Early Progressive Mobility is a Must

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Disclosures for Kathleen Vollman

- Consultant-Michigan Hospital Association Keystone Center
- Consultant/Faculty for CUSP for MVP—AHRQ funded national study
- Subject matter expert for CAUTI and CLABSI for CMS/HEN 1.0 & 2.0
- Consultant and speaker bureau for Sage Products LLC
- Consultant and speaker bureau for Hill-Rom Inc
- Consultant and speaker bureau for Eloquest Healthcare
- Niveus medical

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Learning Objectives
At the completion of this activity, the participant will be able to:

- Build the will to understand the significance of early mobility
- Identify and discuss key in-bed and out of bed mobility techniques to successfully achieve your early mobility protocol to improve patient outcomes.
- Overcoming barriers and feeling empowered to own patient mobility within your unit.

Notes on Hospitals: 1859

“It may seem a strange principle to enunciate as the very first requirement in a Hospital that it should do the sick no harm.”

Florence Nightingale

Advocacy = Safety
PROTECT THE PATIENT FROM BAD THINGS

Implement Intervventional Patient Hygiene

Intervventional Patient Hygiene

- Hygiene...the science and practice of the establishment and maintenance of health
- Intervventional Patient Hygiene...nursing action plan directly focused on fortifying the patients host defense through proactive use of evidence based hygiene care strategies

Incontinence Associated Dermatitis Prevention Program
INTERVENTIONAL PATIENT HYGIENE (IPH)

Oral Care/Mobility

HAND

Patient

HYGIENE

Catheter Care

Skin Care/Bathing/Mobility

VAP/HAP

CA-UTI

CA-BSI

SSI

Falls

HASI


Achieving the Use of the Evidence

Factors Impacting the ability to Achieve Quality Nursing Outcomes at the Point of Care

Skills & Knowledge

Resources & System

Value

Attitude & Accountability

Effects of Immobility on Respiratory Function

- Decreased movement of secretions
- Decreased respiratory motion
- Increased risk of pulmonary embolism
- Increased dependent edema
- Increased risk of atelectasis
- Increased risk of pneumonia
- Decreased arterial oxygen saturation


Ventilator-Associated Pneumonia (VAP) Rates

- In North America
  - In the United States, the Centers for Disease Control (CDC), through the National Healthcare Safety Network, has reported critical care unit VAP rates, per 1,000 ventilator-days, ranging from 0.2 (pediatric cardiothoracic) to 4.4 (burn ICU)
  - On average, ICU patients with VAP had an additional 10.5-day LOS³
  - Per case: VAP $40,144. (95% CI, $36,286-$44,220)⁴
- In Ireland: 17.2% of total HAI’s (pneumonia)
- INNIS: VAP rate 15.8 per 1000/vent days, 12 extra days, 15% higher mortality

Effects of Immobility on Cardiovascular Function

- **Fluid shift**
  - Occurs when the body goes from upright to supine position\(^1,2\)
  - 10% of total blood volume is shifted from lower extremities to the rest of the body; 78% of this is taken up in the thorax\(^3,4\)
  - Decreased blood volume (~15% of plasma volume is lost after 4 weeks of bed rest)\(^2\)

- **Cardiac effects**
  - Increased resting heart rate (an increase of ~10 beats/min is observed after 4 weeks of bed rest)\(^1,2\)
  - Cardiac deconditioning\(^2\)

- **Orthostatic intolerance**
  - Increased in bedridden patients due to decreased baroreceptor sensitivity, reduced blood volume, cardiac deconditioning, decreased venous return and stroke volume, and venous distensibility\(^1,2\)

**Effects of Immobility on Integumentary Function**

<table>
<thead>
<tr>
<th>Setting</th>
<th>Facility –Acquired Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical Care</td>
<td>3.3% to 53.4%</td>
</tr>
<tr>
<td>Acute Care</td>
<td>0% to 12%</td>
</tr>
</tbody>
</table>

- Prevalence rates in Ireland are 16%-range of 4%-37%\(^5\)
- Incidence rates in Ireland are 11%-range of 8%-14.4%\(^5\)
  - €119,000 to successfully treat one patient with a grade 4 pressure ulcer
  - €250,000,000 per annum to manage pressure ulcers across all care settings in Ireland

Skeletal Muscle Deconditioning

- Skeletal muscle strength reduces 4-5% every week of bed rest (1-1.5% per day)
- Without activity the muscle loses protein
- Healthy individuals on 5 days of strict bed rest develop insulin resistance and microvascular dysfunction
- 2 types of muscle atrophy
  - Primary: bed rest, space flight, limb casting
  - Secondary: pathology

Candow DG, Chilibick PD J Gerontol, 2005;60A:148-155
Homburg NM, Atheroscler Thromb Vasc Biol, 2007;27(12):2650-2656

Deconditioning During Critical Care

Deconditioning Can Occur Within 1 Week of Bed Rest

Skeletal Muscle Deconditioning

- Muscle groups that lose strength most quickly related to immobilization are those that maintain posture, transferring positions & ambulation.
- > 1/3 of patients with ICU stays greater than two weeks had at least two functionally significant joint contractures.
- Muscle atrophy in mechanically ventilated patients contribute to fatigue of the diaphragm and challenges with weaning.
- Degradation within 6-8 days; continues as long as bedrest occurs
- One day of bed rest requires two weeks of reconditioning to restore baseline muscle strength

Definition:
- Syndrome of generalized limb weakness that develops while the patient is critically ill and for which there is no alternative explanation other than the critical illness itself. Average Medical Research Council Scale (MRC) score <4 across all muscles tested.

Incidence:
- 25% of patients with prolonged mechanical ventilation will develop ICUAW
- Est 75,000 pts in US, 1 million worldwide

Caused By:
- Critical illness polyneuropathy, myopathy &/or muscle atrophy
- Combination

ICU-Acquired Weakness (ICUAW)

Definition:
- Syndrome of generalized limb weakness that develops while the patient is critically ill and for which there is no alternative explanation other than the critical illness itself. Average Medical Research Council Scale (MRC) score <4 across all muscles tested.

Incidence:
- 25% of patients with prolonged mechanical ventilation will develop ICUAW
- Est 75,000 pts in US, 1 million worldwide

Caused By:
- Critical illness polyneuropathy, myopathy &/or muscle atrophy
- Combination

References:
- Topp R et al, Am J of Crit Care, 2002;13(2):263-76
- Candes D, Chilicki PD J Gerontol. 2005;60A:148-155
- Zhang et al. 2008 GenomProtBioinf: 6
- Jolley SE, et al Chest, 2016; published online
ICU-Acquired Weakness (ICUAW)

Risk factors:
- Severe Sepsis\(^1,6\)
- Duration of mechanical ventilation\(^1,4\)
- ICU LOS\(^5,7\)
- Systemic inflammatory response syndrome\(^2\)
- Multiple organ failure\(^2,4\)
- Immobility\(^2,7\)
- Use of corticosteroids/neuromuscular blockers\(^2,3,6,7\)

Negative impact:\(^1,2\)
- Prolong mechanical ventilation
- Reoccurring respiratory failure & VAP
- Increased ICU and hospital length of stay
- Increase mortality


Brain-ICU Study

- Multicenter RCT- medical-surgical ICU’s
- 821 patients with ARF or Shock
- Evaluated in-hospital delirium and cognitive impact
- 3-12 months post d/c

Results
- 74% of patients developed delirium during hospital stay
- 3 months: 40% had global cognition scores 1.5 SD below population mean, 26% had scores 2 SD below pop mean
- 12 months: 34%(older) & 24%(younger) global cognition scores below the mean

Post Intensive Care Syndrome


http://www.icudelirium.org/testimonials.html
Outcomes of Early Mobility Programs

- ↓ incidence of VAP
- ↓ time on the ventilator
- ↓ days of sedation
- ↓ incidence of skin injury
- ↓ delirium
- ↑ ambulatory distance
- Improved function
- ↓ in hospital readmissions
- ↓ ICU & Hospital LOS

Thomsen GE, et al. CCM 2008;36:1119-1124
Winkelman C et al, CCN,2010;36:36-60
Corcoran JR, et al. PMR J, 2016 in press

Early Mobility Protocol: Impacting Outcomes

- Morris, et al, conducted a prospective cohort study to determine the impact of early mobility therapy using a team on patients who were mechanically ventilated with respiratory failure
  - The control group received standard passive ROM and turning (n=165)
  - The study group received low-impact mobility by a team (n=165)
    - Therapy initiated within 48 hours of mechanical ventilation
    - Therapy 7 days/week until ICU discharge
    - Mobility team included 1 ICU nurse, 1 physical therapist, and 2 nursing assistants

**Early ICU Mobility Therapy**

**Results**

- Baseline characteristic similar in both groups
- Protocol group:
  - Received as least 1 PT session vs. usual care (80% vs. 47%, p < .001)
  - Out of bed earlier (5 vs. 11 days, p < .001)
  - Reduced ICU LOS (5.5 days vs. 6.9 days, p=.025)
  - Reduced Hospital LOS (11.2 days vs. 14.5 days, p =.006)
  - No adverse outcomes;
    - Most frequent reason for ending mobility session was patient fatigue
  - Cost
    - Average cost per patient was $41,142 in the protocol group
    - Average cost per patient was $44,302 in the control group


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**Early Physical and Occupational Therapy in Mechanically Ventilated Patients**

- Prospective randomized controlled trial from 2005-2007
- 1161 screen, 104 patients mechanically ventilated < 72hrs, functionally independent at baseline met criteria
- Randomized to:
  - early exercise of mobilization during periods of daily interruption of sedation (49 pts)
  - daily interruption of sedation with therapy as ordered by the primary care team (55 pts)
- Primary endpoint: number of patients returning to independent functional status at hospital discharge able to perform activities of daily living and walk (independently)

Early Physical and Occupational Therapy in Mechanically Ventilated Patients

**Table:**

<table>
<thead>
<tr>
<th></th>
<th>Intervention (n=48)</th>
<th>Control (n=55)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time from intubation to first PTOI session (days)</td>
<td>3 (1-6)</td>
<td>7 (4-10.9)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Independent ADLs total at ICU discharge</td>
<td>3 (2-5)</td>
<td>0 (0-5)</td>
<td>0.15</td>
</tr>
<tr>
<td>Independent ADLs total at hospital discharge</td>
<td>6 (4-8)</td>
<td>4 (0-6)</td>
<td>0.06</td>
</tr>
<tr>
<td>MCS examin at time of hospital discharge</td>
<td>52 (25-81)</td>
<td>48 (0-98)</td>
<td>0.38</td>
</tr>
<tr>
<td>Hand grip strength at hospital discharge (kgf/cm²)</td>
<td>39 (10-95)</td>
<td>35 (0-94)</td>
<td>0.67</td>
</tr>
<tr>
<td>Greater walking distance at hospital discharge (m)</td>
<td>33.4 (10-93.4)</td>
<td>0 (0-20.4)</td>
<td>0.004</td>
</tr>
</tbody>
</table>

**Figure:**

- Safe
- Well tolerated
- ↓ duration of delirium
- ↑ VFD
- Functional independence at discharge
  59% protocol group vs. 35% in control arm

Protocol Driven Mobility Program: Impacting Neurological Outcomes

- Pre-post intervention study
- Large academic NICU
- 637 patients
  - 260 pre
  - 377 post
- Intervention: Early Progressive Mobility Protocol
  - Exclusion criteria
  - Readiness criteria
  - Started on admission
  - Encourage to use ICU bed features & lifts to assist
  - Protocol place at bedside


Multivariate analysis done to control for group differences:

<table>
<thead>
<tr>
<th>Factor</th>
<th>Adjusted Model Mean (± se)</th>
<th>Preintervention</th>
<th>Postintervention</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute Physiology and Chronic Health Evaluation II score*</td>
<td>55.0 (2.04)</td>
<td>58.7 (2.54)</td>
<td>0.90</td>
<td></td>
</tr>
<tr>
<td>Length of stay</td>
<td>15.16 (0.96)</td>
<td>19.31 (1.04)</td>
<td>&lt;0.0001</td>
<td></td>
</tr>
<tr>
<td>Neurologic ICU, d (± se)</td>
<td>737 (9.08)</td>
<td>475 (9.04)</td>
<td>&lt;0.0001</td>
<td></td>
</tr>
<tr>
<td>Psychological factors</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depression, mean (± se)</td>
<td>0.75 (0.22)</td>
<td>0.51 (0.22)</td>
<td>0.12</td>
<td></td>
</tr>
<tr>
<td>Anxiety, mean (± se)</td>
<td>0.69 (0.21)</td>
<td>0.42 (0.21)</td>
<td>0.088</td>
<td></td>
</tr>
<tr>
<td>Hostility, mean (± se)</td>
<td>0.38 (0.14)</td>
<td>0.27 (0.14)</td>
<td>0.31</td>
<td></td>
</tr>
<tr>
<td>Combined, mean (± se)</td>
<td>1.80 (0.50)</td>
<td>1.21 (0.48)</td>
<td>0.11</td>
<td></td>
</tr>
</tbody>
</table>

Multi-Center Pilot Feasibility RCT of Early Goal-Directed Mobilization in the ICU

- A pilot randomized controlled trial.
- Five ICUs: Australia/New Zealand
- Fifty critically ill adults mechanically ventilated for > 24 hours
- EGDM: functional rehabilitation tx conducted at the highest level of activity possible for that patient assessed by the ICU mobility scale while on a vent.
- Results
  - Highest level of activity (IMS) 7.3 versus 5.9 when compared with controls (p = 0.05)
  - Proportion of patients that walk was almost double in the EGDM group (p=0.05)
  - No difference in hospital stay
  - Safe and feasible


Standard Rehab & Hospital LOS in ARF


- Single center RCT from 10/2009-05/2014
- Randomized to SRT or usual care
  - SRT: passive ROM, physical therapy & progressive resistance 3x per day for every day of hospitalization
- Measured hospital LOS (primary)
  - Physical function and health quality of life
  - Measurements performed at hospital d/c, 2, 4 and 6 months. Physical function also performed at ICU d/c
- Results:
  - 4804 screened/ 618 eligible/No ABC protocol
  - SRT: 1 day PRM, 3 days to PT, 4 days for resistance ex
  - SRT received tx: PRM-87%, PT-54.6%, Resistance-35.7%
  - Usual care: PT-11.7% (1 day-0 to 8)
  - Hospital LOS no difference
  - Secondary outcomes all significantly better in SRT at 6 months
**Systematic Review of Early Rehabilitation in the ICU**

- **14 studies/1753 patients**
- **880 patients in intervention group**
- **873 patient in control group**
- **Varying methodologies**
- **Results**
  - No difference in short or long term mortality

Tipping CJ, et al. ICM, 2017;43:171-183

### Results of Active Rehab

- ↑ muscle mass at ICU d/c
- ↑ probability of walking without assistance at hospital d/c
- ↑ more days alive and out of hospital 180 days

### Limitations

- Variation in dosage, small sample sizes of individual studies

Tipping CJ, et al. ICM, 2017;43:171-183
International Survey of Early Mobilization Practices: Where Do We Stand

- Surveyed directors of medical and mixed medical surgical ICUs in 4 countries
- Institutions selected a random
- Results
  - 951 ICUs (US 500; France 151, UK 150, Germany 150)/response rate 64%
  - Staffing models of RN/patient and Physiotherapist differ by country

<table>
<thead>
<tr>
<th></th>
<th>France</th>
<th>Germany</th>
<th>UK</th>
<th>US</th>
</tr>
</thead>
<tbody>
<tr>
<td>% EM practice</td>
<td>40%</td>
<td>59%</td>
<td>52%</td>
<td>45%</td>
</tr>
<tr>
<td>% EM protocol</td>
<td>24%</td>
<td>30%</td>
<td>20%</td>
<td>30%</td>
</tr>
</tbody>
</table>

- Factors associated with EM practice
  - presence of multidisciplinary rounds
  - setting daily goals
  - Presence of a dedicated physiotherapist
  - Nurse patient ratio
  - Sedation protocol

ABCDE Bundle Reduces Ventilation, Delirium & ↑OOB

- 18 month, prospective, cohort, before-after study
- 5 adult ICU’s, 1 step down, 1 oncology unit
- Compared 296 patients (146 pre-bundle) & 150 post bundle
- Intervention: ABCDE
- Measured:
  - For mechanical ventilation patients (187) examined ventilator free days
  - All patients examined incidence of delirium, mortality, time to discharge and compliance with the bundle


### ABCDE Bundle Component Outcome

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Pre-ABCD Bundle (n = 146)</th>
<th>Post-ABCD Bundle (n = 150)</th>
<th>Unadjusted P</th>
<th>Adjusted Odd 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 (m)</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 (7–25)</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>0.59 (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 (18.8–60)</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 (1–6)</td>
<td>2 (1–6)</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 (125–42.9)</td>
<td>0.89</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Richmond Agitation-Sedation Scale Score, mean (m)</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 (65.0)</td>
<td>0.002</td>
<td>2.11* (1.30–3.45)</td>
<td>0.003</td>
</tr>
<tr>
<td>29-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* (0.29–1.06)</td>
<td>0.09</td>
</tr>
<tr>
<td>ICU mortality, n (%)</td>
<td>24 (16.4)</td>
<td>14 (9.3)</td>
<td></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, 6)</td>
<td>4 (3, 6)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>From hospital, median (IQR)</td>
<td>13 (9, 15)</td>
<td>11 (9, 15)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Delirium risk ↓ from 62.3% to 48.7% & 17% less time spent delirious

ABCDEF Bundle: Improving Survival & Reducing Brain Dysfunction

- Ventilated and non-ventilated medical and surgical ICU patients enrolled between January 1, 2014, and December 31, 2014
- Determine association between ABCDEF bundle compliance/total & partial & outcomes of hospital survival and delirium-free and coma-free days/adjusting for age, severity of illness, and presence of mechanical ventilation
- Patients experienced more days alive and free of delirium and coma with both total bundle compliance (incident rate ratio, 1.02; 95% CI, 1.01–1.04; p = 0.004) and partial bundle compliance (incident rate ratio, 1.15; 95% CI, 1.09–1.22; p < 0.001).

10% ↑ in total bundle compliance, patients had a 7% higher odds of hospital survival

Progressive Mobility + Care Giver Safety + Skin Safety & Fall Prevention

Driving Change

- Gap analysis
- Build the Will
- Protocol Development

Structure

- Make it Prescriptive
- Overcoming barriers
- Daily Integration

Process

Outcomes
Early Mobility

Progressive Mobility:
Planned movement in a sequential manner beginning at a patient's current mobility status and returning them to baseline & includes:

- Head elevation
- Manual turning
- Passive & Active ROM
- Continuous Lateral Rotation Therapy/Prone Positioning
- Movement against gravity
- Physiologic adaptation to an upright/leg down position (Tilt table, Bed Egress)
- Chair position
- Dangling
- Ambulation

The Mobility Initiative

Objective
- To create a progressive mobility initiative that will help ICU teams to address key cultural, process and resource opportunities in order to integrate early mobility into daily care practices.

Methods
- Multi-center implementation of key clinical interventions
- An evidence-based, user-friendly progressive mobility continuum was developed, lead by the Clinical Nurse Specialist faculty
- Implementation plan: process design, culture work & education
- 130 patients/3120 prospectively collected hourly observations
- Qualitative and quantitative data collected
  - 15 process and 5 outcome metrics
- Results reported as cohort and unit specific data

Determining Readiness

- Perform initial mobility screen w/in 8 hours of ICU admission & daily
  - PaO2/FiO2 > 250
  - Peep <10
  - O2 Sat > 90%
  - RR 10-30
  - No new onset cardiac arrhythmias or ischemia
  - HR >60 <120
  - MAP >55 <140
  - SBP >90 <180
  - No new or increasing vasopressor infusion
  - RASS > -3

Patient
Stable, Start at Level II & progress

Patient is unstable, start at Level I & progress


Consensus on Safe Criteria for Active Mobilization

- Systematic review performed than 23 international experts gather to reach consensus

<table>
<thead>
<tr>
<th>Categories</th>
<th>Consensus reach on all criteria. If no other contraindications; vasoactives, endotracheal tube, FIO2 &lt; 60% with SaO2 90% &amp; RR &lt; 30/min were considered safe criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory</td>
<td>Hodgson CL, et. al Critical Care, 2014;18:658</td>
</tr>
<tr>
<td>Cardiovascular</td>
<td></td>
</tr>
<tr>
<td>Neurological</td>
<td></td>
</tr>
<tr>
<td>Other Considerations</td>
<td></td>
</tr>
</tbody>
</table>

Use of a ICU Mobility Scale (IMS) - Standardizing Language

Construct and predictive validity were assessed by comparing IMS values at ICU discharge in 192 patients to other variables

The IMS at ICU discharge demonstrated a moderate correlation with muscle strength (r = 0.64, P < 0.001).

Significant difference between the IMS at ICU discharge in patients with ICU-acquired weakness vs those without P=0.001).

Increasing IMS values at ICU discharge were associated with survival to 90 days and discharge home

### Progressive Mobility Continuum

#### START HERE

Perform initial mobility screen w/in 8 hours of ICU admission

**Level I**
- RASS -5 to -3
  - Goal: clinical stability, passive ROM
  - Activities: Tolerates Level I Activities

**Level II**
- RASS -3 & up
  - Goal: upright sitting, increased strength and moves arm against gravity
  - Activities: Tolerates Level II Activities

**Level III**
- RASS -1 & up
  - Goal: increased trunk strength, moves leg against gravity and readiness to weight bear and transfer to chair
  - Activities: Tolerates Level III Activities

**Level IV**
- RASS 0 & up
  - Goal: Increased distance in ambulation & ability to perform some ADLs
  - Activities: Tolerates Level IV Activities

**Level V**
- RASS 0 & up
  - Goal: Increase distance in ambulation & ability to perform some ADLs
  - Activities: Tolerates Level V Activities

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### B.M.A.T. - Banner Mobility Assessment Tool for Nurses

<table>
<thead>
<tr>
<th>Test</th>
<th>Task</th>
<th>Response</th>
<th>Fail</th>
<th>Pass</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sit and Stroke</td>
<td>if patient can, if not assist to move</td>
<td>✔</td>
<td>✗</td>
</tr>
<tr>
<td>2</td>
<td>Stand and Stretch</td>
<td>if patient can, if not assist to move to standing</td>
<td>✔</td>
<td>✗</td>
</tr>
<tr>
<td>3</td>
<td>Level I</td>
<td>if patient can, if not assist to move to standing</td>
<td>✔</td>
<td>✗</td>
</tr>
<tr>
<td>4</td>
<td>Level II</td>
<td>if patient can, if not assist to move to standing</td>
<td>✔</td>
<td>✗</td>
</tr>
<tr>
<td>5</td>
<td>Level III</td>
<td>if patient can, if not assist to move to standing</td>
<td>✔</td>
<td>✗</td>
</tr>
</tbody>
</table>

---

#### Mobility

- Mobility is the responsibility of the RN, with the assistance of the RT’s Unlicensed Assistive Personnel and PT/OT. PT and OT may assist the team with placement to the appropriate mobility level of activity, always prioritizing patient and provider safety. Placement is based on clinical judgment.

---

**For each position/activity change allow 5-10 minutes for equilibration before determining the patient is intolerant**

---

**Refer to the following criteria to assist in determining mobility level**

- **Yes**
  - PaO2/FIO2 > 250
  - Peep <10
  - O2 Sat > 90%
  - HR >60 <120
  - MAP >35 <140
  - SBP >90 <180
  - No new or increasing vasopressor infusion
  - RASS > 3

- **No**
  - PaO2/FIO2 ≤ 250
  - Peep ≥10
  - O2 Sat ≤ 90%
  - HR >120
  - MAP <35 <140
  - SBP <90 >180
  - No new or increasing vasopressor infusion
  - RASS ≤ 3

---

**Always default to the safest lifting/transferring method (e.g., total RN if there is any doubt in the patient’s ability to perform the task).**
Do We Even Achieve the Minimum Mobility Standard… “Q2 Hours”?

How Well Are We Really Doing?

- Body position: clinical practice vs standard\(^1\)
  - Study of 74 patients in which the change in body position was recorded every 15 minutes for an average observation time of 7.7 hours
  - 49.3% of observed time showed no body position change for >2 hrs, and 2.7% had every-2-hour demonstrable body position change
- Positioning prevalence\(^2\)
  - Prospectively recorded, 2 days, 40 ICUs in the United Kingdom
  - Average time between turns, 4.85 hours

**Progressive Mobility Continuum**

**START HERE**

Perform initial mobility screen within 8 hours of ICU admission. Reassess mobility level at least every 24 hours (Recommended at shift change).

Refer to the following criteria to assist in determining mobility level:

- **PaO2/FiO2 ≥ 250**
- **Peep ≤ 10**
- **O2 Sat ≥ 90%**
- **RR 10-30**
- **No new onset cardiac arrhythmias or ischemia**
- **HR ≥ 60 < 120**
- **MAP ≥ 55, < 140**
- **SBP ≥ 90, < 180**
- **No new or increasing vasopressor infusion**
- **RASS ≥ 3**

If the patient is intolerant of current mobility level activities, reassess and place in appropriate mobility level.

**Goal: Clinical Stability, Passive ROM**

**Activity:**
- HOB > 30°
- Passive ROM 2X/d performed by RN, or UAP
- NMES 30 min x2

CLRT/Pronation initiated if patient meets criteria based on institutional practice or Q 2 hr turning.

**Goal:**
- Clinical Stability, Passive ROM

**Activity:**
- HOB > 30°
- Passive ROM 2X/d performed by RN, or UAP

CLRT/Pronation initiated if patient meets criteria based on institutional practice or Q 2 hr turning.

**Goal:**
- Increase distance in ambulation & ability to perform some ADLs

**Activity:**
- Full assist into cardiac chair 2X/day

**Goal:**
- Ambulate progressively longer distances with less assistance x2 or x3/day with RN/PT/RT/UAP

*Mobility is the responsibility of the RN, with the assistance from the RT’s, Unlicensed Assistive Personnel and PT/OT. PT and OT may assist the team with placement to the appropriate mobility level of activity, always prioritizing patient and provider safety. Placement is based on clinical judgment.*
ROM Active & Passive

- When muscles are immobilize in shorten positions there is remodeling of muscle fibers
- Bed rest entails immobilization of limb extensor muscles in shortened positions
- Passive movement has been shown to enhance ventilation, prevent contractures in patients in high dependency units
- Low resistance multiple repetition muscle training can augment muscle mass & strength

Recommended 10 repetitions each extremity x2 daily


Use of Neuromuscular Stimulation

- NMES utilizes skin electrodes to deliver electrical stimuli to muscles to produce visible contractions
- Studies have reported it to be safe, feasible, well-tolerated, and beneficial for preserving muscle mass, strength, and function
- Review of studies of NMES in ICU pts (n > 350): “NMES has an impact on muscle strength, length of mechanical ventilation and intensive care stay. These are important findings identifying that NMES can have an impact on clinically important outcomes in critically ill patients”

Bax L, Sports Med 2005; 35
Williams N, et al. Physiother Therory Pract, 2014;30(1)
Reducing HAPI & Patient Handling Injuries

- Compared pre-implementation turning practice: pillows/draw sheet vs turn and position system (breathable glide sheet/foam wedges/wick away pad)
- Baseline: November 2011-August 2012
- Implementation period: November 2012 to August 2015
- 3660 patients
- Compared HAPI rates, patient handling injuries and cost

<table>
<thead>
<tr>
<th>Patient Handling Injury and Costs</th>
<th>74% reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>January 2012 to October 2012</td>
<td></td>
</tr>
<tr>
<td>(Before)</td>
<td></td>
</tr>
<tr>
<td>November 2012 to August 2013 (After)</td>
<td></td>
</tr>
<tr>
<td>November 2013 to August 2014 (After)</td>
<td></td>
</tr>
<tr>
<td>November 2014 to August 2015 (After)</td>
<td></td>
</tr>
</tbody>
</table>

Injuries/Cost: 19/8427,500 85/190,000 2/545,000 5/8112,500

Way H, Am JSPHM, 2016;6(4):160-165
Continuous Lateral Rotation Therapy

Goldhill DR et al. Amer J Crit Care, 2007;16:50-62

Rotational Therapy Using Cushion-Based Rotation

- The Medical Center of Central Georgia evaluated the impact of CLRT
- A CLRT protocol was implemented in patients who were identified as at risk for pulmonary complications, and outcomes were compared with a historical comparison group

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Vent Days</th>
<th>ICU Days</th>
<th>Hospital Days</th>
<th>Cost to Treat, Thousands of Dollars</th>
<th>ICU Readmission Rates, %</th>
<th>Reintubation Rates, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>No CLRT</td>
<td>17.4</td>
<td>18.4</td>
<td>29.7</td>
<td>59.4</td>
<td>21</td>
<td>19</td>
</tr>
<tr>
<td>CLRT after 48 hours</td>
<td>16.6</td>
<td>18.9</td>
<td>28.8</td>
<td>62.1</td>
<td>17</td>
<td>13</td>
</tr>
<tr>
<td>CLRT within 48 hours</td>
<td>12.4</td>
<td>13.1</td>
<td>23.4</td>
<td>45.2</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

- When introduced early, CLRT may reduce critical care length of stay and cost to treat
- CLRT is an option for patient mobility

CLRT=continuous lateral rotation therapy.
No CLRT: 75 patients; CLRT after 48 hours: 46 patients; CLRT within 48 hours: 50 patients.
Systematic Method of Approaching Placement & Removal of Rotational Therapy

Prone Positioning: The New Evidence

- RCT 466 patients with severe ARDS
  - Severe ARDS P/F ratio < 150 mm Hg, w Fio2 0.6, PEEP of at least 5 cm of water and a Tv to 6 ml per kg of PBW
- Initiation 12-24hrs
- Prone-positioning 16hrs/or supine position
- NMB used 5 days
- Results:
  - Prone 16% mortality, supine 32.8% p<0.0001
  - No differences in complications except > cardiac arrest in supine position

Transition: Level I to Level II

The patient meets the criteria for physiological stability, including cardiovascular, respiratory and neurological stability, including cardiovascular, respiratory and neurological.

**Progressive Mobility Continuum**

**Level I**
- Includes complex, intubated, hemodynamically unstable and stable intubated patients; may include non-intubated.
- RASS -5 to -3

**Level II**
- RASS -3 & up
- Includes intubated, non-intubated hemodynamically stable/stabilizing, no contraindications
- Mobility is the responsibility of the RN, with the assistance from the RT's Unlicensed Assistive Personnel and PT/OT. PT and OT may assist the team with placement to the appropriate mobility level of activity, always prioritizing patient and provider safety. Placement is based on clinical judgment.
- *Mobility is the responsibility of the RN, with placement to the appropriate mobility level of activity, always prioritizing patient and provider safety. Placement is based on clinical judgment.*

**Level III**
- RASS -1 & up

**Level IV**
- RASS 0 & up

**Level V**
- RASS 0 & up

**Activity:**
- Q 2 hr turning/NMES 30min x2
- Passive /Active ROM 3x/d
- 1. HOB 45º X 15 min.
- 2. HOB 65º Legs in dependent position X 15 min.
- 3. Step (3) & full chair mode X20 min
- Full assist into cardiac chair 2X/day

**Activity:**
- Self or assisted Q 2 hr turning
- Bed sitting Position Min. 20 min. 3X/day
- Sitting on edge of bed: stand w/RN, PT, RT assist
- Active Transfer to Chair (ODB) w/RN/PT/RT assist Min. 3X/day
- Meals consumed while dangling on edge of bed or in chair

**Activity:**
- HOB > 30º
- Passive ROM 2X/d performed by RN, or UAP before determining the patient is intolerant to the activity

**Activity:**
- Mobility is the responsibility of the RN, with placement to the appropriate mobility level of activity, always prioritizing patient and provider safety. Placement is based on clinical judgment.
Transition: Level II to Level III

An acceptable strength to advance is considered to be a 3/5 with zero being no movement observed against gravity and five being muscle contracts normally against full resistance

The patient meets the mobility goals for level II and is able to move their arm bicep against gravity

Grading Muscle Strength

- Grade 5: Muscle contracts normally against full resistance.
- Grade 4: Muscle strength is reduced but muscle contraction can still move joint against resistance.
- Grade 3: Muscle strength is further reduced such that the joint can be moved only against gravity with the examiner's resistance completely removed. As an example, the elbow can be moved from full extension to full flexion starting with the arm hanging down at the side.
- Grade 2: Muscle can move only if the resistance of gravity is removed. As an example, the elbow can be fully flexed only if the arm is maintained in a horizontal plane.
- Grade 1: Only a trace or flicker of movement is seen or felt in the muscle or fasciculations are observed in the muscle.
- Grade 0: No movement is observed.

Medical Research Council. Aids to the examination of the peripheral nervous system, Memorandum no. 45, Her Majesty's Stationery Office, London, 1981
## Progressive Mobility Continuum

<table>
<thead>
<tr>
<th>LEVEL I</th>
<th>LEVEL II</th>
<th>LEVEL III</th>
<th>LEVEL IV</th>
<th>LEVEL V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Includes complex, intubated and unstable patients.</td>
<td>Includes intubated, non-intubated, hemodynamically stable/stabilizing, no contraindications.</td>
<td>Tolerates Level III Activities</td>
<td>Tolerates Level IV Activities</td>
<td>Tolerates hemodynamically stable/stabilizing, no contraindications.</td>
</tr>
</tbody>
</table>

### Level II

**Goal:** Increased trunk strength, moves leg against gravity and readiness to weight bear

**Activity:** Self or assisted 2 hr turning/Possible NMES therapy

1. Sitting on edge of bed w/RN, PT, RT assist x 15 min.
2. Progressive bed sitting position Min. 20 min. 3X/d

Or

Pivot to chair position 2X/d

**Tolerates Level III Activities**

**Tolerates Level III Activities**

**Mobility is the responsibility of the RN, with the assistance from the RT's, Unlicensed Assistive Personnel and PT/OT. PT and OT may assist the team with placement to the appropriate mobility level.**

### Level III

**Goal:** Increased trunk strength, moves leg against gravity and readiness to weight bear

**Activity:** Self or assisted 2 hr turning/Possible NMES therapy

1. Sitting on edge of bed w/RN, PT, RT assist x 15 min.
2. Progressive bed sitting position Min. 20 min. 3X/d

Or

Pivot to chair position 2X/d

**Tolerates Level III Activities**

**Tolerates Level III Activities**

### Level IV

**Goal:** Increased distance in ambulation & ability to perform some ADLs

**Activity:** Self or assisted 2X daily & OT x1 daily

**Tolerates Level IV Activities**

**Tolerates Level IV Activities**

### Level V

**Goal:** Independent ambulation, able to perform more ADLs

**Activity:** Self or assisted 2X daily & OT x1 daily

**Tolerates Level V Activities**

**Tolerates Level V Activities**

---

**In-Bed Progressive Mobility**

Journey to tolerating upright position, turning tilt, sitting, standing and walking and out of bed chair sitting can occur quicker through the use of technology.
Transition: Level III to Level IV

An acceptable strength to advance is considered to be a 3/5 with zero being no movement observed against gravity and five being muscle contracts normally against full resistance.

The patient meets the mobility goals for level III and is able to move their leg against gravity.
**Out of Bed Technology**

**Progressive Mobility Continuum**

**Level V**
- RASS 0 & up

**Goal:** Increase distance in ambulation & ability to perform some ADLs

**Activity:** Self or assisted
- Q 2 hr turning
  1. Chair (OOB) w/ RN/PT/RT assist Min. 3x/day
  2. Meals consumed while dangling on edge of bed or in chair

**Level IV**
- Tolerates Level I Activities

**Activity:**
- Q 2 hr turning
  1. Passive (Active ROM)
  2. Full assist into chair
  3. Full assist into cardiac chair "2/day"

**Level III**
- Tolerates Level II Activities

**Activity:**
- Q 2 hr turning
  1. HOB 45º X 15 min.
  2. HOB 45º, Legs in dependent position X 15 min.
  3. Step (3) & full chair mode
  4. Full assist into cardiac chair "2/day"

**Level II**
- Tolerates Level III Activities

**Activity:**
- Q 2 hr turning
  1. HOB 65º X 15 min.
  2. Step (3) & full chair mode
  3. Full assist into cardiac chair "2/day"

**Level I**
- Tolerates Level IV Activities

**Activity:**
- Ambulate progressively longer distances with less assistance x2 or x3/day with RN/PT/RT/UAP

**START HERE**

Perform initial mobility screen w/in 1st 8 hours of ICU admission

Reassess mobility level at least every 24 hours (Recommended at shift change)

**Refer to the following criteria to assist in determining mobility level**

- PaO2/FiO2 ≥ 200
- PaO2 > 100
- O2 Sat ≥ 95%
- RR 10-30
- No new or increasing vasopressor infusion
- RASS ≥ 3

**AMBULATE**

- Progressive longer distances with less assistance x2 or x3/day with RN/PT/RT/UAP

**Goal:** Upright sitting; increased strength and moves arm against gravity

**Goal:** Increased trunk strength, moves leg against gravity and readiness to weight bear

**Goal:** Stands w/ min. to mod. assist; able to march in place, weight bear and transfer to chair

**Goal:** Clinical stability; passive ROM

**Goal:** Increase distance in ambulation & ability to perform some ADLs

**PT x 2 daily**
**OT x 1 daily**

*Mobility is the responsibility of the RN, with the assistance from the RN’s Unlicensed Assistants with placement to the appropriate mobility level of activity, always prioritizing patient and provider safety.*

---

**NOTE:**
- Level I includes complex intubated, hemodynamically unstable and stable intubated patients; may include non-intubated intubated, non-intubated hemodynamically stable/stabilizing, no contraindications
- Level IV RASS 0 & up
- Level V RASS 0 & up
- Level I includes intubated, non-intubated hemodynamically stable/stabilizing, no contraindications
- Level III RASS -3 & up
- Level II RASS -1 & up
- Level IV RASS 0 & up

**For each position/activity change allow 5-10 minutes for equilibration before determining the patient is intolerant**

**CLRT/Pronation initiation if patient meets criteria based on institutional practice or**

**OPT consult for ADL’s**
Ambulation Assist Devices

"Even if you are on the right track, you will get run over if you just sit there."

Will Rogers
Early Mobility: Can We Do It? Is it Safe?

Safety

- > 1% adverse events during 1449 sitting, standing and walking sessions with patients on ventilators.
- Impact of safety of therapy intervention in a single center (routine care) between 2009-2011
  - 1787 admission of at least 24hrs
  - 1110 participated in 5267 PT sessions (1-3 days from admission)
  - 10 different therapist on 4580 days
- Results:
  - Physiological abnormalities: 34 session (0.6%)
    - Arrhythmias: 10 occurrences (0.2%)
    - MAP > 140: 8 occurrences (0.2%)
    - MAP < 55: 5 occurrences (0.1%)
    - Oxygen desaturation: 4 occurrences (0.8%)
    - Falls: 3 occurrences (0.6%)
    - 1 chest tube, feeding tube and arterial line

Challenges to Mobilizing Critically Ill Patients

• Patient-related barriers (50%)
  – Hemodynamic instability
  – ICU devices
  – Physical & neuropsychological

• Structural (18%)
  – Human or technological resources

• ICU culture (18%)
  – Knowledge/priority/habits

• Process related (14%)
  – Service delivery/lack of coordination
  – Clinician function

Potentially Modifiable Barriers


Hemodynamic Instability

???

Is it a Barrier to Positioning?

50% reported in studies as the #1 patient barrier
The Role of Hemodynamic Instability in Positioning\textsuperscript{1,2}

- Lateral turn results in a 3%-9% decrease in SVO\textsubscript{2}, which takes 5-10 minutes to return to baseline
- Appears the act of turning has the greatest impact on any instability seen
- Minimize factors that contribute to imbalances in oxygen supply and demand
- Factors that put patients at risk for intolerance to positioning:\textsuperscript{3}
  - Elderly
  - Diabetes with neuropathy
  - Prolonged bed rest
  - Low hemoglobin and cardiovascular reserve
  - Prolonged gravitational equilibrium

\textsuperscript{2}. Price P. Dynamics. 2006;17:12-19.

Decision-Making Tree for Patients Who Are Hemodynamically Unstable With Movement\textsuperscript{1,2}

Screen for mobility readiness within 8 hrs of admission to ICU & daily initiate in-bed mobility strategies as soon as possible

<table>
<thead>
<tr>
<th>Is the patient hemodynamically unstable with manual turning?</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>O\textsubscript{2} saturation $\leq$ 95%</em></td>
</tr>
<tr>
<td><em>New onset cardiac arrhythmias or ischemia</em></td>
</tr>
<tr>
<td><em>HR &lt; 60 &lt; 120</em></td>
</tr>
<tr>
<td><em>MAP &lt; 55 &gt; 140</em></td>
</tr>
<tr>
<td><em>New or increasing vasopressor infusion</em></td>
</tr>
</tbody>
</table>

- Yes
  - Try the position turn or HOB maneuver slowly to allow adaptation of cardiovascular response to the inner ear position change
- No
  - Begin in-bed mobility techniques and progress out-of-bed mobility as the patient tolerates

<table>
<thead>
<tr>
<th>Is the patient still hemodynamically unstable after allowing 5-10 minutes’ adaption post-position change before determining tolerance?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Screen for mobility readiness within 8 hrs of admission to ICU &amp; daily initiate in-bed mobility strategies as soon as possible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Has the manual position turn or HOB elevation been performed slowly?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Initiate continuous lateral rotation therapy via a protocol to train the patient to tolerate turning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
</tr>
</tbody>
</table>

HOB=head of bed; HR=heart rate; MAP=mean arterial pressure; SPB=systolic blood pressure.
Evidence Based Strategies to Overcome Barriers

- Patient-related
  - Inclusion, exclusion criteria, protocols, research on specific equipment for safety (CCRT, etc.)
- Structural
  - Development and implementation of protocols, increase staffing & purchase of equipment
- ICU culture
  - Education, training, coaching, video’s, improve coordination between professionals
- Process related
  - Interprofessional meetings and rounds, sharing clinical responsibility, collaboration with champions, remove default orders


It Takes a Village For Sustainability

1. Necessary Components for Early Rehab
   - Buy-in
   - Multiple disciplines
   - Team communication
   - Opinion leader
   - Individual discipline champion
   - Dedicated rehab personnel
   - Equipment
   - Sedation practice
   - Administrative funding

2. Implementation Strategies
   - Team center approach
   - Staff education
   - Strength & quality of evidence

3. Perceived Barriers
   - Increase workload
   - Safety concerns

4. Positive Outcomes
   - Improved patient outcomes
   - Staff satisfaction
   - Changed culture
   - Financial savings

Ensuring Safety & Success

- Mobility readiness assessment
- Determining absolute contraindications for any mobility protocol
- Criteria for stopping a mobility session
- Changing the culture
- Sufficient resources and equipment to make it easy & safe to do

TABLE 4. Financial Model for ICU Rehabilitation Program Using Example Data

<table>
<thead>
<tr>
<th>Row</th>
<th>Description</th>
<th>Number</th>
<th>Calculations</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Average ICU length of stay (LOS) before intervention</td>
<td>6.40</td>
<td>Table 1</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Average floor LOS before intervention</td>
<td>10.30</td>
<td>Table 1</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>% Reduction in ICU LOS</td>
<td>22%</td>
<td>Table 1</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>% Reduction in floor LOS</td>
<td>19%</td>
<td>Table 1</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>Average reduction in ICU LOS (in days)</td>
<td>1.19</td>
<td>A x C</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>Average reduction in floor LOS (in days)</td>
<td>1.96</td>
<td>B x D</td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>Average ICU LOS after intervention</td>
<td>4.21</td>
<td>A - E</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>Average floor LOS after intervention</td>
<td>8.34</td>
<td>B - F</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>ICU direct-variant cost for patient with average LOS before intervention</td>
<td>$7404</td>
<td>[see Methods]</td>
<td>Table 2 (using 10019 ICU costs)</td>
</tr>
<tr>
<td>J</td>
<td>Floor direct-variant cost for patient with average LOS before intervention</td>
<td>$3,546</td>
<td>[see Methods]</td>
<td>Table 3 (using 10096 floor costs)</td>
</tr>
<tr>
<td>K</td>
<td>Total direct-variant cost for patient with average ICU and floor LOS before intervention</td>
<td>$10,950</td>
<td>I + J</td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>ICU direct-variant cost for patient with average LOS after intervention</td>
<td>$6,644</td>
<td>[see Methods]</td>
<td>Table 2 (using 10019 ICU Costs)</td>
</tr>
<tr>
<td>M</td>
<td>Floor direct-variant cost for patient with average LOS after intervention</td>
<td>$2,877</td>
<td>[see Methods]</td>
<td>Table 3 (using 10096 Floor Costs)</td>
</tr>
<tr>
<td>N</td>
<td>Total direct-variant cost for patient with average ICU and floor LOS after intervention</td>
<td>$8,522</td>
<td>L + M</td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>Total average cost savings per patient</td>
<td>$1,307</td>
<td>K - N</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>Annual number of ICU admissions</td>
<td>220</td>
<td>Table 1</td>
<td></td>
</tr>
<tr>
<td>Q</td>
<td>Total cost savings across all admissions</td>
<td>$1,116,912</td>
<td>P x O</td>
<td></td>
</tr>
<tr>
<td>R</td>
<td>Costs for rehabilitation program</td>
<td>$10,000</td>
<td>K - N</td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>Net savings associated with ICU rehabilitation program</td>
<td>$9,883.96</td>
<td>O - R</td>
<td></td>
</tr>
</tbody>
</table>

Lord R. Crit Care Med, 2013;41:717
It is not enough to do your best, you have to know what to do and then do your best.

E Deming