“Minimal Physiologic Mobility Requirement”

Move Every 11 Minutes During Sleep


1990’s CLRT Research

Methodology
- 12 adult healthy baboons were randomized to CLRT or control for 11 days
- Mechanically ventilated, paralyzed and sedated and received normal supportive therapy
- Measured x-ray results, cultures, bronchioalveolar lavage, oxygenation indices, pulmonary function and lung volumes

Anzueto A et al Crit Care Med 1997;25(9):1560-1564

1990’s CLRT Research

Results
- No significant difference in hemodynamics, gas exchange or pulmonary function
- Day 7 the control group showed patchy atelectasis
- Day 11 two animals showed persistent radiological abnormalities. Bronchoalveolar lavage day 7 and 11 revealed significant increase in neutrophils
- Lung pathology in control group showed areas of bronchiolitis with 5 of 7 of the control animals demonstrating surrounding bronchopneumonia

Anzueto A et al Crit Care Med 1997;25(9):1560-1564

Reduction in FRC in the Supine Position

⇒ Influence of the abdominal contents on the diaphragm
⇒ Position of the heart and relationship of the supporting structures to the lung and its influence on pleural pressure gradients
Blood Flow Changes with Position

**Supine position:** Distribution becomes more uniform. Zone 3 maintained throughout the lung. Greater vertical perfusion gradient.

**Lateral position:** Similar to supine except lung transforms to zone 2 approximately 18 cm above the most dependent part of the chest.

**Prone position:** Zone 3 maintain throughout the lung. Reduced gravitational flow noted.

The Effects of Immobility/Supine Position on Respiratory Function

- Decreased Respiratory Motion
  - Abdomen influence on diaphragm motion
  - Atelectasis
- Increased Risk of Pulmonary Embolism
- Increased Dependent Edema
  - Fluid accumulation in the dependant regions
  - Compression atelectasis

The Effects of Immobility/Supine Position on Respiratory Function

- Decreased Movement of Secretions
  - Impaired ability to clear tracheobronchial secretions
- Normal mechanism dysfunctional in supine position
  - Mucociliary escalator
  - Gravity drainage
  - Cough reflex
- Increased Risk of Atelectasis & the Development of a Ventilator Associated Pneumonia
Hospital Acquired Pneumonia (HAP) and Ventilator-Associated Pneumonia (VAP)

- VAP crude mortality approximately 10-40%.
- HAP crude mortality 15-18%
- Median rates range 2.4 to 14.7 per 1000 ventilator days.
- HAP rates 5-15 per 1000 patient days.
- Associated cost $30,000-$40,000 per VAP.
- Increase LOS up to 16 days.
- Annual cost $2 billion dollars.

Rello J. Chest. 2002;121:2115-2121
ATS Guidelines for Healthcare Acquired Pneumonia 2006

Immobility = Deconditioning

Multiple changes in organ system physiology that are induced by inactivity and reversed by activity.

Skeletal Muscle Deconditioning

- Skeletal muscle strength reduces 1% to 2% daily with strict bed rest.
- Without activity the muscle lose protein.
- 2 types of muscle atrophy:
  - Primary: bed rest, space flight, limb casting
  - Secondary: pathology.
- Muscle groups that lose strength most quickly related to immobilization are those that maintain posture, transferring positions & ambulation.
- 1.5 kg of skeletal muscle per day, up to 50% within 2 weeks.
- One day of bed rest requires two weeks of reconditioning to restore baseline muscle strength.


Immobility = Skin Injury

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
  - 2.7% had a q 2 hour body position change.
  - 80-90% believed q 2 hour position change should occur but only 57% believed it happened in their ICU.

Krishnagopalan S. Crit Care Med 2002;30:2588-2592
CLINICAL RESEARCH

- Supine vs. Head Elevation
- Supine vs. Lateral
- Supine vs. Prone

Supine vs. Degrees of Head Elevation Research

- Rabow, et. al. 1972
- Vaughan, et. al. 1976
- Dalrymple, et. al. 1979
- Russell 1981
- Ciresi, et. al. 1981
- Gui, et. al. 1982
- Marti & Ulmer 1982
- Minh, et. al. 1986
- Burns, et. al. 1994

Supine vs. Degrees of Head Elevation Research for Prevention of Ventilator-Associated Pneumonia

Risk Factor Categories for Health Care Acquired Pneumonia

- Factors that increase risk of aspiration
- Factors that increase bacterial burden or colonization

HOB Research

Methodology:
- 86 patients
- Randomly assigned to supine position or HOB 45 degrees (39 semi recumbent, 47 supine)
- Monitored clinical suspected & microbiologically confirmed nosocomial pneumonias

Results:
- Microbiologically confirmed nosocomial pneumonia lower in the semi recumbent group 2/39 (5%) vs. 11/47 (23%)
- Supine position & enteral nutrition were independent risk factors for VAP & had the greatest number of VAP’s 14/28 (50%)


*p < .001

HOB Research

Methodology
- Prospective multicenter trial randomly assigned to targeted 45° vs. 10° HOB
- 112 to targeted 45° vs. 109 patients to 10°
- Continuous measurement of backrest elevation first wk of MV
- Dx of VAP by bronchoscopic techniques

Results
- Baseline characteristics similar
- Average elevations
  - 10° group day 1 & 7: 9.8 & 16.1
  - 45° group day 1 & 7: 28.1 & 22.6
- Target 45° not achieved 85% of the time
- VAP: 10° = 6.5% vs. 45° = 10.7%

**Lateral Positioning Research**

- Bilateral lung disease
- Unilateral lung disease

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**Meta-Analysis CLRT**

Methodology

- 419 Patients
- 6 Studies:
  - Fink MP. Chest, 1990:97:132
  - Nelson LD. Clin Inten Care, 1992:3:248
  - Summer WR. J Crit Care, 1989;4:45

- Outcomes Measured:
  - Pneumonia, embolus, pressure sores, ARDS, atelectasis, mortality hours intubated ICU days, ICU charges, hospital days

Meta-Analysis CLRT Results

- CLRT vs. Conventional Turning
  - 50% reduction in incidence of pneumonia (p <0.002)
  - 35% reduction in time intubated (p <0.04)
  - 24% reduction in ICU stay (p<0.02)


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**Rotation Therapy Outcome Studies**

<table>
<thead>
<tr>
<th>Installation</th>
<th>Year</th>
<th>Setting</th>
<th>Patients</th>
<th>Intervention</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stanford Univ MC</td>
<td>1994</td>
<td>MICU</td>
<td>Decreased ICU LOS by 5.2 days Decreased Days of Pneumonia by 52%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cape Fear Valley MC</td>
<td>1994</td>
<td>Decreased H &amp; ICU LOS, Decreased Vent Days 48 fewer NP year of the 6 month bed study</td>
<td>Lag time effect: decreased days on therapy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sarasota Memorial</td>
<td>2001</td>
<td>Decreasing LAG time resulted in 14% decrease in HLOS, Vent Days, &amp; 20% decrease of SNR [standard mortality ratio]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medical Center of Georgia</td>
<td>2002</td>
<td>Decrease Vent Days, Decreased Hospital LOS, Decrease ICU LOS by 5-6 days.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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**2000’s CLRT Research**

Methodology

- 234 Medical-Surgical-Trauma patients
- 137 control, 97 rotation, 22 did not tolerate
- Dialed 40 degrees, > 18hrs, 10min/5min/10min cycle vs. q 2hr with pillows
- HOB degree not mentioned
- Measured incidence of VAP, lobar atelectasis & cost

Results

- Incidence of VAP p=0.002
- Incidence of lobar atelectasis p=0.02
- No difference in ICU LOS, Hospital LOS or mortality
- Rotation average of 5 days


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**Table: Proportion of patients with pneumonia**

<table>
<thead>
<tr>
<th>Study or settings category</th>
<th>Patients</th>
<th>Odds ratio (Fixed)</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumonia &amp; prophylaxis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Demetrius et al</td>
<td>116</td>
<td>0.74</td>
<td>3.45</td>
</tr>
<tr>
<td>Ferri et al</td>
<td>751</td>
<td>0.96</td>
<td>14.98</td>
</tr>
<tr>
<td>Garrett et al</td>
<td>333</td>
<td>0.40 (0.26, 0.63)</td>
<td>7.05</td>
</tr>
<tr>
<td>Kimbell et al</td>
<td>518</td>
<td>0.74</td>
<td>6.27</td>
</tr>
<tr>
<td>Kronic et al</td>
<td>517</td>
<td>0.70</td>
<td>6.27</td>
</tr>
<tr>
<td>Lengel et al</td>
<td>42</td>
<td>0.58 (0.35, 0.93)</td>
<td>1.23</td>
</tr>
<tr>
<td>Tranter et al</td>
<td>694</td>
<td>0.50 (0.32, 0.78)</td>
<td>10.28</td>
</tr>
<tr>
<td>Williams et al</td>
<td>10,300</td>
<td>0.50 (0.32, 0.78)</td>
<td>10.28</td>
</tr>
<tr>
<td>Walkley et al</td>
<td>614</td>
<td>0.50 (0.32, 0.78)</td>
<td>10.28</td>
</tr>
<tr>
<td>Subtotal (95% CI)</td>
<td>9,865</td>
<td>0.50 (0.32, 0.78)</td>
<td>10.28</td>
</tr>
</tbody>
</table>

**Goldhill DR et al. Amer J Crit Care, 2007;16:50-62**
Systematic method of approaching placement & removal of rotational therapy

Prolonged Pause Time in Deep Lateral Position: Negative Impact on Pulmonary Mechanics

- Prospective observational study
- 12 ICU patients with ALI/ARDS undergoing CLRT (62 degree angle)
- Measurement (gases and mechanics) taken during R, L, C rotation and 30 minutes R, L, C

Results
- No changes in gases, shunt or cardiac index
- Lower compliance* & higher PaCO2** in steep lateral 30 minutes pause position than supine

*\( p<0.0001 \)
**\( p<.01 \)

Schellongowski P, et al. Intensive Care Medicine, 2006;

WHEN TO STOP CLRT
- When the patient no longer fits the criteria that placed them on CLRT
- When the patient can be mobilized into an upright position without hemodynamic compromise

What is Your Next Move!!!!
Combate deconditioning through progressive positioning when CLRT treatment is completed

When to Initiate Progressive Mobilization
- Is the Patient:
  - Deconditioned by > 3 days of immobility, or
  - Ready to begin weaning from the ventilator, or
  - Does the patient require orthostatic training to the upright position

MOBILITY PROTOCOL
- Mobility Protocol - Michelle Tracy RN, PhD unit educator at Pitt County Memorial Hospital, Greenville, NC
- Patient’s that meet criteria to be moved are mobilized into Chair Position using the a Bed System 3 times / day.
- Quality tool developed to track outcomes
- Staff have been 90% compliant or greater
- Preliminary results have shown a decrease in LOS and a decrease in VAP

Tracey M. Critical Care Nurse, 2004 * In Our Unit
**Mobility Matters**

### Science of Chair Position

- Examine the effect of body position on pulmonary mechanics, gas exchange and lung volumes in elderly subjects without lung disease
- 10 subjects, mean age 59, 6F/4M randomly placed in each position for 30min. On 21% 100%
- 3 POSITIONS:
  - Sitting with Feet Down (ST) 75 degrees
  - Semi-fowlers with feet level (SF) 45 degrees
  - Supine with feet level (SP) 0 degrees

Pulmonary mechanics and gas exchange are best when ST @ 75 degrees with feet down. May benefit from a bed capable of sitting (ST), with feet down

Slide courtesy of Branson 2006

Johanningman, Campbell, Branson et al, CHEST 1997, New Orleans, LA, ACCP

### 2007 - Progressive Patient Positioning

- **Old way**
  - Admission, bed, immobilized, supine, complications
- **New way**
  - Lateral rotation
  - HOB elevation
  - Full-chair position
  - Bed egress/weight bearing
  - Bedside chair
  - Ambulation
  - Enhanced recovery

### WHY PRONE POSITION IN ACUTE RESPIRATORY FAILURE ?

- To improve oxigenation during prone positioning and after repositioning supine (Langer, Chest 1998; Gattinoni, NEJM 2001)
- To improve the response to recruitment maneuvers during prone positioning ( Pelosi, AJRCCM 2003; Oczenski, CCM 2005)
- To improve respiratory mechanics after repositioning supine ( Pelosi, AJRCCM 1998)
- To improve drainage of secretions ( Pelosi, Eur Respir J 2002; Reignier, Intensive Care Med 2005)

### Review of Prone Research

Research up to 2004
- 651 patients turned prone (1105 total)
  - 17 studies (46 total)
  - 58% abdomen free (versus 80%)
  - 50% volume ventilation (versus 93%)
  - 50% pressure controlled

RESULTS: 71% reported a response >20% change in P/F ratio or 10mmHg increase in PaO2 within 1 to 2 hours
  - Time in prone position 30 minutes to 20 hours
  - Trend of complications associated with > time spent in the prone position


### Prone-Supine II: The Effects of Prone Positioning for Patients Affected by ARDS

Phase III Trial in Progress

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Kathleen M. Vollman MSN, RN, CCNS, FCCM
Barriers to Mobility Strategies

- Human or Technological Resources
- Hemodynamic instability
- Knowledge/Priority

Human & Technological Resources

- Personnel
- Aging personnel
- Use of Lift teams
- Fear
- Lines and tubes
- Patient size

Morris PE Crit Care Clin, 2007;23:1-20

Hill-Rom Patient Turning Survey
AACN/NTI Survey 2001

Why it doesn’t always get done

<table>
<thead>
<tr>
<th>Staff Concerns</th>
<th>CC Replies</th>
<th>M/S Replies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limited staff available</td>
<td>85.5%</td>
<td>83.7%</td>
</tr>
<tr>
<td>Patient to difficult to move</td>
<td>75.0%</td>
<td>71.6%</td>
</tr>
<tr>
<td>Patient too painful to move</td>
<td>62.0%</td>
<td>41.3%</td>
</tr>
<tr>
<td>Risk of staff injury</td>
<td>53.1%</td>
<td>58.7%</td>
</tr>
<tr>
<td>Staff not capable of moving pt.</td>
<td>27.0%</td>
<td>31.5%</td>
</tr>
<tr>
<td>Risk of patient injury</td>
<td>26.3%</td>
<td>27.2%</td>
</tr>
<tr>
<td>Too time consuming</td>
<td>21.6%</td>
<td>28.3%</td>
</tr>
</tbody>
</table>

2001 NTI Survey on Patient Positioning = 916 Critical Care Nurses responded

Can We Safely Mobilize Intubated Patients?

Early Activity is Safe & Feasible in ARF Patients

Methodology
- Prospective cohort study
- 103 patients/1449 activity events
- Mechanically ventilated patients for > 4 days
- Airway: Tracheotomy & endotracheal tube
- Measured recorded activity events & adverse events
- Activity events included:
  - Sit on bed, Sit in chair, Ambulate
- Adverse events defined as:
  - Fall to knees, tube removal, SBP > 200 mmHg, SBP < 90 mmHg, O2 desaturation < 80% & extubation

**Early Activity is Safe & Feasible in ARF Patients**

Results:
- Activity events included:
  - Sit on bed (233 or 16%)
  - Sit in chair (454 or 31%)
  - Ambulate (762 or 53%)
- With an ET in place:
  - Sit on bed, chair or ambulate (593)
  - Ambulate (249 or 42%)
- Adverse events
  - < 1% activity related adverse events (no extubations occurred)
  - 69% all to ambulate at > 100 feet at RICU discharge


**Hemodynamic Instability**

Is it a Barrier to Positioning?

**The Effects of Immobility on Cardiovascular Function**

- Orthostatic Intolerance
  - Deteriorates rapidly with bed rest
  - Occurs within 1-2 days with maximum effect at 3 weeks
  - Results from decreased autonomic tone & fluid shifts

Melada, G.A., et al. Space and Environmental Medicine, August 1976

**Hemodynamic Status**

- No differences noted in hemodynamic variables between supine & positions
- Lateral turn results in a 3-9% decrease in SVO2 which takes 5-10 minutes to return to baseline
- Appears the act of turning has the greatest impact on any instability seen
- Minimize factors which contribute to imbalances in oxygen supply & demand


**Patients at Risk for Intolerance to Positioning**

- Elderly
- Diabetes with neuropathy
- Prolonged bedrest
- Low Hb an cardiovascular reserve
- Prolonged gravitational equilibrium


**Barriers to Mobility Strategies**

- Human or Technological Resources
- Hemodynamic instability
- Knowledge/Priority
**One-Year Outcomes In Survivors in ARDS/ALI**

- 109 ARDS survivors evaluated at 3, 6 & 12 months post illness
- Survivors young (45 years), Long ICU LOS (median 25 days) and APACHE II > 23
- Loss of 18% Body wt at d/c from ICU
- Muscle wasting & fatigue were reasons for functional limitations
- Lung function & spirometric’s normal 6 months
- CO2 diffusion capacity low for full 12 months
- Absence of steroid use, absence of illness acquired during ICU stay & MODS had better functional status.


**Building a Comprehensive Mobility Protocol**

Impacting Patient Outcomes

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**Typical ICU Patient**

What is the Rest of the Story

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**Strategies For Change**

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Implementation/Measuring Success

• Create a Team
• Review the evidence-based guideline
• Ensure you have policies and procedures for progressive mobility (prone, CLRT, Upright/chair/ambulation)
• Identify additional resources for the change
• Determine outcomes measures
  – VAP, time on ventilator, LOS, functional ability, pressure ulcers
• Build value using the science
• Change strategies
• Measuring the outcome and celebrating