Advancing Early Mobility in Critical Care: Evidence Based Strategies for Making it Happen

Created in Conjunction With
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Disclosures

• Sage Products Speaker Bureau & Consultant
• Eloquest Healthcare Speaker Bureau & Consultant
• Hill-Rom Speaker Bureau & Consultant
• Off label discussion of a CHG cloth
Learning Objectives

- Understand the importance of early patient mobility
- Recognize the traditional standards of care for patient mobility
  - Identify current practice patterns
- Understand institutional costs associated with immobility
- Recognize what evidence supports the use of early mobility
- Determine how to implement an early mobility protocol
- Strategies for creating sustainability

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 HAPPENING ON YOUR WATCH

Implement Interventional Patient Hygiene

Interventional Patient Hygiene

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

Comprehensive Oral Care Plan
INTERVENTIONAL PATIENT HYGIENE (IPH)

VAP/HAP

Oral Care/
Mobility

HAND
Patient

HYGIENE

Catheter Care

Skin Care/
Bathing/Mobility

CA-UTI

CLA-BSI

SSI

HASI

Rank Order of Error Reduction Strategies

Forcing functions and constraints

Automation and computerization

Standardization and protocols

Checklists and double check systems

Rules and policies

Education / Information

Be more careful, be vigilant
Achieving the Use of the Evidence

- Factors Impacting the ability to Achieve Quality Nursing Outcomes at the Point of Care
- Attitude & Accountability
- Value
- Resources & System
- Skills & Knowledge


Why Is Early Patient Mobility Important?
Respiratory: respiratory tract infections, atelectasis, and pulmonary embolism

Cardiovascular: postural hypotension, cardiac muscle atrophy, orthostatic intolerance, and deep vein thrombosis

Hematologic: anemia

Metabolic: glucose intolerance

Skin: pressure ulcers

Neurological: depression, anxiety, forgetfulness, and confusion

Musculoskeletal: osteoporosis, muscle atrophy and weakness, and contractures

Renal: calculi

Gastrointestinal: constipation and fecal impaction

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 0.7 (pediatric cardiothoracic) to 5.8 (burn ICU)
  - On average, ICU patients with VAP had an additional 10.5-day LOS

Ventilator-Associated Events

The CDC defines ventilator-associated events (VAE) as deterioration in respiratory status after a period of stability or improvement on the ventilator, evidence of infection or inflammation, and laboratory evidence of respiratory infection.

Before:
VAP was the only VAE that the National Healthcare Safety Network (NHSN) collected data on

Now:
NHSN has revised its policy to include surveillance of all VAE, including
- Ventilator-associated conditions (VAC)
- Infection-related ventilator-associated complications (IVAC)
- Possible and probable VAP

Patient criteria for VAE surveillance
- Included patients: mechanically-ventilated patients ≥18 years who have an event on or after calendar day 3 of mechanical ventilation
- Excluded patients: patients receiving rescue mechanical ventilation therapies (eg, on high frequency ventilation, extracorporeal membrane oxygenation, or ventilating in the prone positioning)

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

- Pressure ulcers
  - The current prevalence of pressure ulcers is high
    - 1 in 10 patients in acute care experience a pressure ulcer
    - 8.9% of adult ICU patients experience a facility-acquired pressure ulcer
  - Because the Centers for Medicare & Medicaid Services no longer makes additional payment for care associated with stage III or IV facility-acquired pressure ulcers, pressure ulcers can have a significant financial impact
    - The average cost per hospital stay for a patient with a stage III or IV pressure ulcer in the acute care setting is $43,180
  - Mobilization of patients is recommended to help prevent pressure ulcers and might coordinate with 2-hour repositioning schedules


Identify Patients at High Risk
Risk Assessment on Admission, Daily, Change in Patient Condition

- Use standard EB risk assessment tool
- Research has shown Risk Assessment Tools are more accurate than RN assessment alone
- Braden Scale for Predicting Pressure Sore Risk
  - 6 subscales
    - Pressure on tissues
      - Rated 1-4
    - Mobility, sensory perception, activity
      - Tissue tolerance for pressure
        - Nutrition, moisture, shear/friction
      - Score 6-23
- www.ihi.org; Macklebust, JA (2009) The Braden scale: reliable assessment to effective interventions
Its About the Sub-Scale’s

- Retrospective cohort analysis of 12,566 adults patients in progressive & ICU settings for yr. 2007
- Identifying patients with HAPU Stage 2-4
- Data extracted: Demographic, Braden score, Braden subscales on admission, LOS, ICU LOS, presence of Acute respiratory and renal failure
- Calculated time to event, # of HAPU’s

**Results:**
- 3.3% developed a HAPU
- Total Braden score predictive (C=.71)
- Subscales predictive (C=.83)


Braden Score

Friction Score of 1=126 times the risk

Multivariate model included 5 Braden subscales, surgery and acute respiratory failure C=0.91  (Mobility, Activity and sensory perception more predictive when combined with moisture or shear and friction)
Effects of Immobility on Skeletal Muscle

- Muscle atrophy (almost half of the normal muscle strength is lost after 3-5 weeks of bed rest)
  
- Loss of maximum force generation

- Change in type or density of muscle fibers (muscle protein synthesis decreases by 50% after 2 weeks of bed rest)

- Functional denervation

- Separate phenotypes of muscle atrophy
  - Primary: bed rest, space flight, limb casting, and denervation
  - Secondary: pathology

References:
Effects of Immobility on Skeletal Muscle (Cont.)

• During immobilization, the muscle groups involved with transferring position, ambulation, and posture lose strength most quickly\(^1,2\)

• After less than a day of immobility, contractures start to develop. After 2-3 weeks of immobility, firmer contractures develop, and after 2-3 months of immobility, surgical correction may be needed\(^2\)

• Recovering from muscle atrophy caused by immobility takes \(\sim 4\) weeks. With exercise, disuse weakness is reversed at a rate of \(\sim 6\% / \text{week}\)\(^2\)

• Respiratory muscle weakness is a predictor for prolonged mechanical ventilation and delayed weaning\(^3\)


Pathological ICU-Acquired Weakness

Critical illness polyneuropathy and myopathy

• Occurs in patients with severe acute illness requiring ICU stay

• Involves peripheral nerves or muscles

• Delays weaning and compromises rehabilitation

• Associated with increased hospital and ICU stays and increased mortality rates

• Risk factors:
  – Duration of ICU stay
  – Systemic inflammatory response syndrome
  – Multiple organ failure
  – Sepsis
  – Blood glucose level
  – Use of corticosteroids/neuromuscular blockers

Effects of Immobility on Neurological Function

- Delirium¹
  - Acute, fluctuating change in consciousness and cognition
  - Develops over a brief time period
  - Hyperactive or hypoactive (most common)
  - Often an ICU complication
- Depression²
- Anxiety²
- Forgetfulness²
- Confusion²

Neurological: depression, anxiety, forgetfulness, and confusion


Neuromuscular Dysfunction in Critical Illness

- Ventilation-sedation-delirium-weakness cycle: a common complication in the ICU
  - Neurological:
    - 49%-77% of patients in the ICU for at least 7 days will acquire critical illness polyneuropathy and/or myopathy¹
    - Delirium develops in approximately 2/3 of critically ill patients²
    - Neurological conditions lead to prolonged ventilation and increased ICU and hospital days¹
  - Musculoskeletal:
    - Patients suffered 25% extreme weakness when ventilated >7 days³
    - ICU-acquired weakness leads to functional decline and is predictive of poor outcomes²

Relationship Between ICU-Acquired Delirium and Weakness in a Patient With Sepsis


Ventilation-Sedation-Delirium-Weakness Cycle: Long-term Impacts

- Patients with acute respiratory distress syndrome lose up to 18% total average body mass¹
- Only 49% returned to work or activities of daily living 1 year post ICU¹
- Muscle dysfunction remains after 1 year in up to 60% of patients²
- Up to 78% of ICU survivors experience neurocognitive impairments³
  - 46% neurocognitive impairment prevalence at 1 year
  - 25% neurocognitive impairment prevalence at 6 years

³ Hopkins RO, Jackson JC. Chest. 2006;130:869-878.
SCCM and ACCN Practice Guidelines to Address this Cycle

- Society of Critical Care Medicine: Clinical Practice Guidelines for the Management of Pain, Agitation, and Delirium in Adult Patients in the ICU\(^1\)
  - “Delirium is associated with increased mortality in adult ICU patients…prolonged ICU and hospital LOS in adult ICU patients… the development of post-ICU cognitive impairment in adult ICU patients”
  - Recommend performing early mobilization of adult ICU patients whenever feasible to reduce the incidence and duration of delirium

- AACN Practice Alert: Delirium Assessment and Management\(^2\)
  - All ICU patients should be assessed for delirium using validated tools
  - Strategies to decrease delirium risk factors should be used, including early exercise

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Effects of Immobility: Conclusion

"Because the consequences of immobility and bed rest are so severe, mobilizing critically ill patients early appears to have merit."

–K.M. Vollman

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Summary: Importance of Early Patient Mobility

• Immobility and how we manage sedation has a significant impact on the incidence and duration of delirium, as well as numerous adverse effects on the different body systems.

• Some of these effects may be associated with greater time on the ventilator, increased hospital LOS, and higher mortality rates.

• In addition, they may have long-term impacts on quality of life that persist long after the ICU stay.

Early mobility in critically ill patients is essential to the prevention of complications associated with immobility.

What Are Some Traditional Standards of Care for Patient Mobility?
What Are Some Traditional Standards of Care for Patient Mobility?

**Pressure ulcers and pneumonia**
- Traditional intervention
  - Every 2 hours*
  - Manual turning
  - Head of bed at 30°

**Out of bed to chair**
- The old standby physician order…

*Although 80%-90% of surveyed ICU physicians believe that every-2-hour turning should occur, only 57% of them believe that it is currently happening in their ICU.¹


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How Well Are We Really Doing?

Every-2-Hour Turning
Body Position: Clinical Practice vs Standard

Methodology
• 74 patients/566 total hours of observation
• 3 tertiary hospitals
• Change in body position recorded every 15 minutes
• Average observation time 7.7 hours
• Online MD survey

Results
• 49.3% of observed time no body position change for > 2 hours
• 2.7% had an every-2-hour demonstrable body position change
• 80% to 90% believed every-2-hour position change should occur, but only 57% believed it happened in their ICU

Positioning Prevalence

Methodology:
• Prospectively recorded, 2 days, 40 ICUs in the UK
• Analysis on 393 sets of observations
• Turn defined as supine position to a right or left side lying

Results:
• Five patients prone at any time, 3.8% (day 1) and 5% (day 2) rotating beds
• Patients on back 46% of observation
• Left 28.4%
• Right 25%
• Head up 97.4%
• Average time between turns 4.85 hours (3.3 SD)
• No significant association between time and age, weight, height, respiratory diagnosis, intubation, sedation score, day of week, nurse/patient ratio, hospital
Potential Barriers to Early Mobilization

Patients noted to be turned less

- Heavier patients
- Patients receiving vasopressors
- Patients receiving a paralytic agent at least once
- Trauma patients with multiple fractures or high intracranial pressure

Perceived patient and environmental barriers to mobilizing ICU patients:

- Fear of line dislodgement
- Heavy sedation
- Patient comfort
- Human and technological resources
- Fear of further decreases in oxygenation or hemodynamic parameters

* *not statistically significant

EBP Recommendations to Achieve Offloading & Reduce Pressure

- Turn & reposition every 2 hours (avoid positioning patients on a pressure ulcer)
  - Repositioning should be undertaken to reduce the duration & magnitude of pressure over vulnerable areas
  - Cushioning devices to maintain alignment /30° side-lying & prevent pressure on boney prominences
  - Use lifting device or other aids to reposition & make it easy to achieve the turn
  - Assess whether actual offloading has occurred

* *not statistically significant
Summary: Traditional Standards of Care

• Every-2-hour turning is considered the current practice to help offset the effects of immobility

• Keeping the head of bed at 30°-45° is an intervention to help prevent VAP

What Are the Average Costs of Immobility for Organizations?
ICU Statistics

In the United States:

- >6,000 ICU beds\(^1\)
- >5 million patients admitted annually to the ICUs\(^1\)
- ICU patients represent 10% of admissions but 30% of hospital costs\(^2\)
- Average mortality in ICUs is 10%-29%\(^1\)
- Average LOS in the ICU is 6.1-9.3 days\(^1\)

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Unplanned ICU Readmissions

- Respiratory complications are the major reason\(^1\)
- Reintubation is associated with increased risk of developing VAP\(^2,3\)
- Average ICU readmission rate of 7% and average ICU daily costs of $3,184\(^4,5\)
- ICU readmissions have twice the average hospital LOS\(^1\)
- Hospital death rates are 1.5-10 times higher\(^1\)

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**Price and Prevalence of Pressure Ulcers**

**In the United States:**

- Acute care facility-acquired pressure ulcer rate: 4.5%\(^1\)
- 60,000 deaths from facility-acquired pressure ulcer complications per year\(^2\)
- Average cost of facility-acquired stage III or IV pressure ulcers: $43,180\(^3\)
- $11 billion per year in preventable costs\(^4\)

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**Quality Implications**

<table>
<thead>
<tr>
<th>Centers for Medicare &amp; Medicaid Services (CMS)</th>
<th>CMS Value-Based Purchasing(^5)</th>
<th>The Joint Commission(^6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Increasing number of quality measures(^1)</td>
<td>• CMS-based program</td>
<td>• National patient safety goals for 2013:</td>
</tr>
<tr>
<td>• CMS financial pressures for quality reporting(^3)</td>
<td>• Started in October 2012</td>
<td>– Patient identification</td>
</tr>
<tr>
<td>• Excessive readmission penalties begin in 2013(^4)</td>
<td>• Pay-for-performance</td>
<td>– Infection prevention</td>
</tr>
<tr>
<td></td>
<td>• CMS will withhold 1% of</td>
<td>– Medication safety</td>
</tr>
<tr>
<td></td>
<td>payments and redistribute the</td>
<td>– Effective communication</td>
</tr>
<tr>
<td></td>
<td>money based on how well</td>
<td>– Surgical mistakes</td>
</tr>
<tr>
<td></td>
<td>hospitals meet quality</td>
<td></td>
</tr>
<tr>
<td></td>
<td>measures compared to baseline</td>
<td></td>
</tr>
</tbody>
</table>

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Summary:
Institutional Costs Associated With Immobility

• ICU patients represent a disproportionate amount of hospital costs

• Respiratory complications are the major reason for unplanned ICU readmissions
  – ICU readmissions average longer hospital LOS and higher mortality rates

• Facility-acquired pressure ulcers represent a large preventable cost

• There may be long-term financial implications associated with poor performance with regard to healthcare safety indicators through the CMS Value-Based Purchasing Program

It is not enough to do your best; you must know what to do, and THEN do your best.
– W. Edwards Deming
Introduction to Early Mobility

Definition of Early Mobility¹

• *Early mobility* definition:
  – Planned movement in a sequential manner beginning at a patient’s current mobility status and returning the patient to baseline

• Early mobility includes:
  – Head elevation
  – Manual turning
  – Passive and active range of motion
  – 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

What Does Clinical Evidence Tell Us About Early Mobility?

Start at the Top: Which Head of Bed Is at 30°?¹

The Clinical Impact of 45° Head of Bed on Ventilator-Associated Pneumonia (VAP)\(^1\)

<table>
<thead>
<tr>
<th>Number of patients</th>
<th>86</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient population</td>
<td>Monitored clinically suspected and microbiologically confirmed nosocomial pneumonias</td>
</tr>
</tbody>
</table>
| Intervention       | Randomly assigned to:  
  • Supine position (n=47)  
  • Head of bed 45° (n=39) |
| Results            | • Microbiologically confirmed nosocomial pneumonia lower in the semirecumbent group, 2/39 (5%) vs 11/47 (23%)  
  • Supine position and enteral nutrition were independent risk factors for VAP and had the greatest number of VAP cases 14/28 (50%) |


A Comparison of Two Measurements of Head of Bed on VAP\(^1\)

<table>
<thead>
<tr>
<th>Number of patients</th>
<th>221</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient population</td>
<td>Critically ill patients undergoing mechanical ventilation</td>
</tr>
</tbody>
</table>
| Intervention       | Randomly assigned to  
  • Head of bed 10° (n=109)  
  • Head of bed 45° (n=112)  
  Head of bed elevation was measured continuously |
| Results            | • Backrest elevation was measured continuously  
  • Average elevation range in the first week  
    - 10° group: 9.8°-14.8°  
    - 45° group: 29.3°-23.1° (intended elevation was not achieved 85% of the time)  
  • Microbiologically confirmed VAP occurred in 7.3% of patients in the 10° group and in 11.6% of the 45° group |

VAP=ventilator-associated pneumonia

The Clinical Impact of Manual Turning on VAP\textsuperscript{1}

**Study**

- Evaluate frequency of bihourly turning (16 hours × 3 days)
- 284 ICU patients, tube fed and on mechanical ventilation

**Results**

- 49% of patients developed VAP
- Patients with VAP were turned less frequently
- Mean number of turns was 9.64/patient vs 23 possible bihourly turns


Continuous Lateral Rotation Therapy

- CLRT mechanism of action
  - A gentle side-to-side, full-body motion of the patient in which one lung is placed above the other
  - This motion allows for gravitational flow and mobilization of pulmonary secretions, as well as enhance gas exchange

- What impact does it have on gas exchange?
  - Increased oxygen
  - Decreased CO\textsubscript{2}
  - Improved blood flow
  - Decreased atelectasis

- What happens inside the airways when patients are turned?
Table-Based vs Cushion-Based Rotation

- Turning on the long axis
- Measured in degrees of angle/turn
  - 124° (62° per side) in 3.5 minutes
- Unstable spine patients

- Rotates patient by inflation/deflation of air cushions
- Longitudinal, full-body rotation
- Measured in percent of air bladder inflation

Key Differences

Table-Based Rotation

- Ideally suited for patients with unstable heads, necks, and spines (neuro and trauma patients)¹
- Uses a firm mattress essential for maintenance of spine alignment¹
  - Can potentially put skin integrity at risk
- Can be set by degree of angle desired
  - Requires 2 fixed planes to accurately determine angle
  - Table-based products can achieve this as both the surface and the frame are moving at the same angle

Cushion-Based Rotation

- Usually does not require transfer to a different surface, allowing it to be initiated more readily
- More user-friendly for clinicians¹
- Beds may include additional features such as assist modes for patient positioning¹

**Cross Section of a Chest in the Supine Position**

- Lung
- Sternum
- Heart
- Rib
- Bronchi
- Pulmonary Infiltrates
- Spine

**Rotation of the Chest**

- 90°
- 62°
- 45°
- 30°

*Supine Position*

- Pulmonary infiltrates are unable to drain into the bronchi
• Pulmonary infiltrates are unable to drain into the bronchi
Rotation of the Chest

90°  62°

- Some amount of drainage of pulmonary infiltrates into the bronchi

180°

- Pulmonary infiltrates can successfully drain into the bronchi
Systematic Review and Meta-Analysis of Rotational Bed Therapy to Prevent and Treat Respiratory Complications

Methods:

- Systematic review and meta-analysis of studies on prophylaxis and/or treatment
- Prospective, randomized controlled trials
- Various types of beds were studied
  - Table- and cushion-based therapies
    - Kinetic (62°) and CLRT (40°, 30°, and 20°)

CLRT = continuous lateral rotation therapy.

Review and Meta-Analysis of Rotational Bed Therapy to Prevent and Treat Respiratory Complications: Meta-Analysis of Pneumonia

- Rotational therapy provides a benefit with respect to the incidence of pneumonia
Conclusions:

- Little evidence on which rotation parameter is most effective
- Effectiveness may not depend entirely on the angle of rotation, but also on
  - Frequency and duration of rotation
  - Pause time
  - Underlying disease
  - Size and weight of patient
  - Use of adjuncts such as vibration, percussion, or pulsation
- Some awake patients do not tolerate steep angle rotation
- May be best for patients with higher BMI, unconscious, or sedated
- Key recommendation: Rotational therapy may be useful for preventing and treating respiratory complications in selected critically ill patients receiving mechanical ventilation

Review and Meta-Analysis of Rotational Bed Therapy to Prevent and Treat Respiratory Complications

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></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 to Prevent VAP: Controlling the Variables

**Methodology**
- Prospective randomized controlled trial, 3 medical ICUs at a single center
- Eligible if ventilated <48 hours and free from pneumonia, ALI, or in ARDS
- 150 patients with 75 in each group
- 35 patients with CLRT allocated to undergo percussion before suctioning
- Measures to prevent VAP were standardized for both groups including head of bed

**Results:** CLRT vs control
- VAP: 11% vs 23% \(P=0.048\)
- Ventilation duration: \(8 \pm 5\) days vs \(14 \pm 23\) days, \(P=0.02\)
- LOS: 25 ± 22 vs 39 ± 45 days, \(P=0.01\)
- Mortality: no difference

ALI=acute lung injury, ARDS=acute respiratory distress syndrome, CLRT=continuous lateral rotation therapy; VAP=ventilator-associated pneumonia.


Introducing CLRT Into Patient Care

- Introduction of CLRT into patient care can provide an efficient way of providing early mobility to those critically ill patients whose condition or instability prevents implementation of other forms of mobility.

Systematic method of approaching placement and removal of CLRT therapy... a protocol

CLRT=continuous lateral rotation therapy.
Moving Those Who Cannot Move Themselves: Which Patients Should Receive CLRT?

- Target high-risk patient populations
  - Pulmonary-hemodynamic instability with manual turning
  - FiO₂ 50% or more
  - Positive end-expiratory pressure (PEEP) 8 or more
  - Existing pulmonary complications
  - FiO₂ increases by 20% (20 points) or PEEP >3 cm H₂O from baseline within 2 calendar days

- Which patients should NOT receive CLRT?
  - Those with unstable spines
  - Those with long bone fractures or patients requiring traction
  - Those with unstable intracranial pressure
  - Marked agitation without therapeutic management
  - Those with severe, uncontrolled diarrhea and patients that weigh more than 300lbs

Ongoing Monitoring/Evaluation and Documentation

- Assess for potential complications frequently
  - Malposition of endotracheal tube
  - Positional transient desaturation
  - Positional hemodynamic instability

- Every 2 hours check to see if patient is in optimal position to promote effective turn

- Every 2 hours manually turn patient and evaluate skin and lungs, then resume rotational therapy

- Document in medical record: degree of rotation, pause time settings, hours of rotation, turn for skin check and lung evaluation every 2 hours

- Discontinue CLRT when the patient:
  - May be mobilized safely using other means (head of bed, chair position, out-of-bed chair, and/or ambulation)
  - Shows improvement in respiratory status
  - Has agitation that is not therapeutically managed

CLRT = continuous lateral rotation therapy.
CLRT Strategies for Success

- Early CLRT intervention
- The therapy must be driven by a protocol and changes in settings are nursing orders
- Monitor initial rotation cycle to ensure one lung is above the other
- Automation of rotation requires insertion of usual assessment practices
- Minimum of 18 hours per day and 6 cycles per hour
- If done incorrectly, can cause skin injury
  - Shorter pause times
  - Assessment to ensure one lung above the other
  - Every two-hour assessment of the lungs and skin
- Yearly competency-based education to ensure proper use of the therapy

Evidence for Active and Passive Range of Motion\textsuperscript{1-3}

- When muscles are immobilized in shortened 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 and strength

Sets of repetitions to perform daily within patient tolerance recommended by ICU patient. e.g., 3 sets of 8-10 repetitions at 50-70\% of 1 rep max.

The Clinical Outcomes of an Early Mobility Protocol: Methods

- Morris, et al, conducted a prospective cohort study at Wake Forest Baptist Medical Center to determine the impact of early mobility therapy 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 (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.

The Clinical Outcomes of an Early Mobility Protocol: Results

- The early mobility protocol:
  - Shortened time to patient first out of bed (Δ=6.3 days).
  - Hospital LOS (Δ=3.3 days).
  - ICU LOS (Δ=1.4 days).
- 80.0% of patients in the protocol group underwent at least 1 physical therapy session at any time during their hospital stay as compared to 47.7% of patients in the control group.
- The direct inpatient costs for the protocol group (including mobility team salaries) were lower than those for the control group:
  - Average cost per patient was $41,142 in the protocol group.
  - Average cost per patient was $44,302 in the control group.
Early Physical and Occupational Therapy of Mechanically Ventilated Patients Impact Outcomes

- Study included 104 adults who were fully functional at baseline and were sedated and on mechanical ventilation (for less than 72 hours) in the ICU. Patients were assigned to either:
  - Intervention group: daily activity (initially passive ROM exercises for all limbs and then progressing to active involvement, as tolerated) during interruption of sedation (n=49)
  - Control group: daily interruption of sedation with standard care (n=55)

- Patients assigned to the early mobilization had:
  - Fewer hospital days with delirium (28% as compared to 41% in the control group)
  - More ventilator-free days (23.5 as compared to 21.1 in the control group)
  - A shorter time from intubation to
    - First PT/OT session (1.5 days as compared to 7.4 days in the control group)
    - Out of bed (1.7 days as compared to 6.6 days in the control group)
    - Standing (3.2 days as compared to 6.0 days in the control group)
    - Transfer to a chair (3.1 days as compared to 6.2 days in the control group)
    - Walking (3.8 days as compared to 7.3 days in the control group)
  - A higher probability of returning to independent functional status at hospital discharge (59% of patients as compared to 35% in the control group)

First PT/OT session = physical/occupational therapy; ROM = range of motion.

Early Physical and Occupational Therapy in Mechanically Ventilated Patients

- Safe
- Well tolerated
- ↑ functional outcome
- ↓ duration of delirium
- ↑ VFD

PT/OT = physical/occupational therapy; ROM = range of motion.
Summary: Clinical Evidence for Early Patient Mobility

• Manual turning, 45° head of bed, continuous lateral rotation therapy, passive and active range of motion, as well as sitting in the chair and ambulating are part of early patient mobility

• Early activity is feasible and safe in patients with respiratory failure

Overcoming Barriers to Early Mobility
Potential Barriers to Early Mobilization

- Patients noted to be turned less often\(^1\):
  - Heavier patients\(^*\)
  - Patients receiving vasopressors\(^*\)
  - Patients receiving a paralytic agent at least once
  - Trauma patients with multiple fractures or high intracranial pressure

- Perceived patient and environmental barriers to mobilizing ICU patients\(^2\):
  - Fear of line dislodgement
  - Heavy sedation
  - Patient comfort
  - Human and technological resources
  - Fear of further decreases in oxygenation or hemodynamic parameters

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Feasibility and Safety of Early Activity in Patients With Acute Respiratory Failure: Methods

- 103 patients who are mechanically ventilated for >4 days
- Mobility team included registered nurse, physical therapist, respiratory therapist, and care technician
- Patients assessed upon admission and daily for readiness
- Activity begins when patient exhibits physiologic stability
- Sedation reduced and oxygen levels supported
- Examples of activity related adverse events
  - Fall to knees, systolic blood pressure >200 or <90 mm Hg, oxygen desaturation <80% and/or extubation, and/or tube removal
Feasibility and Safety of Early Activity in Patients With Acute Respiratory Failure: Results

• Measured 1,449 activity events
• Sit on bed (16%), sit in chair (31%), and ambulate (53%)
• Patients with an endotracheal tube in place had 593 activity events
  – 249 (42%) were ambulated
• 69% survivors ambulated >100 feet at respiratory ICU discharge
• <1% activity-related adverse events

Feasibility and Safety of Early Activity in Mechanically Ventilated Patients Immediately After Intubation

• Methods:
  – Study included 49 ICU patients who had been mechanically ventilated for <72 hours
  – 43% of the patients had ARDS on ICU admission
  – Patients received daily sedative interruption and were screened for the safety of PT/OT
    • PT/OT progressed from passive range of motion to active or active-assisted range of motion,
      then bed mobility exercises (lateral rolling and transferring from semirecumbent to upright),
      followed by sitting at the edge of the bed, balance activities, activities of daily living training,
      transfers, and finally ambulation

• Results:
  – Therapy occurred on
    • 87% of total eligible days on study
    • 90% of days on mechanical ventilation
    • 90% of days in the ICU while not on mechanical ventilation
  – Patients had ICU delirium during 53% of sessions
  – Average time from intubation to initial therapy was 1.5 days
  – Adverse events only occurred during 16% of all PT/OT sessions, including desaturation ≥5%, heart rate increase, ventilator asynchrony/tachypnea, agitation/discomfort, and device removal

ARDS=acute respiratory distress syndrome; PT/OT=physical/occupational therapy.
The Role of Hemodynamic Instability in Positioning\(^1,2\)

- No differences noted in hemodynamic variables between supine and positions
- Lateral turn results in a 3%-9% decrease in SVO\(_2\), 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


The Role of Hemodynamic Instability in Positioning\(^1\) (Cont.)

- Factors that put patients at risk for intolerance to positioning:
  - Elderly
  - Diabetes with neuropathy
  - Prolonged bed rest
  - Low hemoglobin and cardiovascular reserve
  - Prolonged gravitational equilibrium

Decision-Making Tree for Patients Who Are Hemodynamically Unstable With Movement

Is the patient hemodynamically unstable with manual turning?
- O₂ saturation < 90%
- New onset cardiac arrhythmias or ischemia
- HR < 60 >120
- MAP < 55 >140
- SPB < 90 >180
- New or increasing vasopressor infusion

Is the patient still hemodynamically unstable after allowing 5-10 minutes’ adaption post-position change before determining tolerance?

Has the manual position turn or HOB elevation been performed slowly?

Initiate continuous lateral rotation therapy via a protocol to train the patient to tolerate turning

Begin in-bed mobility techniques and progress out-of-bed mobility as the patient tolerates

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

Yes

No

Yes

No

Yes

No

Yes

No

No

No

No

Yes

Yes

Yes

Yes

No

Begin in-bed mobility techniques and progress out-of-bed mobility as the patient tolerates

Try the position turn or HOB maneuver slowly to allow adaption of cardiovascular response to the inner ear position change

No

Yes

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

HOB=head of bed; HR=heart rate; MAP=mean arterial pressure; SPB=systolic blood pressure.


Mobility Initiative to Overcome Process/Culture Barriers: Methods

- Multicenter implementation of key clinical interventions
- An evidence-based, user-friendly early mobility continuum was developed, led by the clinical nurse specialist faculty
- Implementation plan: process design, culture work, and education
- 130 patients/3,120 prospectively collected hourly observations
- Qualitative and quantitative data collected
Mobility Initiative to Overcome Process/Culture Barriers: Results

- Qualitative reports suggest that the collaborative approach improved both the culture and team focus on the process of mobility.
- Substantial utilization of physical therapy within 24 hours of admission.
- There were no significant differences demonstrated in any of the mobility intervention group measurements; however, a reduction in ventilator days (3.0 days pre vs 2.1 days post) approached significance ($P=0.06$).

Learning progression for patient mobility:

- Right type of support, right time
- Cultural Adaptation to Increase Sustainability

Changing Culture

Recognizing the Hard Work and Safety Issues

– Mobilizing critically ill patients is not without risk
  • Having an well-structured framework helps to reduce fear and improve safety...build the will
  • Having the knowledge that it is not as risky as first perceived
  • Acknowledgement that it can be time consuming/labor intensive
– Demands coordination of resources from multiple disciplines
– Ensure the right technology is available to facilitate the plan of care
– Displaying the Progressive Mobility Continuum at the bedside allowed for just-in-time coaching
– Developed formal exclusion criteria. If no exclusions then patient gets mobilized
– Create a reliable process for early mobility that includes measurement & feedback mechanisms

Care Bundles and Protocols
ICU Phase-Specific Approach to Rehabilitation in Critical Illness

Targeting muscles, nerves, and brain during and after the ICU stay

- Resuscitation, steroids, NMB, ventilation
- Glycemic control, sedation
- Delirium treatment
- Wakefulness, early mobility, physical therapy

Serial measures of muscle weakness: MRC, strength, function
Serial measures of wakefulness, sedation, and delirium

MRC = Medical Research Council; NMB = neuromuscular blockade.

ABCDE Bundle to Mitigate ICU-Acquired Delirium and Weakness

- ABCDE bundle = Awakening and Breathing Coordination, Delirium monitoring, and Exercise/early mobility

- ABCDE is designed to:
  - Promote collaboration among clinical team members
  - Standardize care
  - Break the ICU ventilation-sedation-delirium-weakness cycle

ABCDE Bundle Clinical Evidence

- The ABCDE bundle was evaluated in critically ill patients receiving mechanical ventilation in a prospective before-after study of 186 patients from 5 ICUs (93 patients pre-ABCDE bundle implementation and 94 patients post implementation)\(^1\)
  - After ABCDE bundle implementation, patients experienced more days breathing without assistance (average of 24 days without vent assistance vs 21 days in the pre-bundle group) and were less likely to experience ICU delirium (66% vs 75.3% in the pre-bundle group).

- A prospective study evaluated nonventilated patients in the ICU both prior to (n=53) and after (n=56) the implementation of the ABCDE bundle\(^2\)
  - ABCDE bundle implementation resulted in a reduction in the overall incidence (19.6% vs 39.6% in the pre-bundle group) and duration of delirium in nonventilated ICU patients.


Use of an Early Mobility Protocol and Technology to Increase Activity Among ICU Patients\(^1\)

Studied the impact of utilizing an early mobility protocol on patient outcomes among ICU patients.

Results
- Decreased ICU LOS by 4.1 days\(^1\)
- Decreased ventilator days by 2.9 days\(^1\)
- First activity occurred 3.4 days sooner\(^1\)
Use of a Mobility Bundle Toolkit and Technology in a Neurointensive Care Unit

**Methods:**
- A mobility bundle toolkit was developed, including an 11-step algorithm progressing from 45° head of bed → partial chair → full bed chair → standing in place → pivot and into chair → transfers → ambulation with increasing distances and levels of independence.
- Additional mobility aids were purchased.
- Interdisciplinary education was initiated.

**Results:**
- Mobility was increased among the neurointensive care patients by 300%.
- Neurointensive care unit LOS was reduced by 13%.
- Hospital LOS significantly decreased from +/- 12 days to +/- 8.6 days.
- Hospital-acquired infections were reduced by 60%.
- Ventilator-associated pneumonia significantly decreased from a rate of 2.14 +/- 0.95 VAP cases per 1,000 ventilator days to 0.

LOS=length of stay.

Average ICU Costs

<table>
<thead>
<tr>
<th>Potential Cost Savings if 1 Day Reduced ICU LOS (with no mechanical ventilation) in an ICU With an Average of 500 Patients Annually</th>
<th>Potential Cost Savings if 1 Day Reduced ICU LOS (with mechanical ventilation) in an ICU With an Average of 200 Vent Patients Annually</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICU reduced LOS</td>
<td>Reduced ventilator days</td>
</tr>
<tr>
<td>ICU cost/day</td>
<td>Vent cost/day</td>
</tr>
<tr>
<td>ICU savings/patient</td>
<td>Vent savings/patient</td>
</tr>
<tr>
<td>Annual number of ICU patients</td>
<td>Annual number of vent patients*</td>
</tr>
<tr>
<td>Annual ICU LOS savings</td>
<td>Annual ventilator savings</td>
</tr>
<tr>
<td>$1,592,000</td>
<td>$793,600</td>
</tr>
</tbody>
</table>

Early mobility has the potential to help reduce ICU LOS for non-vented and vented patients, creating the potential for significant savings.

How Can We Implement a Program to Help Patients Achieve Early Mobility and Potentially Reduce Organizational Costs?

Utilizing bed systems combined with lifts and a early mobility protocol, caregivers can progress patients from the flat/supine position through exiting the bed safely, easily, and more often.

This early mobility protocol is a simplified process of small, interventional activities that can be easily accomplished at the bed side with a minimum number of caregivers.
### Initial Patient Assessment

- Assess patients’ mobility levels within 8 hours of admission to the ICU and reassess at least every 24 hours.

<table>
<thead>
<tr>
<th>Mobility Level Criteria</th>
<th>Start at Level 1 if:</th>
</tr>
</thead>
<tbody>
<tr>
<td>PaO₂/FiO₂</td>
<td>&lt;250</td>
</tr>
<tr>
<td>Positive end-expiratory pressure (PEEP)</td>
<td>≥10 cm H2O</td>
</tr>
<tr>
<td>O₂ saturation</td>
<td>&lt;90%</td>
</tr>
<tr>
<td>Respiratory rate (RR)</td>
<td>Not within 10-30 per min.</td>
</tr>
<tr>
<td>Cardiac arrhythmias or ischemia</td>
<td>New onset</td>
</tr>
<tr>
<td>Heart rate (HR)</td>
<td>&lt;60 or &gt;120 beats per min.</td>
</tr>
<tr>
<td>Mean arterial pressure (MAP)</td>
<td>&lt;55 or &gt;140 mm Hg</td>
</tr>
<tr>
<td>Systolic blood pressure (SBP)</td>
<td>&lt;90 or &gt;180 mm Hg</td>
</tr>
<tr>
<td>Vasopressor infusion</td>
<td>New or increasing</td>
</tr>
<tr>
<td>Richmond agitation sedation scale (RASS)</td>
<td>≤–3</td>
</tr>
<tr>
<td>Riker sedation-agitation scale (SAS)</td>
<td>≤3</td>
</tr>
</tbody>
</table>


### Early Mobility Protocol

**Level 1: Breathe**

**Patient Assessment**

- RASS –5 to –3; SAS 1-2 (eg, cannot participate)

**Activities**

- Every-2-hour turning
- Passive range of motion
- 20° Reverse Trendelenburg/Tilt Table with lower extremity exercises/retracting footboard

**HOB angle – improve VAP protocol compliance**

- The Centers for Disease Control and Prevention recommends an HOB angle of 30°-45°, unless contraindicated.
- Visually confirm the HOB is elevated ≥30° to comply with VAP prevention protocols

---

Continuous lateral rotation therapy (CLRT) can be considered part of early mobility therapy in patients who are at high risk for pulmonary complications.

CLRT provides side-to-side rotation to help facilitate gravitational effects on pulmonary secretions and blood flow.

Consult the CLRT Quick Reference Guide for additional information:
- The CLRT QRG provides information regarding patient assessments and activities to be implemented in both hemodynamically stable and hemodynamically unstable patients.

Where Does CLRT Fit Into a Early Mobility Program?

CLRT=continuous lateral rotation therapy; PEEP=positive end-expiratory pressure.
Where Does CLRT Fit Into a Early Mobility Program? (Cont.)

CLRT Protocol for Hemodynamically Stable Patients

- Indications: Prior to hemodynamic stability with manual turning and/or difficulty with repositioning (FR), increases by 30°/45° in total rotation of the patient and increases in PEEP 0.5 cm H2O from baseline within 2-4 days
- Combination: patient with unstable supine cold injury
- Patient Assessment: Hemodynamically Stable

Activities
- Maintain HOB at 15° and 15° Trendelenburg "Half Table" position
- Minimum total rotation of the patient optimally 10-12
- Set rotation 30° and pause 10 min on either left or right
- Monitor for signs of hemodynamic instability
- Within 2 hours, move to 100° rotation
- Decrease pain by 0.5 cm H2O after patient is no longer stable
- If pain persists, consider changing position to promote effective range of motion (shoulders aligned with the long axis of the bed) and to manually move the patient to evaluate posterior skin and range of motion

Move to Level 2 When the Patient...
- May be mobilized safely using other means (HIC, Chair position, out-of-bed chair, and/or ambulation)
- Shows improved respiratory status
- Has agitation that is not therapeutically managed

CLRT=continuous lateral rotation therapy; PEEP=positive end-expiratory pressure.
CLRT Protocol for Hemodynamically Unstable Patients

Activities

- Maintain HOB > 30° and 15° reverse Trendelenburg/11° Table (to achieve 30°)
- CLRT 14 hours per day, 24 hours of complete rotations, optimal 10-12
- Use the training mode, or if not tolerated, set rotation 60% and pause 20 min for right/left and reverse
- Monitor that on each side the patient will sit up 90° with a turn of 180° or 90° for rotation and sit up 180°
- Increase rotation percentage if tolerated
- Rotation percentages should be increased up to 100% within 24 hours
- Decrease pause to 0-1 min as the patient adjusts
- Check every 3 hours to ensure that the patient is in optimal position to promote effective turn (shoulders aligned with the long axis of the bed) and to manually turn patient to evaluate posterior skin and lungs

Move to Level 2 When the Patient...

- May be repositioned safely using other means (HOB, Chair position, out-of-bed chair, and/or ambulation)
- Shows improved respiratory status
- Has agitation that is not therapeutically managed

Early Mobility Program Protocol

Level 1: Breathe (Cont.)

**Breathe**

- Move to Level 2 when the patient...
  - Has acceptable oxygenation/hemodynamics
  - Tolerates every-2-hour turning
  - Tolerates HOB > 30° or Reverse Trendelenburg 20°
Early Mobility Program Protocol
Level 2: Tilt

**Patient Assessment**

RASS ≥–3; SAS >3 (e.g., opens eyes; may have profound weakness)

**Tilt**

20° Reverse Trendelenburg/Tilt Table position

- Tilt Table positioning allows for orthostatic training in fragile patients
- If available, use in conjunction with retracting foot section to allow for partial weight bearing prior to sitting up in bed or getting out of bed

**Activities**

- Maintain head of bed ≥30°
- Every-2-hour turning
- Passive/active range of motion
- Legs dependent (partial chair)
- PT consultation


---

Early Mobility Protocol
Level 2: Tilt (Cont.)

- Move to Level 3 when the patient...
  - Tolerates active-assistance exercises 2 times a day
  - Tolerates lower extremity exercises against footboard/20° Reverse Trendelenburg
  - Tolerates partial chair position (legs dependent/HOB ≥30°)
  - Can move arms against gravity
Early Mobility Protocol
Level 3: Sit

Patient Assessment
RASS >-1; SAS >3 (eg, weak but may move arms/legs independently)

**Sit**

**Chair mode (footboard on)**
- Full upright positioning allows for diaphragmatic excursion and lung expansion
- Sitting with legs in a dependent position facilitates gas exchange

**Activities**
- Maintain head of bed ≥30°
- Every-2-hour turning (assisted)
- Active range of motion
- Encourage activities of daily living
- Dangling
- PT/Occupational therapist actively involved

---

Early Mobility Protocol
Level 3: Sit (Cont.)

- Move to Level 4 when the patient...
  - Tolerates increasing active exercise in bed
  - Actively assists with every-2-hour turning or turns independently
  - Tolerates chair position 3 times/day
  - Can move leg against gravity
Early Mobility Protocol
Level 4: Stand

Patient Assessment
RASS >0; SAS >4 (eg, weak but may tolerate increased activity)

Stand Attempts
• Chair egress position (footboard off/feet on the floor)
• Consider using a sit-to-stand lift
• If tolerates partial weight bearing, pivot to chair

Activities
• Maintain head of bed ≥30°
• Every-2-hour turning (self/assisted)
• Active range of motion
• Encourage activities of daily living
• PT/OT actively involved

Early Mobility Protocol
Level 4: Stand (Cont.)

• Move to Level 5 when the patient...
  – Can successfully comply with all activities
  – Tolerates trial periods of chair egress position (footboard off/feet on the floor) 3 times a day
  – Tolerates partial weight-bearing stand and pivots to chair
Early Mobility Protocol
Level 5: Move

**Patient Assessment**

RASS >0; SAS >4 (eg, weak but may tolerate increased activity)

**Move**

Achieve “out-of-bed” orders
- Utilize mobile floor lift (or ceiling lift) to ambulate to bedside chair

**Activities**
- Maintain head of bed ≥30°
- Every-2-hour turning (self/assisted)
- Active range of motion
- Encourage activities of daily living
- Patient stands/bears weight >1 minute
- Patient marches in place
- PT/OT actively involved

**Patients continue to ambulate progressively longer distances as tolerated until they consistently participate and move independently**

Summary: Implementing the Early Mobility Protocol Using Technology

- Implementation of the early mobility protocol may result in better clinical outcomes and financial outcomes
  - Clinical outcomes may include patients getting off the ventilator sooner, less VAP, less potential for skin injury, and a reduction in delirium
  - Financial outcomes may include decreased ICU LOS, decreased ventilator days, and decreased hospital LOS

- Use of early mobility is safe
  - It can be used in patients with ARDS or delirium
  - It can increase the comfort of staff and patients

- Various tools and techniques can facilitate the implementation of a simple, 5-step early mobility protocol

ARDS=acute respiratory distress syndrome; LOS=length of stay; VAP=ventilator-associated pneumonia.
Questions?
References


References (Cont.)


References (Cont.)


References (Cont.)

Sijsrand T. Volume and distribution of blood and their significance in regulating the circulation. Physiol Rev. 1953;33:203-228.
References


References (Cont.)