Benefits of Prone Positioning and Kinetic Therapy in Acute Respiratory Failure

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Acute Lung Injury/ Acute Respiratory Distress Syndrome

- Severe lung injury characterized by noncardiogenic pulmonary edema, decreased lung compliance, and refractory hypoxemia

  - 3-criteria definition, with formal diagnosis established by chest radiograph, oxygenation score, and exclusion of cardiogenic causes
    - Acute onset (<2 weeks)
    - Bilateral infiltrates on chest radiography
    - Pulmonary-artery wedge pressure ≤18 mm Hg or lack of evidence of left atrial hypertension

<table>
<thead>
<tr>
<th>Acute Lung Injury (ALI)</th>
<th>Acute Respiratory Distress Syndrome (ARDS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PaO₂/FiO₂ ≤ 300</td>
<td>PaO₂/FiO₂ ≤ 200</td>
</tr>
</tbody>
</table>

PaO₂ = partial pressure of arterial oxygen; FiO₂ = fraction of inspired oxygen

ARDS — One of the Most Challenging Acute Clinical Processes to Treat

ARMS — One of the Most Challenging Acute Clinical Processes to Treat

ARMS — One of the Most Challenging Acute Clinical Processes to Treat

Acute Respiratory Failure Spectrum

- ALI and ARDS
- Acute onset
- Persistent
- Associated with one or more known risk factors
- Characterized by arterial hypoxemia resistant to oxygen therapy alone
- ALI represents a small fraction of ALF patients
- ARDS makes up most of the ALI population

ARDS (~18%)
ALI (~23%)

Relative percentage of patients along the continuum of acute respiratory failure (simplex and mechanical ventilation [MV]): Acute lung failure (ALF) \( = \frac{P_aO_2/FCO_2}{300} \) mm Hg


Risk Factors for ALI and ARDS

- The most common risk factors are
  - Pneumonia
  - Aspiration

- Other risk factors include
  - Pulmonary contusion
  - Smoker/toxic gas inhalation
  - Fat embolism
  - Major surgery
  - Pancreatitis
  - Sepsis
  - Severe trauma with multiple transfusions (>15 units)
  - Drug reaction or overdose
  - Reperfusion pulmonary edema after lung transplantation or
  - Neurogenic pulmonary edema due to stroke, seizure, head trauma

ARNL — Acute Respiratory Failure spectrum

Acute Lung Failure (ALF) = \( \frac{PAO_2}{FCO_2} \) > 300 mm Hg

ALI Often Evolves into ARDS

ALI is frequently observed in the ICU

- 7.1% (n = 463) of 6,522 admissions
- 16.1% of all mechanically ventilated patients
- 65.4% cases occurred on ICU admission

- ALI Unchanged/Improved
- ALI Developed ARDS


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ALI and ARDS have a Substantial Impact on Public Health

<table>
<thead>
<tr>
<th></th>
<th>ALI</th>
<th>ARDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incidence per 100,000 person-yrs*</td>
<td>86.2</td>
<td>64.0</td>
</tr>
<tr>
<td>Mortality (95% CI) %</td>
<td>38.5 (34.9-42.2)</td>
<td>41.1 (36.7-45.4)</td>
</tr>
<tr>
<td>Estimated annual cases*</td>
<td>190,600</td>
<td>141,500</td>
</tr>
<tr>
<td>Estimate annual deaths*</td>
<td>74,500</td>
<td>59,000</td>
</tr>
<tr>
<td>Estimated annual days in ICU*</td>
<td>2,154,000</td>
<td>1,642,000</td>
</tr>
</tbody>
</table>

* Age-adjusted to 2000 US Census


Measures of Long-term Disability Indicate Slow and Incomplete Recovery from ARDS

<table>
<thead>
<tr>
<th></th>
<th>FVC</th>
<th>6-minute walk</th>
<th>Return to work</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Months</td>
<td>72</td>
<td>49</td>
<td>16</td>
</tr>
<tr>
<td>6 Months</td>
<td>60</td>
<td>64</td>
<td>32</td>
</tr>
<tr>
<td>12 Months</td>
<td>85</td>
<td>66</td>
<td>66</td>
</tr>
</tbody>
</table>

FVC = Forced vital capacity

Measures of Long-term Disability Indicate Slow and Incomplete Recovery from ARDS (cont.)

Lung Function
- FEV1 and FVC were normal
- DLCO minimally reduced
- 20% had mild abnormalities on chest radiograph
Measures of Long-term Disability Indicate Slow and Incomplete Recovery from ARDS (cont.)

Functionally
- Survivors’ perception of health was <70% of normal in
  - Physical role: extent to which health limits physical activity
  - Physical functioning: extent to which health limits work
  - Vitality: degree of energy
  - 6-minute walk remained low
- Only 49% had returned to work

Improved Outcomes Are Needed for Patients with ALI/ARDS

- Mechanical ventilation contributes to the high mortality level in ARDS1
- Research continues to fine-tune lung-protective strategies to respiratory mechanics while reducing ventilator injury
- An increase in oxygenation has been demonstrated in patients ventilated in the prone position2,4
- For patients at imminent risk of death from hypoxemia, prone ventilation intervention can make sense1

Multiple Benefits of Prone Positioning for ARDS Patients

- Improved respiratory mechanics1
  - Homogenize pleural pressure gradient, alveolar inflation, and ventilation distribution
  - Increase lung volume and reduce atelectasis
- Improved oxygenation2,3
- Facilitation of secretion drainage1
- Reduced ventilator-associated lung injury1,4
Why Does Prone Positioning Work?

Prone positioning changes distribution of alveolar inflation.

- More homogeneous distribution of transpulmonary pressure and alveolar inflation
- Optimized ventilation/perfusion match
  - Gravity effects
- Shape of lungs
  - Triangular
  - Larger surface area posterior
- Pleural gradient changes
  - Abdomen position
    - Decreased pressure on vena cava when abdomen not constricted
  - Improved alveolar recruitment


Effects of Long-term Prone Positioning in Patients with Trauma-Induced ARDS

Design
- Prospective, nonrandomized, crossover design
- Trauma induced, AECC-defined ARDS
- All patients receiving mechanical ventilatory support

Methods
- Repeating cycles of supine to prone and return to supine (until recovery or death)
- Turns performed manually by 3 staff members
- Patients remained prone for 20 hours each cycle
- Essential nursing care and chest radiographs obtained while in supine position
- Before and 60 minutes after each turn, arterial and mixed venous blood gases and hemodynamic variables were recorded

AECC = American European Consensus Conference

Oxygenation variable improved after prone positioning, but most beneficial effects were lost when patients were returned to the supine position

* P<0.05
Benefits of Prone Positioning and Kinetic Therapy in Acute Respiratory Failure

Effect of Prone Positioning on the Survival of Patients with Acute Respiratory Failure

Design
- Prospective, randomized study of 304 ARDS/ALI patients in 28 intensive care units (ICUs)

Methods
- Patients placed in prone position 6 or more hours daily for 10 days
- Respiratory, biochemical, and skin care assessed daily while supine
- Change to the prone position was triggered each day if PaO\textsubscript{2}/FiO\textsubscript{2} ratio met AECC-defined ARDS/ALI criteria

Endpoints
- Primary = Death at 10 days, at ICU discharge, and at 6 months
- Secondary = Improvements in respiratory and organ function


Prone Positioning Improves Oxygenation in Patients with Acute Respiratory Failure

Oxygenation was improved in 73.2% of the pronation procedures
69.9% of the improved oxygenation was seen within the first hour of pronation

Incidence of complications was similar in the two groups


Prone Positioning of Patients at Highest Risk Suggested a Survival Advantage

- Improved 10-day survival in patient quartile with the highest risk of mortality
  - PaO\textsubscript{2}/FiO\textsubscript{2} ratio <88 (prone = 23.1% vs. supine = 47.2%; RR of death 0.49; 95% CI, 0.25-0.95)
  - Simplified Acute Physiology Score II >49 (prone = 19.4% vs. supine 48.5%; RR of death, 0.40; 95% CI, 0.19-0.85)
  - Tidal volume >12 mL per kilogram predicted body weight (prone = 18.2% vs. supine = 41.0%; RR of death 0.44; 95% CI 0.20-1.00)

A Decrease in PaCO$_2$ with Prone Positioning is Predictive of Improved Outcomes in ARDS

**Design**
- Retrospective analysis of 255 ARDS/ALI patients pooled from the pronation arm of the previous study and a similarly designed pilot study.

**Methods**
- Patients placed in prone position for 6 hours daily for 10 days
- Respiratory, biochemical, and skin care were assessed daily while supine
- Patients pronated each day only if PaO$_2$/FiO$_2$ ratio met AECC-defined ARDS/ALI criteria

**Endpoints**
- PaCO$_2$ responders defined as patients whose PaCO$_2$ decreased ≥1 mm Hg after 6 hours in the first pronation; PaO$_2$ non-responders, those patients whose PaCO$_2$ did not change or increase after 6 hours

AECC = American European Consensus Conference


28-Day Survival Increased in ALI/ARDS Patients Whose PaCO$_2$ Declines with Pronation

![Graph showing 28-Day Survival Increased in ALI/ARDS Patients Whose PaCO$_2$ Declines with Pronation](image)

- RR 1.48
- 95% CI, 1.0-2.05
- *p=0.01

A Multicenter Trial of Prone Ventilation in Severe Acute Respiratory Distress Syndrome

**Design**
- Prospective, randomized, multicenter trial of 136 patients (60 supine, 76 prone) with an AECC-defined diagnosis of ARDS from 13 intensive care units

**Methods**
- Patients were enrolled within 48 hours of tracheal intubation
- Prone ventilation treatments were maintained continuously for 20 hours/day

**Outcome variables**
- ICU mortality
- Secondary endpoints included hospital mortality, associated complications, length of stay
- Multivariate analysis for risk factors

Prone Ventilation May Reduce Mortality in ARDS Patient Subgroups

- ARDS patients who were ventilated prone within 48 hours of entry and who remained prone for most of the day had a 15% absolute and a 25% relative reduction in ICU mortality compared to supine.

- Multivariate analysis revealed that randomization to the supine position was an independent risk factor for mortality (odds ratio, 2.53; \( P = 0.03 \)).

Prone Kinetic Therapy Outcomes in Trauma and Surgical Patients with ALI/ARDS

- Greater improvements in \( \text{PaO}_2/\text{FiO}_2 \) ratios in trauma and surgical ALI/ARDS patients with prone kinetic therapy.
Benefits of Prone Positioning and Kinetic Therapy in Acute Respiratory Failure

Beneficial Effect of Prone Position for Patients with Hypoxemia after Esophagectomy

Rationale
- Extended transthoracic esophagectomy with lymphadenectomy is frequently associated with postoperative respiratory complications such as pneumonia, atelectasis, or pleural effusion because of the invasiveness of the procedure
- Although prone position ventilation has been studied in ALI/ARDS patients, there had been no clinical studies on its efficacy in patients with hypoxemia after esophagectomy

Design
- Prospective, randomized, university hospital ICU study included 16 patients who underwent three-field lymphadenectomy and showed hypoxemia (PaO_2/FiO_2 ratios of <200) on the fifth postoperative day
- Patients were randomly assigned to prone (8 patients) and nonprone (8 patients) groups
- Prone position for 6 hours was carried out for 4 consecutive days

Endpoints
- Measured PaO_2/FiO_2 ratio, duration of ventilatory support, and length of stay

Prone Position Improved Oxygenation and Shortened Duration of Ventilation and ICU Days

PaO_2/FiO_2 Ratio

<table>
<thead>
<tr>
<th>Days</th>
<th>Supine to Prone</th>
<th>Prone to Supine</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>186.0</td>
<td>266.9</td>
</tr>
<tr>
<td>10</td>
<td>246.8</td>
<td>266.9</td>
</tr>
<tr>
<td>20</td>
<td>194.2</td>
<td>17.2</td>
</tr>
</tbody>
</table>

PaO_2/FiO_2 Ratio

<table>
<thead>
<tr>
<th>Days</th>
<th>Ventilation</th>
<th>Length of Stay</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>14.0</td>
<td>12.8</td>
</tr>
<tr>
<td>10</td>
<td>11.6</td>
<td>11.0</td>
</tr>
</tbody>
</table>

A Meta-analysis: Prone ventilation reduces mortality in patients with acute respiratory failure and severe hypoxemia

Objective
- To determine effects of prone versus supine ventilation in AHRF (acute hypoxic respiratory failure) and severe hypoxemia (partial pressure of arterial oxygen (PaO_2)/inspired fraction of oxygen (FiO_2) <100 mmHg) compared with moderate hypoxemia (100 mmHg \leq PaO_2/FiO_2 \leq 300 mmHg).

Methods
- Systematic review and meta-analysis
- Electronic databases (to Nov 2009) and conference proceedings searched.
- Ten trials (N = 1,867 patients) met inclusion criteria; most patients had acute lung injury.

Results
- Post hoc analysis demonstrated statistically significant improved mortality in the more hypoxic subgroup and significant differences between subgroups using a range of PaO_2/FiO_2 thresholds up to approximately 140 mmHg.
Benefits of Prone Positioning and Kinetic Therapy in Acute Respiratory Failure

General Principles for Effective Prone Positioning in ALI/ARDS

Conditions for which prone positioning could be beneficial include:

- Moderate to severe ALI/ARDS and no contraindications
- When high values for ventilatory pressure, positive end-expiratory pressure (PEEP), and FiO\textsubscript{2} are needed to maintain adequate arterial oxygen pressure
- >10 cm H\textsubscript{2}O PEEP at FiO\textsubscript{2} of >0.6 to maintain oxygen saturation at >90%
- Tidal thoracic compliance (tidal volume/plateau pressure – total PEEP) of <0.040 L/cm H\textsubscript{2}O
- For an ARDS patient at imminent risk of death from hypoxemia


Management considerations

- Scheduled reversion to the supine position should be done at least once per day for cleanup, dressing changes, edema clearance, and diagnostic procedures
- Prone positioning can be discontinued when it no longer makes an impressive difference to oxygenation and plateau pressure can be kept in a safe range when supine
- Prone positioning should not be used in the presence of a clear contraindication or if the patient is rapidly improving

Prone Therapy Offers Physiological and Clinical Benefits That May Improve Outcomes

- Imparts rapid and sustained improvement in oxygenation
- Reduces ventilation time
- Provides lung-protective ventilation by decreasing inflammation, injury, barotrauma, and ventilator-associated lung injury
- Facilitates drainage of pulmonary secretions
- Eliminates compression of the lungs by the heart
- Reduces ICU length of stay
- Lowers mortality and improves survival

Kinetic Therapy beds continuously rotate the patient from side to side to:

- Mobilize secretions
- Redistribute pressure in the lung
- Re-expand areas of atelectasis
- Improve blood flow, gas exchange, and oxygenation


Improvement in Oxygenation and Resolution of Atelectasis with Kinetic Therapy

* Baseline PaO2/FiO2 in TriaDyne group was different from all other time points (3, 7, and 14 days) in the TriaDyne group (P<.05).
** Manual and TriaDyne groups different at 3, 7, and 14 days (P<.03).
*** Manual and TriaDyne groups different at 3, 7, and 14 days (P<.05).

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Benefits of Prone Positioning and Kinetic Therapy in Acute Respiratory Failure

Kinetic Therapy Helps Prevent Ventilator-Associated Pneumonia and Atelectasis

- Standard ICU Bed with Manual Turning
- TriaDyne™ II Kinetic Therapy Bed

![Graph showing reduced VAP and lobar atelectasis with kinetic therapy](image)

Reduction in VAP and Atelectasis:
- **Ventilator-Associated Pneumonia**: 33% vs. 16% (p < 0.01)
- **Lobar Atelectasis**: 31% vs. 16% (p < 0.02)

Reduced Ventilator-Associated Pneumonia and Related Sequelae with Kinetic Therapy

- **Ventilator-Associated Pneumonia (VAP)**: 23% vs. 13% (p = 0.048)
- Days on Mechanical Ventilation: 14 vs. 12 (p = 0.02)
- Length of Hospital Stay (days): 25 vs. 14 (p = 0.001)
- Days with Atelectases: 2 vs. 1 (p = 0.001)
- Duration of Antibiotic Therapy (days): 3.6 vs. 1.6 (p = 0.001)

Kinetic Therapy Provides Positive Pulmonary Outcomes in ALI/ARDS Patients

- A minimum rotation of 40°, side to side, for a total arc of at least 80°, can lead to positive pulmonary outcomes, including:
  - 50% reduction in nosocomial pneumonia
  - 42% reduction in median days intubated
  - 37.5% reduction in ICU length of stay
  - 82.3% partial or complete resolution of atelectasis
  - 32% reduction in incidence of lower respiratory tract infections
  - 42% reduction in ICU-related expenditures
  - 52% fewer patients developed ventilator-associated pneumonia (VAP)

References:

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Options for Prone Positioning

**Manual Prone Positioning**
- Kinetic Therapy™ Surface

**Automated Prone Positioning**
- Kinetic Therapy™ Surface

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Features of the RotoProne™ Therapy System

**CPR**
- Returns patient from prone to supine in <40 seconds in the event of a code

**Rotation** programmable in 1° increments
- Allows customization of therapy

**Pause and hold functions**
- Facilitates nursing care or medical procedures

**Tube-management system**
- Helps prevent line and tube dislodgement

**Electronically monitored buckles**
- Ceases rotation and alarms if buckles not secured

**Intuitive touch-screen control panel**

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RotoProne™ Therapy System

Prone positioning is an aggressive noninvasive therapy that can be used adjunctively with other modes of ventilation

- **Kinetic Therapy**
  - Reduces VAP
  - Reduces ICU stay
  - Reduces and resolves atelectasis

- **RotoProne™ Therapy System**
  - Quickly improves oxygenation
  - Effective lung-protective therapy
  - Reduces ICU stay
  - Reduces ventilation time
  - Reduces barotrauma
  - Mobilizes secretions

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Introduction

- Advanced patient care system for treatment and prevention of pulmonary complications associated with immobility
- Rotation up to 62° in both prone and supine positions
  - Kinetic Therapy: Gentle side-to-side rotation of a patient ≥ 40°
    - Mobilizes pulmonary secretions
    - Improves ventilation/perfusion matching
    - Resolution of atelectasis
    - Reduction in incidence of nosocomial pneumonia
  - Prone Therapy:
    - Improves oxygenation in patients with ARDS
    - Aids in recruitment of collapsed alveoli
    - Enhances drainage of airway secretions
    - Improves ventilation/perfusion matching
- RotoProne™ Therapy System:
  - Allows immobile patient with respiratory complications to be moved from supine to prone position
  - Most aggressive form of positioning therapy for treatment of pulmonary complications

Indications

- Treatment and prevention of pulmonary complications associated with immobility
  - Acute Respiratory Distress Syndrome (ARDS)
  - Acute Lung Injury (ALI)
  - Ventilator Associated Pneumonia (VAP)
  - Ventilator Induced Lung Injury (VILI)
Benefits of Prone Positioning and Kinetic Therapy in Acute Respiratory Failure

**Contraindications**

Patient conditions for which the application of RotoProne™ Therapy is contraindicated include:

- Unstable cervical, thoracic, lumbar, pelvic, skull or facial fractures
- Cervical and/or skeletal traction
- Uncontrolled Intracranial Pressure (ICP)
- Patient weight below 40 kilograms (88 lbs.)
- Patient weight above 159 kilograms (350 lbs.)
- Patient height in excess of 6 feet 6 inches

**Precautions**

Precautions may also need to be taken when using this product with certain patient conditions, including, but not limited to:

<table>
<thead>
<tr>
<th>Condition</th>
<th>Precaution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemodynamic Instability</td>
<td>Wounds at risk of dehiscence while in prone position</td>
</tr>
<tr>
<td>Severe Agitation</td>
<td>Patients in prone position with open sternal wound or thoracic post-surgical incision</td>
</tr>
<tr>
<td>Uncontrollable Claustrophobia or Fear of confinement</td>
<td>Patient in prone position with open abdomen</td>
</tr>
<tr>
<td>Uncontrollable Diarrhea</td>
<td>Any implant potentially increases risk of skin breakdown including but not limited to breast implants or penile prosthesis</td>
</tr>
<tr>
<td>Intolerance to face down position</td>
<td>Pregnancy</td>
</tr>
</tbody>
</table>

**Risks**

Use of the RotoProne™ Therapy System is typically prescribed for patients at high risk of mortality. While some studies have demonstrated that proning improves mortality, there are inherent risks with proning itself. For instance, some studies and caregiver experience have suggested or reported risks of the following in relation to proning in general.

<table>
<thead>
<tr>
<th>Risk</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skin breakdown and/or pressure necrosis</td>
<td>Corneal Abrasion</td>
</tr>
<tr>
<td>Wound dehiscence</td>
<td>Myositis Ossification</td>
</tr>
<tr>
<td>Cardiac Arrest</td>
<td>Venous Air Embolism</td>
</tr>
<tr>
<td>Loss of invasive lines or tubes; extubation (endotracheal &amp; one)</td>
<td>Increased Intraorbital Pressure</td>
</tr>
<tr>
<td>Edema and/or swelling</td>
<td>Central Retinal Artery Occlusion</td>
</tr>
<tr>
<td>Splenic rupture</td>
<td>Pain and Discomfort</td>
</tr>
<tr>
<td>Numbness and other consequences of damage to the ocular nerve</td>
<td>Difficulty performing CPR</td>
</tr>
</tbody>
</table>
Prone Protocols

- Early intervention
- Longer prone times
- No standard protocol in the literature
  - Manual prone procedures usually proned for 6 – 12 hrs then supine for 6 – 12 hrs
  - KCI Protocol:
    - 3 hrs and 15 min in the prone position with Kinetic Therapy (min of 40° and max of 62°)
    - 45 min supine
    - Provides for approximately 19 – 20 hrs of prone time per 24 hrs
    - Timing designed to allow for every 4 hr complete assessment by nursing staff
    - No real science to back up the “4 hr” protocol

- Reverse Trendelenburg
  - Reduces facial swelling
- Open exterior hatches
  - Provides visibility and access to patient by nursing staff
  - Provides cooler environment
  - Prevents pressure against back of heels
- Kinetic Therapy
  - Minimum of 40°
  - Mobilizes secretions
  - Needed to prevent skin breakdown from immobility

Features of the RotoProne™ Therapy System

- Rotation programmable in 1° increments
- Allows customization of therapy
- Acclimation mode
  - Slow increase in degree of turn allows unstable patients to gradually become accustomed to therapy
- Pause and Hold Functions
- Facilitates nursing care
- Tube Management System
  - Helps prevent line and tube dislodgement
- Electronically Monitored Buckles
  - Ceases rotation and alarms if buckles not secured
- Ergonomically Designed Head Positioning System
  - Adjustable for size and shape of patient
- CPR
  - Returns patient from prone to supine in < 40 seconds in the event of a code
Benefits of Prone Positioning and Kinetic Therapy in Acute Respiratory Failure

The RotoProne™ Therapy System is an Affordable ICU Intervention

<table>
<thead>
<tr>
<th>Name of Common ICU Interventions</th>
<th>Cost Per Day Per Patient</th>
<th>Approximate Length of Treatment</th>
<th>Total Cost of Treatment</th>
<th>Expected Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surfactant Replacement Therapy</td>
<td>$30,800/day</td>
<td>Single Treatment (1 day)</td>
<td>$30,800</td>
<td>Improve oxygenation</td>
</tr>
<tr>
<td>Inhaled Nitric Oxide</td>
<td>$1,000/day</td>
<td>Maximum 4 days</td>
<td>$12,000</td>
<td>Improve blood flow through the lungs</td>
</tr>
<tr>
<td>Extracorporeal Membrane Oxygenation and Carbon Dioxide Removal (ECMO/ECOD)</td>
<td>$6,000/day</td>
<td>10 days</td>
<td>$60,000</td>
<td>Survival; improve oxygenation</td>
</tr>
<tr>
<td>Sigs</td>
<td>$1,750/day</td>
<td>4 days</td>
<td>$6,900</td>
<td>Survival</td>
</tr>
<tr>
<td>Continuous Renal Replacement Therapy (CRRT)</td>
<td>$550/day</td>
<td>15 days</td>
<td>$8,250</td>
<td>Survival</td>
</tr>
<tr>
<td>RotoProne™ Therapy System</td>
<td>$1,250/day</td>
<td>4.4 days</td>
<td>$5,700</td>
<td>Survival; improve oxygenation</td>
</tr>
</tbody>
</table>


The RotoProne™ Therapy System is indicated for the treatment and prevention of pulmonary complications associated with immobility, including:

- Acute respiratory distress syndrome (ARDS)
- Acute lung injury (ALI)
- Ventilator-associated pneumonia (VAP)
- Ventilator-induced lung injury (VILI)

Contraindications for RotoProne™ Therapy

- Unstable cervical, thoracic, lumbar, pelvic, skull, or facial fractures
- Cervical and/or skeletal traction
- Uncontrolled intracranial pressure (ICP)
- Patient weight below 88 lbs (40 kg)
- Patient weight above 350 lbs (159 kg)
- Patient height less than 4 feet 6 inches (140 cm) or in excess of 6 feet 6 inches (200 cm)
References

- Physical exam/cause of lung injury
- Decrease in Paco2
- Albert, RK et al. The prone position eliminates compression of the lungs by the heart.
- Labs
- Alberto, RK et al. The prone position eliminates compression of the lungs by the heart.
- Gattinoni, L et al. Decrease in Paco2
- Albert, RK et al. The prone position eliminates compression of the lungs by the heart.
- Section would include
- Brief description of the current presentation
- Past medical history
- Physical exam/cause of lung injury
- Labs
- Diagnosis

Case Studies [~10 slides]

Presentation of Patient with ARDS

- Section would include
- Brief description of the current presentation
- Past medical history
- Physical exam/cause of lung injury
- Labs
- Diagnosis

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Pulmonary Assessment

- Section would include
  - Ventilatory and gas-exchange values
  - Chest radiography
  - Hemodynamics

Case Considerations

- Discussion of findings
  - Patient risk factors
  - Challenge associated with this specific case
  - Factors considered in determination of prone positioning for this patient

Clinical Course

- Section would include overview of care provided and outcomes achieved during treatment
Case Pearls

- Discuss why this case demonstrates the clinical benefits of prone positioning, or
- Why this patient was an ideal candidate for prone therapy, or
- How prone therapy improved long-term outcomes for the patient