work*  48%  77%

*depression, PTSD, muscle weakness and fatigue, short-term memory loss

18% loss of body weight at 1 year

The Post-Intensive Care Syndrome is increasingly described in survivors of critical illness and their families.


Davidson et al CCM 2013;41:S136
Historically, Early Mobility was Standard

- Early ambulation in hospitalized patients was introduced in WWII [Rheum Dis Clin NA 1990; 16: 791]

  - “First morale is greatly improved…General health and strength are better maintained and convalescence is more rapid”

- Thomas Petty comparing today to 1964 [CHEST 1998;114:360]
  - “When we started our ICU in 1964, patients who required mechanical ventilation were awake and alert and often sitting in a chair…”
  - “When I make rounds in critical care units these days…I see…paralyzed sedated patients, lying without motion, appearing to be dead, except for the monitors that tell me otherwise.”
  - “Patients – cannot even maintain muscular tone…”

Courtesy of Dale Needham
Historically, patients in our MICU remained sedated and on bed rest until extubation.

- In 2010 in our ICU
  - Bedrest was common
  - Sedation Interruption (SI) protocol was not routinely followed
  - Benzodiazepine use was high

Data July 2010

N=85
Ventilated Patients

- # SBT completed
- # SI completed
- # PT consult ordered
- # OOB orders
- # OOB completed
Deconditioning is common with standard approach to mobilization in the MICU.

Early mobilization is designed to move the PT intervention earlier in the ICU stay to prevent functional deterioration.

Physical Rehabilitation in the ICU involves shifting the paradigm to involve PT early after intubation.
Early mobilization of ICU patients has gained considerable interest in recent years

- To demonstrate feasibility 103 patients underwent >1400 activity events over 6 month period
  - Median APACHE II = 21
  - 41% in patients with endotracheal tube
    - 42% ambulation
- Adverse events <1%
  - Falls to knees, desaturation, hypo/hypertension
  - NO ETT removals
- Required stability prior to initiation

Adapted from Bailey et al Crit Care Med 2007;35:139
PT/OT may be safely initiated soon after intubation

- 357 therapy sessions on 395 MICU days
  - onset 1.0-2.1 days

- 68% during mechanical ventilation
  - 69% Sit
  - 33% Stand
  - 33% Chair
  - 67% Simulate Eating
  - 15% Ambulate

- Premature termination 4%

Pohlman et al Crit Care Med 2010;38: 2089
Does early PT/OT intervention improve outcomes in critical illness?

Early physical and occupational therapy in mechanically ventilated, critically ill patients: a randomised controlled trial

William D Schweickert, Mark C Pohlman, Anne S Pohlman, Celerina Nigos, Amy J Pawlik, Cheryl L Esbrook, Linda Spears, Megan Miller, Mietka Franczyk, Deanna Deprizio, Gregory A Schmidt, Amy Bowman, Rhonda Barr, Kathryn E McCallister, Jesse B Hall, John P Kress

Schweickert et al Lancet 2009; 373: 1874-82
Inclusion Criteria

• Patients ≥ 18yo admitted to the MICU
• Mechanical ventilation < 72 hr
• Baseline functional independence
  – Barthel Index ≥ 70 (proxy assessment)
    • 1-100 scale with >70 indicative of independent functionality
• Absence of:
  – Rapidly developing neuromuscular disease
  – Cardiopulmonary arrest
  – 6 month mortality >50%
  – Raised ICP
  – Absent limbs

Schweickert et al Lancet 2009; 373: 1874-82
Study Intervention

• Intervention
  – Exercise and mobilization protocol initiated upon enrollment

• Control
  – PT/OT as ordered by care team

• ALL patients underwent daily sedation interruption

Schweickert et al Lancet 2009; 373: 1874-82
Subjects look like typical MICU population

<table>
<thead>
<tr>
<th></th>
<th>Intervention (n=49)</th>
<th>Control (n=55)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>57.7 (36.3–69.1)</td>
<td>54.4 (46.5–66.4)</td>
</tr>
<tr>
<td>Female</td>
<td>59%</td>
<td>42%</td>
</tr>
<tr>
<td>Black race</td>
<td>61%</td>
<td>56%</td>
</tr>
<tr>
<td>Barthel Index score</td>
<td>100 (85–100)</td>
<td>100 (90–100)</td>
</tr>
<tr>
<td>APACHE II score</td>
<td>20.0</td>
<td>19.0</td>
</tr>
<tr>
<td>Primary diagnosis on admission to intensive care</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALI</td>
<td>55%</td>
<td>56%</td>
</tr>
<tr>
<td>COPD exac</td>
<td>8%</td>
<td>11%</td>
</tr>
<tr>
<td>Acute asthma</td>
<td>10%</td>
<td>7%</td>
</tr>
<tr>
<td>Sepsis</td>
<td>14%</td>
<td>16%</td>
</tr>
<tr>
<td>Haemorrhage</td>
<td>2%</td>
<td>4%</td>
</tr>
<tr>
<td>Malignancy</td>
<td>4%</td>
<td>2%</td>
</tr>
<tr>
<td>Other</td>
<td>6%</td>
<td>4%</td>
</tr>
</tbody>
</table>

Adapted from Schweickert et al Lancet 2009; 373: 1874-82
Protocol adherence and therapies evenly distributed

- 100% compliance with daily interruption of sedation
- Trend toward reduced duration of sedation in intervention group
  - 2.7 vs. 4.3 days (p=0.06)
- No difference in nutrition or glycemic control
- Intervention group fewer desaturation events during sedation interruption
  - (2% vs. 6%, p=0.08)

Schweickert et al Lancet 2009; 373: 1874-82
Early mobilization improved functionality at hospital discharge

<table>
<thead>
<tr>
<th></th>
<th>Intervention (n=49)</th>
<th>Control (n=55)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Independently functional at discharge</td>
<td>29 (59%)</td>
<td>19 (35%)</td>
<td>0.02</td>
</tr>
<tr>
<td>Discharge Barthel Index</td>
<td>75 (7.5–95)</td>
<td>55 (0–85)</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Schweickert et al Lancet 2009; 373: 1874-82
More patients in the early mobilization group were discharged to home after hospitalization.

Adapted from Schweickert et al. Lancet 2009; 373: 1874-82
Early mobilization improved performance of ADL upon discharge

Adapted from Schweickert et al Lancet 2009; 373: 1874-82
Early mobilization improved 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 (0.0–6.0)</td>
<td>4.0 (2.0–7.0)</td>
<td>0.03</td>
</tr>
<tr>
<td>Time in ICU with delirium (%)</td>
<td>33% (0–58)</td>
<td>57% (33–69)</td>
<td>0.02</td>
</tr>
<tr>
<td>Hospital delirium (days)</td>
<td>2.0 (0.0–6.0)</td>
<td>4.0 (2.0–8.0)</td>
<td>0.02</td>
</tr>
<tr>
<td>Hospital days with delirium (%)</td>
<td>28% (26)</td>
<td>41% (27)</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Adapted from Schweickert et al. Lancet 2009; 373: 1874-82
Early mobilization increased days breathing free of the ventilator but had no impact on LOS or mortality.

<table>
<thead>
<tr>
<th></th>
<th>Intervention (n=49)</th>
<th>Control (n=55)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ventilator-free days*</td>
<td>23.5 (7.4–25.6)</td>
<td>21.1 (0.0–23.8)</td>
<td>0.05</td>
</tr>
<tr>
<td>Length of stay in ICU (days)</td>
<td>5.9 (4.5–13.2)</td>
<td>7.9 (6.1–12.9)</td>
<td>0.08</td>
</tr>
<tr>
<td>Length of stay in hospital (days)</td>
<td>13.5 (8.0–23.1)</td>
<td>12.9 (8.9–19.8)</td>
<td>0.93</td>
</tr>
<tr>
<td>Hospital mortality</td>
<td>9 (18%)</td>
<td>14 (25%)</td>
<td>0.53</td>
</tr>
</tbody>
</table>

Adapted from Schweickert et al Lancet 2009; 373: 1874-82
Study Limitations

• Resource intensive intervention may limit generalizability

• Lack of blinding
  – Assessors blinded to intervention
  – Patients, families, and practitioners not blinded

• Learning effect?
  – Is this a weakness of the study?
  – Goal of PT/OT is learning to cope with disability
  – If anything this would bias against the mobility intervention
Summary

• When combined with sedation interruption / minimization
  – Early mobilization is safe
  – Early mobilization improves functionality at the time of hospital discharge
  – Early mobilization reduces delirium
Early mobilization has since been demonstrated to improve long term outcomes

- Early introduction of physical rehabilitation in the ICU has been demonstrated to:
  - Improve physical function and quality of life in ICU survivors
  - Reduce duration of mechanical ventilation (MV) and ICU and hospital LOS
Early ICU Rehabilitation Reduces Duration of Mechanical Ventilation

### A

<table>
<thead>
<tr>
<th>Randomised Controlled Trials</th>
<th>Statistics for each study</th>
<th>Hedge’s g and 95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hedge’s g</td>
<td>Lower Limit</td>
</tr>
<tr>
<td>Ventilator-Free Days</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Routsi et al 2010(30)</td>
<td>0.51</td>
<td>0.17</td>
</tr>
<tr>
<td>Schweickert et al 2009(31)</td>
<td>0.39</td>
<td>0.00</td>
</tr>
<tr>
<td>Burtin et al 2009(32)</td>
<td>0.18</td>
<td>-0.23</td>
</tr>
<tr>
<td>Pooled Effect Size (n=334)</td>
<td>0.38</td>
<td>0.16</td>
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</tbody>
</table>

Kayambu et al; *Crit Care Med* 2013; 41:1543-54
Early ICU rehabilitation reduces length of stay

<table>
<thead>
<tr>
<th>Outcome Measure</th>
<th>Ctrl Period (May–August 2006)</th>
<th>QI Period (May–August 2007)</th>
<th>Relative Change (%)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>MICU average LOS, d</td>
<td>7</td>
<td>4.9</td>
<td>↓30</td>
<td>0.02</td>
</tr>
<tr>
<td>Hospital average LOS, d</td>
<td>17.2</td>
<td>14.1</td>
<td>↓18</td>
<td>0.03</td>
</tr>
<tr>
<td>In-hospital mortality (%)</td>
<td>23.3</td>
<td>21</td>
<td>↓10</td>
<td>0.55</td>
</tr>
</tbody>
</table>

Early ICU rehabilitation reduces length of stay

### B.

<table>
<thead>
<tr>
<th>Randomised Controlled Trials</th>
<th>Statistics for each study</th>
<th>Hedge’s g and 95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hedge’s g</td>
<td>Lower Limit</td>
</tr>
<tr>
<td><strong>Length of Hospital Stay</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Schweickert et al 2009(31)</td>
<td>-0.02</td>
<td>-0.40</td>
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<tr>
<td>Burtin et al 2009(32)</td>
<td>-0.30</td>
<td>-0.72</td>
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<tr>
<td>Muehling et al 2009(34)</td>
<td>-0.49</td>
<td>-0.89</td>
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<td>Muehling et al 2008(33)</td>
<td>-0.43</td>
<td>-0.87</td>
</tr>
<tr>
<td>Delanay et al 2003(38)</td>
<td>-0.58</td>
<td>-1.08</td>
</tr>
<tr>
<td><strong>Pooled Effect Size (n=441)</strong></td>
<td>-0.34</td>
<td>-0.53</td>
</tr>
</tbody>
</table>

Favors PT  Favors standard care

Kayambu et al; *Crit Care Med* 2013; 41:1543-54
Early Mobilization in Presby MICU

- Pilot project to evaluate the feasibility, safety, efficacy, and cost effectiveness of early mobility through the employment of dedicated physical therapy support for the acute respiratory failure patients in the MICU

- Coupled with alteration in sedation algorithm according to SCCM guidelines for management of pain, agitation, and delirium
Early Mobilization in Presby MICU

- 3 month trial with dedicated PT for acute respiratory failure patients
- Multidisciplinary participation (PT, Nursing, Respiratory)
- Implementation of a delirium assessment tool (ICDSC)
- Streamline sedation management
- Implementation of weekly mobility rounds with clinical experts from Critical Care Medicine, PM&R, PT, Nursing focusing on patient specific activity and barriers
- Evaluate safety, numbers of PT interventions and level achieved in mobility protocol
- Evaluate effect on outcomes (e.g. LOS)
Enrollment Criteria

Mobility Criteria:
• Age greater 17
• Mechanically ventilated
• Able to follow simple commands prior to admission to the MICU

Relative Contraindications
• Potentially lethal arrhythmia in last 24 hr
• Current or recent myocardial ischemia without revascularization
• Acute PE

Relative Contraindications (cont)
• Mobility risk related to spinal injury
• Tenuous Airway
• Status Epilepticus
• Continuous Paralytic
• Actively Titrating Vasopressors
• Severe Agitation
• Premorbid immobility with contractures
• CVVHD via Femoral Catheter
• Active Bleeding
• CMO
**MICU Mobility Protocol**

**LEVEL 1**
Passive Range of Motion

**ASSESSMENT**
- Sedated
- Does not follow commands

**ACTION**
- Screen Range of Motion
- Turn patient Q2 hours
- Initiate Passive Range of Motion
  - Bedside PROM
  - Begin Motomed
    - Lower Extremities
      - 20 min at 20 RPMs daily
    - Upper Extremities
      - 10 min at 10 RPMs daily
- Dependent Slide to Chair or sit upright 60 degrees
  - Check orthostatics
    - If positive return patient to recumbent position and notify MD

**LEVEL 2**
Active Range of Motion

**ASSESSMENT**
- Awake
- Follows simple commands

**ACTION**
- Does patient require assist to sit EOB?
  - NO
    - Assist pt to Edge of Bed
      - 2X/day
      - 2 - 10 min sessions of LE on AROM 1-3 sets of 10 reps as tolerated by pt
      - 2X/day
      - Progress to Level 3
  - YES
    - Return to supine and dependent slide to chair
      - AROM 1-3 sets of 10 reps as tolerated by 2X/day
    - Dependent slide to chair
    - Check mobility protocol under special instructions
      - Check Orthostatics
        - If positive return patient to recumbent position and notify MD
    - Consult PT

**LEVEL 3**
Edge of Bed to Out of Bed

**ASSESSMENT**
- Awake
- Follows simple commands

**ACTION**
- Did patient tolerate edge of bed activity?
  - YES
    - Attempt Sit to Stand
      - 2X/day
    - Progress to marching
      - 2X/day
    - Attempt steps to chair
    - Work with PT on plan to progress to Level 4
  - NO
    - Dependent slide to chair with nursing continue Level 2
    - Check mobility protocol under special instructions
      - Check Orthostatic
        - If positive return patient to recumbent position and notify MD

**LEVEL 4**
Ambulation

**ASSESSMENT**
- Awake
- Follows simple commands

**ACTION**
- Is patient able to stand/pivot or take steps to chair?
  - YES
    - Work with PT on mobility plan
    - Attempt Sit to Stand
      - 2X/day
    - Attempt marching > 30 sec
    - Stand Pivot Transfer with assist progress to ambulation with Mobility Team increase distance as tolerated
  - NO
    - Continue Level 3
## Mobility Interactions January 7 – March 30, 2013

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of Patients</strong></td>
<td>94</td>
</tr>
<tr>
<td><strong>Mobility Interactions</strong></td>
<td>528</td>
</tr>
<tr>
<td><strong>PT Interventions</strong></td>
<td>334</td>
</tr>
<tr>
<td><strong>% PT Intervention</strong></td>
<td>63</td>
</tr>
<tr>
<td><strong>Average Occurrence/Patient</strong></td>
<td>5.6</td>
</tr>
</tbody>
</table>

### Reasons for Exclusion:

<table>
<thead>
<tr>
<th>Reason</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMO/CTB:</td>
<td>9</td>
</tr>
<tr>
<td>Plan of care (= too sedated)</td>
<td>52</td>
</tr>
<tr>
<td>Medically unstable (= care team uncomfortable or met exclusion)</td>
<td>53</td>
</tr>
<tr>
<td>Intubation/extubation/trach:</td>
<td>10</td>
</tr>
<tr>
<td>IR/OR/Procedure/Tests:</td>
<td>20</td>
</tr>
<tr>
<td>Agitation:</td>
<td>8</td>
</tr>
<tr>
<td>On HD:</td>
<td>8</td>
</tr>
<tr>
<td>Transferred/Off floor/DC:</td>
<td>12</td>
</tr>
<tr>
<td>No command following/pending funct eval:</td>
<td>3</td>
</tr>
<tr>
<td>Nurse had gotten up/returned to bed:</td>
<td>2</td>
</tr>
<tr>
<td>Switch from PT to mobility/OT:</td>
<td>3</td>
</tr>
</tbody>
</table>
Goal of early rehabilitation is to prevent deconditioning and promote functionality while in the hospital.

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Occurrences</th>
<th>Patients</th>
<th>MV Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Participation (1):</td>
<td>192</td>
<td>73*</td>
<td>61</td>
</tr>
<tr>
<td>Passive ROM (2):</td>
<td>126</td>
<td>52</td>
<td>48</td>
</tr>
<tr>
<td>Active ROM (3):</td>
<td>32</td>
<td>21</td>
<td>15</td>
</tr>
<tr>
<td>Edge of Bed (4):</td>
<td>43</td>
<td>25</td>
<td>18</td>
</tr>
<tr>
<td>Out of Bed to Chair (5):</td>
<td>21</td>
<td>16</td>
<td>6</td>
</tr>
<tr>
<td>Standing (6):</td>
<td>68</td>
<td>36</td>
<td>15</td>
</tr>
<tr>
<td>Marching in Place (7):</td>
<td>7</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Walking (8):</td>
<td>36</td>
<td>15</td>
<td>5</td>
</tr>
</tbody>
</table>

* 12 failed to progress to higher level
Goal of early rehabilitation is to prevent deconditioning and promote functionality while in the hospital

- 25 patients sat at the edge of the bed on 43 occasions
  - 18 while mechanically ventilated
  - Image to left taken on $F_{iO_2}$ 60% PEEP 10 cmH$_2$O with CVVHD running through left internal jugular catheter
Goal of early rehabilitation is to prevent deconditioning and promote functionality while in the hospital

- 25 patients sat at the edge of the bed (EOB) on 43 occasions
  - 18 while mechanically ventilated
  - Image to left taken on \( F_iO_2 \) 100% PEEP 20 cmH\(_2\)O
Goal of Early Rehabilitation is to Promote Functionality and Prevent Deconditioning while in the Hospital

- 15 patients ambulated on 36 occasions
  - 5 while mechanically ventilated
Important Notes

- This is a sick group
  - Must be intubated to qualify
  - Mortality 24% (23/94)
  - 28% progressed to chronic respiratory failure (26/94)
    - Defined by placement of tracheostomy tube

- Only 13% did not receive any PT intervention
  - Due to medical instability as defined by treating physician
Overall hospital length of stay decreased in ALL patients with MICU stay during hospitalization

<table>
<thead>
<tr>
<th>Timeframe</th>
<th>Number of Accounts</th>
<th>Total Hospital ALOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012 (Jan-May)</td>
<td>531</td>
<td>13.21</td>
</tr>
<tr>
<td>2013 (Jan-May)</td>
<td>541</td>
<td>11.98</td>
</tr>
<tr>
<td>Variance</td>
<td></td>
<td>(1.24)</td>
</tr>
</tbody>
</table>

- Remember, patients had to be mechanically ventilated with acute respiratory failure to qualify for intervention
- LOS data from **ALL** patients with MICU stay during hospitalization for defined time period
Mobility in the ICU is safe

- <10% of sessions interrupted for safety concern
  - Majority sustained desaturation $S_pO_2 < 90%$
    - Conservative definition – up to 2 minutes
  - 1 syncope episode with spontaneous recovery
    - When sat up in bed
  - 1 AICD discharge – AF with aberrant conduction and RVR
  - 0 Falls / Assist to floor
  - 0 CVC, feeding tube dislodgement
  - 1 partial ETT dislodgement
  - <10% Rectal tube dislodgement
Barriers to Mobilization in ICU

- Time requirements and adequate staffing
- Need for staff training
- Need for team work and coordination
- Over-sedation of ICU patients
- Dislodgement of devices (CVC, Feeding tube, ET tube)
- Worsening gas exchange
- Unstable hemodynamics
- Inadequate patient comfort, pain control
Target awake and breathing ASAP after intubation and initiation of mechanical ventilation

- Use whatever is needed to sedate for crisis/intubation
- Frequent reassessment of sedation needs
  - Starting at 4 hours after intubation
- Favor intermittent sedative/analgesic dosing
  - If infusion necessary favor shorter acting drug
    - Fentanyl, propofol, dexmedetomidine
- Limit benzodiazepine infusions
  - Favor intermittent dosing if need benzodiazepines
- If not candidate for sedation interruption reduce by 20% and reassess needs
- Routine delirium assessment
  - Non-pharmacologic prevention/treatment
  - Medicate if necessary
Early implementation of ICU rehabilitation best done as a bundle (ABCDE)

<table>
<thead>
<tr>
<th>Awakening and Breathing</th>
<th>Safety Screen Criteria—Conditions for Exclusion</th>
<th>Pass/Fail Criteria—Conditions Denoting Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spontaneous awakening trial</td>
<td>1) Active seizures 2) Alcohol withdrawal 3) Neuromuscular blockade 4) Control of increased ICP 5) ICP &gt; 20 mm Hg 6) Receiving ECMO 7) Documentation of MI in past 24 hr 8) Current RASS &gt; 2</td>
<td>1) RASS score &gt; 2 for ≥ 5 min 2) Pulse oximetry reading &lt; 88% for ≥ 5 min 3) Respirations &gt; 35 breaths/min for ≥ 5 min 4) Acute cardiac arrhythmia 5) ICP &gt; 20 mm Hg 6) Two or more of the following: heart rate increase ≥ 20 BPM, heart rate &lt; 55 BPM, use of accessory muscles, abdominal paradox, diaphoresis, or dyspnea</td>
</tr>
<tr>
<td>Spontaneous breathing trial</td>
<td>1) Chronic ventilator dependence 2) Pulse oximetry reading &lt; 88% 3) $F_O_2$$ &gt; 50%$ 4) Set PEEP &gt; 7 5) ICP &gt; 20 mm Hg 6) Receiving mechanical ventilation in an attempt to control ICP 7) Documentation of MI in past 24 hr 8) Increasing doses of vasopressor medications 9) Lack of inspiratory effort</td>
<td>1) Respiratory rate &gt; 35 breaths/min for ≥ 5 min 2) Respiratory rate &lt; 8 3) Pulse oximetry reading &lt; 88% &gt; 5 min 4) ICP &gt; 20 mm Hg 5) Mental status changes 6) Acute cardiac arrhythmia 5) Two or more of the following: use of accessory muscles, abdominal paradox, diaphoresis, and dyspnea</td>
</tr>
<tr>
<td>Early exercise/mobility</td>
<td>1) RASS &lt; -3 2) $F_O_2$$ &gt; 0.6$ 3) Set PEEP &gt; 10 cm H₂O 4) Increasing doses of vasopressor infusions in the last 2 hr 5) Evidence of active MI 6) Administration of a new antiarrhythmic agent 7) Receiving therapies that restricted mobility (e.g., ECMO and open abdomen) 8) Injuries in which mobility is contraindicated (e.g., unstable fractures)</td>
<td>1) Symptomatic drop in mean arterial pressure 2) Heart rate &lt; 50 or &gt; 130 BPM ≥ 5 min 3) Respiratory rate &lt; 5 or &gt; 40 breaths/min ≥ 5 min 4) Systolic blood pressure &gt; 180 mm Hg ≥ 5 min 5) Pulse oximetry reading &lt; 88% ≥ 5 min 6) Marked ventilator dyssynchrony 7) Patient distress 8) New arrhythmia or evidence of active MI 9) Concern for airway device integrity or endotracheal removal 10) Fall to knees</td>
</tr>
</tbody>
</table>

RASS = Richmond Agitation-Sedation Scale, ICP = intracranial pressure, ECMO = extracorporeal membrane oxygenation, BPM = beats per minute, MI = myocardial ischemia, PEEP = positive end-expiratory pressure.

• Protocol for implementation of ABCDE bundle proposed by Balas and colleagues

Balas et al CCM 2014;42:1024
Early implementation of ICU rehabilitation best done as a bundle (ABCDE)

AWAKENING: Applied daily to patients receiving continuous sedative medications and mechanical ventilation - RN driven

Every 24 hours

SAT Safety Screen

Pass

Perform SAT

Pass

Every 24 hours

COORDINATION: Prompt performance of SBT Safety

BREATHING: Applied daily to patients receiving mechanical ventilation - RT driven

Every 24 hours

SBT Safety Screen

Pass

Perform SBT

Pass

Every 24 hours

COORDINATION: If SBT tolerated for > 2 hours, prompt extubation

DELIRIUM MONITORING/MANAGEMENT: Applied daily to all patients - RN driven

Every 24 hours

Administer RASS every 2 hours

Administer CAM-ICU every 8 hours

Every 24 hours

COORDINATION: Discuss RASS, CAM-ICU, and treatment plans

EARLY EXERCISE/MOBILITY: Applied daily to all patients - RN/PT driven

Every 24 hours

Exercise/Mobility Safety Screen

Pass

Perform Exercise/Mobility

Pass

Every 24 hours

COORDINATION: Discuss mobility progression on daily rounds

Balas et al CCM 2014;42:1024
## TABLE 3. Effectiveness Outcomes of ABCDE Bundle Implementation

<table>
<thead>
<tr>
<th>ABCDE Bundle Component Outcome</th>
<th>Pre-ABCD Bundle (n = 146)</th>
<th>Post-ABCD Bundle (n = 150)</th>
<th>Unadjusted p</th>
<th>Adjusted Odds Ratio</th>
<th>Adjusted p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Awakening and breathing coordination*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ventilator-free days*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (±)</td>
<td>15 (11.4)</td>
<td>18 (10.6)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>21 (0–25)</td>
<td>24 (7–26)</td>
<td>0.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delirium monitoring/management</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delirium anytime, n (%)</td>
<td>91 (62.3)</td>
<td>73 (48.7)</td>
<td>0.02</td>
<td>0.55* (0.33–0.93)</td>
<td>0.03</td>
</tr>
<tr>
<td>Duration of delirium, days, median (IQR)</td>
<td>3 (1–6)</td>
<td>2 (1–4)</td>
<td>0.52</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent ICU days spent delirious, median (IQR)</td>
<td>50 (30–64.3)</td>
<td>33.3 (18.8–50)</td>
<td>0.003</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coma anytime, n (%)</td>
<td>41 (28.1)</td>
<td>43 (28.7)</td>
<td>0.91</td>
<td>1.00*</td>
<td>0.99</td>
</tr>
<tr>
<td>Coma days, median (IQR)</td>
<td>2 (1–4)</td>
<td>2 (1–5)</td>
<td>0.35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent ICU days spent in coma, median (IQR)</td>
<td>25 (18.2–44.4)</td>
<td>25 (12.5–42.9)</td>
<td>0.89</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Richmond Agitation-Sedation Scale Score, mean (±)</td>
<td>0.02 (1.4)</td>
<td>-1.03 (1.2)</td>
<td>0.38</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Early exercise/mobility</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mobilized out of bed anytime in ICU, n (%)</td>
<td>70 (48)</td>
<td>99 (66.0)</td>
<td>0.002</td>
<td>2.11* (1.30–3.45)</td>
<td>0.003</td>
</tr>
<tr>
<td>28-day mortality*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospital mortality (ICU and post-ICU), n (%)</td>
<td>29 (19.9)</td>
<td>17 (11.3)</td>
<td>0.04</td>
<td>0.56* (0.28–1.10)</td>
<td>0.09</td>
</tr>
<tr>
<td>ICU mortality, n (%)</td>
<td>24 (16.4)</td>
<td>14 (9.3)</td>
<td>0.07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time to discharge*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>From ICU, median (IQR)</td>
<td>5 (3, 8)</td>
<td>4 (3, 5)</td>
<td>0.21</td>
<td>1.16* (0.89–1.50)</td>
<td>0.27</td>
</tr>
<tr>
<td>From hospital, median (IQR)</td>
<td>13 (9, 15)</td>
<td>11 (9, 13)</td>
<td>0.99</td>
<td>1.01* (0.77–1.31)</td>
<td>0.96</td>
</tr>
</tbody>
</table>
Take Home

- Minimize sedation
- Implement physical rehabilitation early in the course of the ICU stay
- Your patients will appreciate your efforts
Special Thanks

- Catherine Wittman, MD
- MICU Mobility Team
  - PT
  - MICU Nurses
  - MICU Respiratory Therapists
  - MICU Pharmacists
  - UPMC IM Residents
  - UPMC PACCM Fellows
  - UPMC PACCM Faculty
  - UPMC PM&R Faculty
- UPMC Presbyterian Administration
- UPMC Presbyterian MICU Leadership
- UPMC Presbyterian PT Department Leadership
- Beckwith Foundation
- Dale Needham, MD PhD
  - www.hopkinsmedicine.org/OACIS