The Right Position at the Right Time: Mobility Makes a Difference

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Is Every Two Hours Enough?

“Minimal Physiologic Mobility Requirement”
Move Every 11 Minutes During Sleep

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

UNDERSTANDING THE IMPACT OF A STATIONARY SUPINE POSITION

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
Basilar 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
Immobilization = Deconditioning

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


Skeletal Muscle Deconditioning

- Skeletal muscle strength reduces 4-5% every week of bed rest
- Without activity the muscle loses protein
- Healthy individuals on 5 days of strict bed rest develop insulin resistance and myocardial dysfunction
- 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.
- One day of bed rest requires two weeks of reconditioning to restore baseline muscle strength

Topp R et al, Am J Crit Care, 2002;11(3):253-70

Critical Illness Neuromuscular Abnormalities

- Systematic review of the literature
- 29 studies with 24 unique populations
- 1421 patients/655 with dx of CINMA (46%)
- 77% of CINMA is unclassified
- Classified: Critical Illness Polynuropathy (CIP) & Critical Illness Myopathy (CIM)
- Risk factors: hyperglycemia, SIRS, MODS, CRRT, Catecholamine administration
- Outcomes: duration of mechanical ventilation, ICU LOS and Hospital LOS, functional limitations post d/c

Stevens RD., et. al, Intens Care Med, 2007;33:1876-1891
Do We Achieve Q2 Hours?

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

Positioning Prevalence

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

Results:
- 5 patients prone at any time, 3.8% (day 1) & 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 hrs (3.3 SD)
- No significant association between time and age, wt, ht, resp dx, intubation, sedation score, day of wk, nurse/patient ratio, hospital

Goldhill DR et al. Anaesthesia 2008;63:509-515
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, bronchoalveolar lavage, oxygenation indices, pulmonary function and lung volumes

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

Positioning Practices/Australian ICU's

- Self reported survey/38 level 3 ICU’s
- Senior Physiotherapist & senior RN
- Survey questions:
  - Knowledge level/rationale for positioning
  - Aims
  - Types of positioning
  - Frequency
  - Duration of directed patient positioning used
  - Perceived risks
  - Barriers to implementation


Positioning Practices/Australian ICU’s

- Response rate: 93%
- 83% agreed there is a standard duration of a position change for mechanically ventilated patients
- 86% stated every 2 hours but only achievable 50% of the time
- Environmental & educational issues impact positioning practices
  - Agreement regarding aims of positioning: strongest in semi-recumbent & side-lying for a range of conditions
  - Physiotherapists focus differed with greater aim focused on drainage, increase patient arousal, reduced muscle tone
  - Nurses focus differed with greater aim focused on patient comfort, pressure ulcer prevention, prevent DVT
- Risks: contraindications include ICP > 20cm H2O, unstable spinal fractures, MAP <60 mmhg

Ventilation

Major Factors Influencing Distribution of Ventilation

- Gravity/weight of the lung
- Compliance/airway resistance
- Heterogeneous lung disease

Air Goes To Area of Least Resistance
Supine Position:

- Distribution becomes more uniform from apex to base
- Dependent lung ventilation > non-dependent
- Reduction in FRC

Amis et al. Respiratory Physiology 1984 56;145
Kaneko et al. J of Applied Physiology 1966 21;767

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

Impact of the Abdomen


Differences in FRC Based on Position

Sitting to Supine Position: FRC declines: 30%
(mean decrease: 800 ml)

Sitting to Lateral Position: FRC declines 15-20%
(mean decrease: 450 ml)

Sitting to Prone Position: FRC declines: 15-20%
(mean decrease: 450 ml)

PERFUSION

Factors Influencing Regional Distribution of Perfusion

- Cardiac output
- Pulmonary vascular resistance
- Gravity/body position
Distribution of Perfusion

**Upright Position:**
Blood flow decreases as it moves from base to apex with virtually little or no flow at the apices.

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 maintains throughout the lung. Reduced gravitational flow noted.

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

Position to Facilitate Weaning in Patients with Large Abdomens

- 19 intubated patients
- Large abdomens r/t obesity, distention & ascites
- CPAP &/or PSV
- Positioned: 0°, 45°, 90°, & RT at 45°

Results: RT at 45° significantly larger tidal volumes & lower respiratory rates than 90°


Lateral Positioning Research

- Patients with predominantly unilateral lung disease improved their PaO₂ when positioned with the GOOD LUNG DOWN
- Patients with more bilateral involvement showed higher PaO₂’s in the right lateral position

Lateral Positioning Research

- Good lung down mean PaO₂: 106.1 ± 12.7 mmHg
- Supine mean PaO₂: 66.8 ± 3.3 mmHg
- Bad lung down mean PaO₂: 58.5 ± 2.7 mmHg


Take Home Points: Positioning for Unilateral Lung Disease

- Patients with unilateral lung disease from a consolidated pneumonia type process oxygenate better with the good lung down.
- Patients with other types of unilateral lung dysfunction may not benefit from this positioning technique.
- CABG patients should be repositioned at least every 2 hours.
- More research is necessary looking at specific unilateral lung disease populations.

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

- Bilateral lung disease
- Unilateral lung disease

Manual Turning: Impact on Pneumonia

- Effect of Post Op Immobilization (Chulay MA et al, CCM, 1982)
  - RCT: 35 post op CABG patient
  - Compared q 2 turning to supine in first 24 hrs post op
  - Results:
    - no problems with Hemo or O2
    - Patient turned has less fever & 3 day ↓ in ICU LOS

- Freq of Turning on Pneumonia (Schallom et al. 2005)
  - Observation: 284 ICU pts for 16/hrs/day x3 days
    - Mean # of observed turns 9.64 vs. 23 possible turns/48 hrs)
  - Results: day 4 patients with pneumonia turned average 8.6x vs. 10.62 without pneumonia

KEANE™ III Mobility Bed
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)

CLRT Research
Methodology
- 106 medical ICU patients
- Assigned to 5 DRG groups (sepsis, stroke, COPD, metabolic coma, drug OD)
- Randomly assigned CLRT vs. conventional bed with DRG group
- Rotated > 18 hours per day
- Measured morbidity, time on vent, ICU, LOS, hospital LOS, incidence of pneumonia
- Higher APACHE II scores in bed therapy group

DeBoisblanc BP et al Chest 1993;103:1543

CLRT Research
Results
- Significant reduction in nosocomial pneumonia in CLRT group (9% vs. 22%)*
- Greatest in sepsis DRG (3% vs. 22%)**
- With higher APACHE II scores no difference in LOS, morbidity, mortality, or time on ventilator

* p=0.05  **p=0.04  DeBoisblanc BP et al Chest 1993;103:1543

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=.002
- Incidence of lobar atelectasis p=.02
- No difference in ICU LOS, Hospital LOS or mortality
- Rotation average of 5 days

Quality Improvement Project

Union Hospital
Union, NJ
November 1999-March 2000
Presented at 2001 NTI/AACN

Pre-Union Hospital Project
Data...Driving the Change

Situation Analysis
- Placement on CLRT was late
- Inconsistent protocol usage
- No internal monitoring of outcomes
- Lack of staff education on CLRT
- Cost of care for pneumonia was rising
- Concern about spending on CLRT beds
- Data collection on non-rotated patients

The Union Hospital Project

The Process
- Literature review
- Evaluate patient population
- Redesigned existing protocol
- Predicus™ Pneumonia Risk Evaluation tool
- Empowered nursing to order CLRT
- Posted algorithm in all patient rooms
- CLRT tracking tool
- Team to follow & measure outcomes
Union Hospital Ventilator Days

- 86 Fewer Vent Days

Union Hospital ICU LOS

- 79 Fewer ICU Days

Union Hospital Hospital LOS

- 80 Fewer Hospital Days
Union Hospital Total Care Charges

$2.2 MM fewer dollars

Union Hospital
Efica Charges Vs. Total Charges for CLRT Patients

48 fewer NP year of the 6 month bed study

Lag time effect: decreased days on therapy

Rotation Therapy Outcome Studies

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Lateral Rotation: Summary of Research Findings

- Lateral rotation is effective in reducing the incidence of pneumonia, atelectasis, time on the vent and stay in the ICU
- The earlier the patient is placed on the therapy during their acute illness the better the response
- CLRT appears to have some benefit on oxygenation variables, however more research is required
- The absolute answer on the degree of rotation and the frequency of rotation to achieve the beneficial effect is not available
Methods
- Retrospective analysis of data collected on 62 CLRT patients
- Mean Apache III score $76.74 \pm 33.65$/Median 71.5
- 45% overall mortality rate
- Dx: ARDS, pneumonia & respiratory failure
- Medical Critical Care area, Trauma & Thoracic Surgery
- Examined change in $\text{PaO}_2/\text{FiO}_2$ ratios based on:
  - Number of hours spent in rotation over course of therapy
  - Degree of rotation (defined as highest degree patients achieved while on therapy)

Cagle, Pieper & Vollman NTI 1993

Results
- 58% improved oxygenation status
- Average days spent in rotation 4.6 $\pm$ 2.3
- Mean hours in rotation 68.45 $\pm$ 48.57
- Positive correlation between hours spent in rotation and improvement in $\text{PaO}_2/\text{FiO}_2$ status
- Mean degree of rotation 29.5 $\pm$ 6.81
- No correlation noted between degree & improvement in ratio

Cagle, Pieper & Vollman NTI 1993

Comparison of Clinical Outcomes in Pulmonary Complications for CLRT via 2 Therapeutic Beds
- Compare outcomes of VAP and Vent LOS with CLRT using 2 different beds
- 12 bed Mixed ICU, 99 intubated patients
- Retrospective analysis of 100% of patients receiving CLRT over a 2 year period (single reviewer)
- Compared outcomes in patients receiving CLRT via TriaDyne and SpO$_2$RT

Fortune D. 2003, White Paper
Chandler Regional Hospital Catholic Health Care West
Comparison of Clinical Outcomes in Pulmonary Complications for CLRT via 2 Therapeutic Beds

- TriaDyne
  - Mean LOS 3.12 days
  - Incidence of VAP while on the bed: 3
  - VAP % during use of TriaDyne 8.8%
- SpO2RT
  - Mean LOS 2.68 days
  - Incidence of VAP while on the bed: 1
  - VAP % during use of the SpO2RT 1.5%

Fortune D. 2003, White Paper
Chandler Regional Hospital Catholic Health Care West

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 or if rotation not in use within 48hrs of intubation if following is present:

- Responsiveness to stimulation (not comatose)
- Respiratory stability (FiO2 < 60% & PEEP < 10 cm H2O)
- Cardiovascular stability (no active cardiac ischemia, hypotension, or increasing infusion of vasopressin medication)
- Absence of unstable fracture (eg. Cervical spine)

Needham DM, JAMA, 2008;300(14):1685-1690

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**Critical Care Nurses & Physiotherapist**

Partners in Progressive Mobility of the ICU patient

- Combat deconditioning and related complications
- Prevent respiratory complications
- Reduce emotional problems and improve communication


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**Safety Mobilizing Critically Ill Patients**

- Review medical background
- Is their sufficient CV reserve?
  - Discuss with team to evaluate
- Are all other factors or conditions favorable?
  - Review with team
- Select appropriate mode and intensity of mobilization

Range of Motion

- The arc through which a joint can be moved, usually a range of flexion and extension
- ~35% of ICU patients with LOS > 8 weeks develop contractures (Clavet et al. 2008)
- PROM does not increase ICP (Koch et al. 1996 & Brimioulle et al 1997)
- Can increase oxygen consumption by 15% (Weissman et al. 1984)
- Begin PROM 3x daily within 48hr of intubation: Protocol based with 3 day LOS reduction (Morris PE, et al, CCM 2008)

Consensus Document
European Respiratory & Intensive Care Society

- Positioning can reduce the work of breathing & improve the efficacy of ventilation (Level C)
- Body positioning should be used to optimize ventilatory pump mechanics in patients with respiratory insufficiency (Level C)
- Active or passive muscle training should be initiated early (Level C)
- Positioning, splinting, passive mobilization and muscle stretching for patients unable to move spontaneously (Level C)
- Therapist driven weaning protocols & SBT implemented depending on MD staffing levels in the ICU (Level A)
- Consider muscle training (Level C)


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"
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) 45degrees
  - 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

Making Early Ambulation a Priority: Impacting Outcomes

- Pre-post cohort study of respiratory failure patients at LDS.
- Respiratory failure requiring > 4 days of mechanical ventilation who were transferred from other LDS units.
- Prospective application of an early activity protocol to 104 patients.
- Protocol: 3 criteria for activity initiation, neurologic (followed commands & cooperative), respiratory (FiO2 < 60% & PEEP < 10cm & circulatory (no drips or symptomatic orthostasis).

Thomsen GE, et al. CCM 2008;36;1119-1124

Making Early Ambulation a Priority: Impacting Outcomes

- Results:
  - Transferring patient to the unit with an early mobility protocol significantly increased the probability of ambulation (p < .0001).
  - After 2 days in the ICU, 3 fold increase in the number of patients ambulating compared to pre-transfer rates.
  - Female gender, absence of sedatives and a lower APACHE predictive of probability to ambulate (p = .017).

Getting Them Moving Makes a Difference

Thomsen GE, et al. CCM 2008;36;1119-1124
**Early ICU Mobility Therapy**

**Methodology**
- Prospective cohort study
- Measured impact of mobility protocol on number of patients receiving physical therapy in ICU, ICU LOS, Hospital LOS & costs when compared to usual care
- 330 mechanically ventilated patients
- Protocol group via Mobility team (nurse, physio, nursing assistant) had the protocol initiated within 48hrs of intubation/72 hours in the ICU
- 4 phase step wise mobility progression based on physiologic condition
- Outcome measures performed on protocol group & usual care patients that survived to discharge


**Results**
- Baseline characteristic similar in both groups
- Protocol group:
  - received at least 1 PT session vs. usual care (80% vs. 47%, p ≤ .001)
  - Out of bed earlier (5 vs. 11 days, p ≤ .001)
  - Therapy initiated more frequently in the ICU (91% vs. 13%, 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
  - No cost difference between protocol/mobility team & usual care

2008 - 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

Strategies for Retained Airway Secretions


Manual vs. Mechanical Bed Chest Percussion

Methodology

- 24 patients with respiratory failure demonstrating segmental, lobular or unilateral entire lung atelectasis
- Ventilated or spontaneously breathing
- 17 patients rotated with q 4 hour percussion at 9 beats for 20 min/18 hours per day
- 7 patients turned q 2 hours with q 2hr CPT

Manual vs. Mechanical Bed
Chest Percussion

Results

• Complete or partial resolution
  - CLRT 14/17 (82%)*
  - Control 1/7 (14%)
• P/F ratio changes over 4 days
  - CLRT 207 to 318
  - Control 181 to 112
• Bronchoscopy required
  - CLRT 0**
  - Control 3

*p < 0.004
**p < 0.002

Percussion and Vibration

Suggested Use of the Percussion/Vibration feature:

- Suctioning every 30 minutes and/or secretions > 30cc per 24 hours
- Areas of consolidation and/or lobar atelectasis per chest x-ray

Percussion and Vibration

- Body positioning & mobilization can be used to enhance secretion clearance (Level C)
- Manual (use judiciously level B) or ventilator hyperinflation & suctioning are indicated for airway secretion clearance (Level B)
- If thick secretions present, use percussion mode
- If thin secretions present, use vibration mode

Remember to use Gravity:
Place the Bed Flat

HFCWO

- Increased sputum mobilization*
- Improved pulmonary function*
- Cost effectiveness
  - Decreased hospitalizations*, ICU days
  - Decreased antibiotic/oxygen needs
- Safety / efficacy in multiple disease states*
- Safety in ICU/post cardiac surgery*
- Improved weaning from vents
- Combining with other airway clearance therapies*

King, Warwick, Landon, Pylpolis, Allen, Brierley

Positioning CLRT, Bed P&V and HFCWO

In the ICU setting:

- For prevention of pulmonary complications use CLRT
- For patients requiring CLRT that have infiltrates/atelectasis provide CLRT w/ P&V Therapy from the Surface
- If CLRT with P&V module does not help improve or effectively address airway clearance therapy, provide the Vest for HFCWO along with CLRT

In the Medical-Surgical care area:

- For airway clearance therapy provide the Vest for HFCWO
- Use CLRT for select immobile patients
WHY PRONE POSITION IN ACUTE RESPIRATORY FAILURE?

- To improve oxygenation during prone positioning and after repositioning supine (Langer, Chest 1988;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 reduce ventilator associated lung injury "per se" (Broccard, Crit Care Med 1997-2000; Valenza, Crit Care Med 2005; Papazian, Crit Care Med 2005)
- To improve drainage of secretions


2000’s Prone Positioning Research

Methodology

- Study Period: 1996-1999
- 304 patients with Acute Lung Injury/Acute Respiratory Distress Syndrome randomized to receive 6 hours of prone positioning q 24 for 10 days or supine position with q 2 hour lateral positioning
- Entrance criteria: modified ALI/ARDS definitions
- Measured: Primary endpoints: mortality at 10 days, hospital D/C & 6 months Secondary endpoints: PaO₂/FIO₂ ratio reduction, organ failure & incidence of complications

### 2000’s Prone Positioning Research

#### Results
- 10 day mortality: 21% vs. 25% (RR 0.84 CI 0.56 to 1.27)
- Hospital d/c mortality: 50.7% vs. 48% (RR 1.05 CI 0.84 to 1.32)
- 6 months mortality: 62.5% vs. 58.6% (RR 1.06 CI 0.88 to 1.28)
- Significant increase in PaO2/FiO2 ratio in the prone group
- No difference in organ dysfunction
- % of patients with new or worsening pressure ulcers per patient was worse in the prone group


### Study Concerns

#### Was the study methodology relevant?
- Testing an intervention using 1996-1999 ventilator management
  - TV: 10.3/ml/kg + 2.9 (s)
  - TV: 10.3/ml/kg + 2.7 (p)
  - Average PEEP: <10cm
- Majority of patients entered into the study were primary respiratory pathology vs. secondary

#### Were the patients in the prone position a sufficient period of time?
- Average time prone: 7.0 ± 1.8

### Study Concerns

#### Was the study powered sufficiently?
- Stopped early with recruitment problems
- Less than half of the targeted number of subjects for whom the study was powered were enrolled
- Deviations from the protocol: 41 patients non-compliant with the study protocol

#### Were the most appropriate patients study?
- Altered ALI/ARDS criteria
- Post-hoc analysis showed sicker patients had a significant improvement in mortality
Mortality Benefit in the Most Severely Ill

2000's Prone Positioning Research

Methodology
- Study conducted: Dec 1998-2002
- 791 ARF patients, multicenter trial, unblended, randomized
- 413 prone, 378 supine (8 hours per day)
- Patient in supine group could cross over to prone if P/F ratio < 100 for > 12 hours, or < 60 for 1 hr or on 100% FiO2
- P/F ratio <300, hemodynamically stable & no contraindications to the prone position
- Measured 28 day all cause mortality, duration of mechanical ventilation, incidence of VAP & oxygenation

Guerin C. et al JAMA 2004;292:2379-2387

Results
- Most patient's in supine group crossed over
- Mechanical ventilation was not performed using a pre-determined algorithm (Tidal volume 8 ml/kg & tidal volume in pressure control 11ml/kg)
- Only in prone position for 8.6 hours for total of 4.6 days

Limitations
- No difference in mortality
- No difference in ventilation days
- Reduction in VAP in the prone group*
- Significantly higher P/F ratio for 28 days in the prone group

Guerin C. et al JAMA 2004;292:2379-2387

*P < 0.045
**Prolonged Prone Ventilation Study**

**Methodology**
- Multicenter trial: 13 ICU's accruing 136 ARDS patients randomized within 48hrs of tracheal intubation (Between 1998-2002)
- 60 to supine, 76 to prone (20h/d)
- Guidelines for ventilation & weaning were established

**Results**
- Mortality: Supine 58% vs. Prone 43% p=0.12
- Simplified APACHE II score higher in prone group
- Independent risk factors for mortality: APACHE score at inclusion, days elapsed prior to inclusion & randomization to supine position
- Minimal complications and rapidly reversible (prone avg. 17hrs for 10 days)


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**Meta-analysis: Prone Positioning**

- Review Literature up to November 2007
- 5 trials met the inclusion criteria (1 trial added to assess the effect on VAP
- 1372 patients
- Enrolled trials significantly underpowered & wide variations in level of severity


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**Effect on Mortality** (effect p=0.79; heterogeneity p = 0.35)

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<th>Mortality</th>
<th>Effect</th>
<th>Heterogeneity</th>
<th>p-value</th>
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<tr>
<td>Supine</td>
<td>58%</td>
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<tr>
<td>Prone</td>
<td>43%</td>
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**Effect on PaO2/FiO2 ratio** (effect p<0.00001; heterogeneity p<0.06)

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**Effect on VAP (effect p=0.09)**

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<td>6.4 ± 0.7</td>
<td>0.90 ± 0.9</td>
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<tr>
<td>prone</td>
<td>6.4 ± 0.7</td>
<td>0.90 ± 0.9</td>
</tr>
</tbody>
</table>

**Effect on Airway Complications (effect p=0.95)**

<table>
<thead>
<tr>
<th>Study</th>
<th>Effect</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>placebo</td>
<td>6.4 ± 0.7</td>
<td>0.90 ± 0.9</td>
</tr>
<tr>
<td>prone</td>
<td>6.4 ± 0.7</td>
<td>0.90 ± 0.9</td>
</tr>
</tbody>
</table>

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

Phase III Trial in Progress

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**Prone Positioning**
Diagram of the pancake method (top and bottom sheet) to turn a critically ill patient prone. (From Balas M.C. Crit Care Nurse, 2000;20(1):35.)
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

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
Barriers to Mobility Strategies

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

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


Barriers to Mobility Strategies

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

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

What is the Rest of the Story

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.


Strategies For Change
Building a Comprehensive Mobility Protocol

Impacting Patient Outcomes

Strategies for Implementation

- Use of protocols
  - Protocols work well with other ICU interventions i.e. sedation, weaning etc.
- Dedicated Team (Morris PE, et al 2008)
  - Physical therapy, nursing, respiratory etc.
  - Trained team, protocol, screen & initiate
- Impact of the Unit Culture
  - No excuses, overcome fears, no delays
  - All patient evaluated and started if they meet criteria (Needham 2008, Thomson et al 2008)
  - Sedation > 7 days has greatest association with immobility (Hopkins et al. 2007)

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