Prone Positioning: The Evidence, The Challenges, The Barriers

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## New Definition

**Acute respiratory distress syndrome**

<table>
<thead>
<tr>
<th>Timing</th>
<th>Within 1 week of a known clinical insult or new/worsening respiratory symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chest imaging*</td>
<td>Bilateral opacities—not fully explained by effusions, lobar/lung collapse, or nodules</td>
</tr>
<tr>
<td>Origin of Edema</td>
<td>Respiratory failure not fully explained by cardiac failure or fluid overload; Need objective assessment (e.g., echocardiography) to exclude hydrostatic edema if no risk factor present</td>
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</tbody>
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<table>
<thead>
<tr>
<th></th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
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<tbody>
<tr>
<td>Oxygenationb</td>
<td>$200 &lt; \text{PaO}_2/\text{FiO}_2 \leq 300$ with PEEP or CPAP $\geq 5$ cmH$_2$O</td>
<td>$100 &lt; \text{PaO}_2/\text{FiO}_2 \leq 200$ with PEEP $\geq 5$ cmH$_2$O</td>
<td>$\text{PaO}_2/\text{FiO}_2 \leq 100$ with PEEP $\geq 5$ cmH$_2$O</td>
</tr>
</tbody>
</table>

Ferguson N. et al ICM August 25th online print

## Basilar Atelectasis / Wet lung

![Image of a medical scan showing basilar atelectasis]
Summary

Supine:
- Marked reduction in lung volumes
- Alteration in lung mechanics (low compliance/high resistance)
- Compression atelectasis
- Moderate hypoxemia

Prone:
- Increased FRC & improved compliance
- Shifting of lung water & densities
- Increased oxygenation

Part of Mobility Program

Where Does The Prone Position Fit into A Mobility Program for ARDS Patients?

“Unless otherwise contraindicated a trial of proning should be attempted in those receiving ventilatory support whose impaired oxygenation fails to respond to usual measures, including sedation, recruiting maneuvers, and PEEP. Proning should be limited to those with severe ARDS (PaO2/FiO2 ratio < 100 mmHg) who show convincing positive recruitment within a few hours.”

Marini JJ. Intensive Care Medicine, 2010;36:559-560.
Prone Positioning: 3 Multicenter RCT’s Completed

<table>
<thead>
<tr>
<th></th>
<th>Italy</th>
<th>Spain</th>
<th>France</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP/PP</td>
<td>152/152</td>
<td>60/76</td>
<td>378/413</td>
</tr>
<tr>
<td>PP hours/day</td>
<td>≥ 6</td>
<td>= 20</td>
<td>&gt; 8</td>
</tr>
<tr>
<td>Patients</td>
<td>ALI</td>
<td>ARDS</td>
<td>ARF (P/F ratio &lt; 300)</td>
</tr>
<tr>
<td>Primary End- Point</td>
<td>Mortality Day-10</td>
<td>Mortality ICU</td>
<td>Mortality Day-28</td>
</tr>
<tr>
<td>Hypothesis</td>
<td>40% ↓ 30%</td>
<td>50% ↓ 30%</td>
<td>40% ↓ 30%</td>
</tr>
</tbody>
</table>

Courtesy of P Pelosi

Prone Study: Moderate to Severe Hypoxemia with ARDS

- Methodology
  - Multicenter unblinded randomized controlled trial
  - 23 centers in Italy and 2 in Spain/ 72hr enrollment
  - 340 adults with ARDS receiving mechanical ventilation process actively stratified to moderate or severe hypoxemia
  - Undergo supine or prone positioning (20 hours per day) during ventilation
  - All patients turn prone using the RotoProner®
  - Measure 28 day all cause mortality, secondary outcomes; six months mortality, organ dysfunction & complication rates

Prone Study: Moderate to Severe Hypoxemia with ARDS

- Results:
  - No difference in mortality (31% vs. 32.8% \( p = .72 \))
  - No difference in 6th month mortality (47% vs. 52.3% \( p = .33 \))
  - Higher complications in the prone group 3x
  - 20% in the prone group did not receive an assigned treatment at least once r/t instability, facial edema, problems with CRRT, line dislodged

Limitations: To standardize the severity of hypoxemia patients on admission to the trail higher PEEP level had to be decreased to 10cm and 72 hr enrollment window


Prone Positioning Meta-analysis: 2011

Meta-analysis:
- 7 RCT’s: 1675 patients of which 862 ventilated prone ALI/ARDS and ARDS alone (4 studies/LPV & duration)
- Relationship between effect size & duration of prone position examined
- Examine major airway side effects

Cumulative

Limitations Of The Clinical Prospective Randomized Prone-supine Trials

- Power of the study
- Criteria for pronation
- Duration and frequency of pronations
- Ventilation tidal volumes high
- Ventilatory setting unmodified during pronation
- Mixed categories of patients
- Differences between centres
- Treatment of the etiologic agent uncertain!!

Courtesy of P Pelosi
Decision Making Factors in Positioning Patients Prone

- Time interval from injury to position change
- Hemodynamic status
Hemodynamic Instability

Is it a Barrier to Positioning?

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

Decision Making Factors in Positioning Patients Prone

- Time interval from injury to position change
- Hemodynamic status
- Mentation
- Patient size
Care Concerns

- Hemodynamic monitoring:
  - In studies that communicated landmarks for zero reference, no difference in HR, SBP or CI
- Feeding:
  - The patient is at most risk for aspiration during the turning process
  - If trendelenburg position is used to reduce facial edema, must weigh risk-benefit of aspiration
  - Tubes placed past the pyloric valve may also reduce the risk of aspiration
- Patients have been placed in the prone position successfully;
  - open abdomens, increased intra-cranial pressure monitoring/increased intracranial pressure, hemodynamic instability, pelvic fractures, external fixators, multiple traumatic injuries, use of extracorporeal membrane oxygenation (ECMO), and continuous renal replacement therapy (CRRT)


Effect on Cannula Position

Methodology
- Retrospective chart review
  - 10 patients with ECMO
  - 42 patients with CRRT
- Examined cannula location, displacement &/or malfunction for a total of 68 turning events
- All had venous cannulation: IJ & femoral sites

Results
- No inadvertent cannula removal during turning
- 2 patients demonstrated poor flow: 1 supine, 1Prone

Goettler CE. Et al Critical Care 2002;6:452-455
Prone Positioning

Fear of the Prone Position
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.)
Vollman Prone Positioner
To Prone or Not to Prone?

Base Your Decision on Research & Clinical Experience

Prone Position In Critically Ill Patients:

- Beneficial effects on gas-exchange and respiratory mechanics in ALI/ARDS patients
- Should be performed as early as possible (within 1 week)
- Ventilatory setting (FiO₂ & RM & PEEP) should be modified during prone position
- The reduction in PaCO₂ (and NOT the improvement in PaO₂) seems to be associated with better outcome
- The reduction in mortality is unclear (more effective in more severe patients? more effective if applied as much of the day as possible?)

Pelosi 2006 Paris
WHEN WOULD NOW BE A GOOD TIME TO DO THIS?

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

Happy Proning