Some Patients Breathe Better Upside Down

By Daniel T. Layish, MD

Acute respiratory distress syndrome (ARDS) is an inflammatory disease of the lungs characterized by the sudden onset of non-cardiogenic pulmonary edema and respiratory failure, usually in the setting of other acute medical conditions resulting from direct or indirect lung injury. Those lung injuries associated with the development of ARDS include: sepsis, aspiration, pneumonia, massive blood transfusion, pancreatitis, drug overdose and severe trauma. There are approximately 150,000 cases of ARDS in the United States per year, and mortality risks of patients suffering from ARDS are reported to be in the range of 35% to 45%. Prone therapy is typically used for patients at high risk of mortality from ARDS and was first used in the 1970s. However, recent advances in technology have improved the safety of this technique and made its use easier for ICU (intensive care unit) staff to implement.

The PaO2/FiO2 ratio (P/F ratio) reflects the effectiveness of oxygen transfer from the lung to hemoglobin and can serve as an indicator for a patient that may benefit from prone therapy. When the P/F ratio is between 201 and 300 mmHg, the patient is defined as having Acute Lung Injury (ALI). When the P/F ratio is below 200, the patient meets criteria for ARDS (in the setting of bilateral infiltrates without evidence of elevated wedge pressure or left atrial pressure).

Standard supportive therapy for ARDS includes mechanical ventilation with positive end-expiratory pressure (PEEP) and high concentrations of inspired oxygen. However, there is substantial concern about oxygen toxicity to the lungs as well as ventilator-induced lung injury through barotrauma and other mechanisms.

Research has shown the effectiveness of prone therapy in improving oxygenation in ARDS patients. Prone positioning has been shown to enhance mobilization of pulmonary secretions, further optimizing the effectiveness of physiotherapy techniques. Other benefits may include reduced risk of iatrogenic lung injury resulting from mechanical ventilation and ventilator-associated pneumonia (VAP). Prone ventilation decreases the pleural pressure gradient, minimizes regional lung collapse from compression by the heart or diaphragm and provides more uniform distribution of ventilation. Studies have shown that initiating prone therapy early (within 24 hours) and for longer periods of times in the course of ARDS may improve patient outcomes.

Educating ICU staff on the pathophysiology of refractory hypoxemia and training them to recognize the signs and symptoms of respiratory failure allows for early initiation of prone positioning. Also, coordinated teamwork is crucial when turning these critically ill patients to avoid dislodging tubes and catheters.

RotoProne™ Therapy System (KCI USA, Inc., San Antonio, TX) is a noninvasive therapy used for treatment and prevention of pulmonary complications associated with immobility. This system combines two methods: kinetic therapy ≥40° and prone therapy. Kinetic therapy ≥40° involves rotating patients from side to side, 40° to 62° in each direction, which can help move mucus and secretions that have concentrated in the lungs and prevent additional fluid buildup.

Patients with the following conditions are candidates for prone positioning with conventional (non-high frequency oscillatory ventilation) or high-frequency oscillatory ventilation utilizing RotoProne™ Therapy:

- Pulmonary complications, such as VAP and ARDS
- P/F ratio less than 140
- PEEP greater than or equal to 10 cm of water

There are no standard guidelines to delineate optimal duration or frequency of prone positioning. Length of prone time and frequency of prone/supine periods may vary from patient to patient. The recommended maximum prone time period is three hours and 15 minutes. The patient should be brought back to supine for approximately 45 minutes for general patient care and to help minimize facial edema. While in the prone position, it is also recommended that the patients be continuously rotated to at least 40° for a minimum of 18 hours per day for maximum benefit. Patients are categorized as responders when an increase in PaO2 of more than 10 mmHg occurs after 30 minutes of prone positioning and also an increase in P/F ratio of more than 20 or 20% occurs within two hours of patient being turned from supine to prone. If there in no change in PaO2, these patients are

RotoProne™ Therapy System
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categorized as non-responders. (NOTE: There have been reports of patients who did not respond on the initial attempt of prone positioning but did respond at subsequent attempts, showing an improvement in PaO2). Spinal instability, spinal fractures and pregnancy are considered to be absolute contraindications to prone ventilation. Recent thoracic and abdominal surgery would be a relative contraindication.

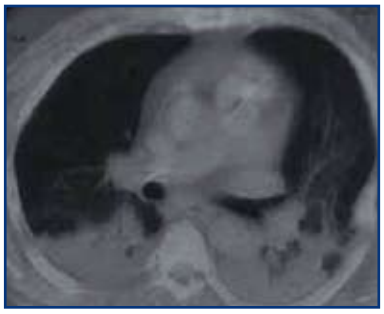
The RotoProne™ Therapy System has an automated button that can be used to bring a patient back to the supine position within 40 seconds in case of emergency as well as a quick release lever that can be used to manually return a patient to supine position in case of no power.

Prone therapy has been shown to help minimize:

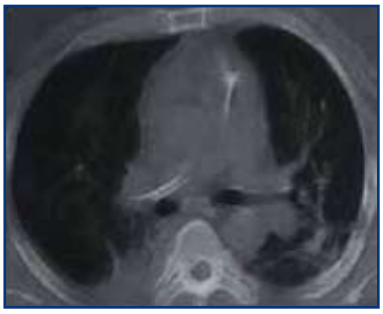
- Overinflation (barotrauma) of the lungs
- Large tidal volumes (volutrauma) of the lungs
- Repeated intratidal collapse and reinflation (atelectrauma) of the lungs

Prone ventilation does not improve survival in ARDS overall but has been shown to improve oxygenation in patients with ARDS. Also, there is evidence that prone ventilation may improve survival among the most severely hypoxemic patients. The optimal duration of prone ventilation should be assessed based upon response for each individual patient. Prone therapy should be considered as early rescue therapy for refractory hypoxia in ARDS after standard strategies, such as low tidal volume ventilation and high PEEP, have failed.

References available upon request.



Chest CT of lungs before prone ventilation.



Chest CT of lungs after prone ventilation.

Daniel Layish, MD, graduated magna cum laude from Boston University Medical School in 1990. He then completed an Internal Medicine Residency at Barnes Hospital (Washington University) in St.Louis, Missouri and a Pulmonary/Critical Care Fellowship at Duke University in Durham, North Carolina. Since 1997, he has been a member of the Central Florida Pulmonary Group in Orlando. He currently serves as Medical Director of the Intensive Care Unit, Respiratory Therapy and Pulmonary Rehab at Winter Park Memorial Hospital.

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