PROCEDURE

# 19 Pronation Therapy

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**PURPOSE:** The prone position may be indicated in patients diagnosed with acute respiratory distress syndrome demonstrating severe hypoxemia, defined as a partial pressure of arterial oxygen ($Pa_{O_2}$)/fraction of inspired oxygen ($Fi_{O_2}$) ratio of <150 mm Hg with an $Fi_{O_2}$ of at least 60% and positive end-expiratory pressure (PEEP) of at least 5 cm $H_2O$ and a tidal volume close to 6 mL/kg of predicted body weight. The prone position is used in an attempt to improve oxygenation and reduce ventilator-induced lung injury in patients with acute respiratory distress syndrome (ARDS). The position also may be used for mobilization of secretions as a postural drainage technique, posterior wound management that allows excellent visualization and management of the site, relief of pressure in the sacral region, positioning for operative or diagnostic procedures, and therapeutic sleep for critically ill patients who normally sleep on the abdomen at home.

## PREREQUISITE NURSING KNOWLEDGE

- Prone positioning is used as an adjunct short-term supportive therapy in an attempt to recruit alveoli to improve gas exchange and reduce ventilator injury in critically ill patients with ARDS with severe hypoxemia.
  - On the basis of numerous studies and three older and one recent meta-analyses, and the latest prospective randomized controlled trial (RCT), patients with ARDS and severe hypoxemia placed in the prone position significantly increase $Pa_{O_2}/Fi_{O_2}$ ratio compared with in the supine position. The greatest effect was seen within the first few days, with continuing benefit up to 8 days.[1–6,10,13,16,17,21,23,29,33,35,37] Guerin and colleagues studied a total of 466 ARDS patients with severe hypoxemia, with 237 in the prone group and 229 in the supine group. Patients were randomly assigned to undergo prone or supine positioning. After eligibility was determined, a stabilization period of 12 to 24 hours took place before randomization. Those in the prone group were turned within 1 hour of randomization and spent at least 16 consecutive hours in the prone position per day. The 28-day mortality was significantly reduced in the prone group. The mortality of the prone group was 16% compared with the supine group at 32.8%. This benefit held out to 90 days.[17] However, the other two of the four meta-analyses showed no improvement in mortality with the use of the prone position.[1,33] The other two meta-analyses showed significant improvement in mortality in patients with severe-hypoxemia ARDS.[3,21] Lee and colleagues also found that >10 hours a day in the prone position was associated with a reduction in mortality.[21]
  - No significant difference was seen in number of days on mechanical ventilation with the prone position.[1,3,33] One meta-analysis showed significant reduction in the incidence of ventilator-associated pneumonia (VAP) in the prone position[33]; another showed a trend toward significance in VAP reduction of 23% ($P = 0.09$)[1]; and the third showed no difference in VAP rates between the two positions.[3] The fourth meta-analysis did not evaluate the effect on VAP.[21]
  - Part of the variability in outcomes between the analyses has to do with the inclusion criteria used to choose the studies incorporated in the meta-analysis. The analysis by Alsaghir and Martian[3] resulted in five trials that met inclusion criteria out of 63 with a total of 1316 patients. The meta-analysis performed by Abroung and group[1] included 5 trials out of 72 with a total of 1372 patients, and the analysis by Sud and colleagues[33] included 13 trials out of 1676 studies with analysis being performed on 1559 patients. Lee et al. analyzed 11 trials totaling 2246 patients. They excluded RCTs conducted on pediatric patients and randomized cross over trials that assigned patients to both groups.[21]
  - The last major outcomes to be examined in the meta-analyses were the presence of significant complications when the prone position was compared with the supine position. Three of the four analyses reported on complications. Two analyses showed a statistically significant higher risk for the development of pressure ulcers in the prone position,[21,33] and Abroung and group[1] showed no significant difference in major airway complications in the prone position; however, Lee and colleagues demonstrated that prone positioning was significantly associated with major airway complications.[21] Guerin and colleagues in their recent prospective RCT showed that the incidence of complications did not differ between groups except with cardiac arrests. The supine group had a significantly higher rate of cardiac arrest than the prone group.[17]

- To enhance an understanding of how prone positioning may affect gas exchange, understanding the factors that influence the distribution of ventilation and perfusion within the lung is important.
  - *Distribution of ventilation:* Regional pleural pressures and local lung compliance jointly determine the volume of air distributed regionally throughout the lungs. Three major factors—gravity and weight of the lung, compliance, and heterogeneously diseased lungs—influence regional distribution. In an upright individual, the pleural pressure next to the diaphragm is less negative than at the pleural apices. The weight of the lung and the effect of gravity on the lung and its supporting structures in the upright position create this difference in regional pleural pressures. This relationship results in a higher functional residual capacity (FRC) in the nondependent zone or the apices, redirecting ventilation to the dependent zone.[11,19,41] When body position changes, changes occur in regional pleural pressures, compliance, and volume distribution. In the supine position, distribution becomes more uniform from apex to base. The ventilation of dependent lung units exceeds that of nondependent lung units, however, and a reduction in FRC is seen.[11,41] The two factors that contribute to the reduction in FRC seen in moving from the upright to the supine position include the pressure of the abdominal contents on the diaphragm and the position of the heart and the relationship of the supporting structures to the lung and its influence on pleural pressure gradients.[11,12,22]
  - The first factor to influence pleural pressure, regional volumes, and FRC is the effect of the abdominal contents on the function of the diaphragm. In spontaneously breathing individuals in the supine position, the diaphragm acts as a shield against the pressure exerted by the abdominal contents, preventing the contents from interfering with dependent lung-volume distribution. When patients are mechanically ventilated with positive-pressure breaths, sedated, or paralyzed, the active muscle tension in the diaphragm is lost, which results in a cephalad displacement of the diaphragm and allows abdominal pressures to decrease dependent lung-volume inflation and FRC.[11,19] The only way to modify this influence is to change the posture to a prone position with the abdomen unsupported.[11,29]
  - The second factor to influence pleural pressure, regional volumes, FRC, and compliance is the position of the heart and supporting structures. The heart and the diaphragm extend farther dorsally and rest against a rigid spine in the supine position, squeezing the lungs beneath them. This pressure on the lungs generates more positive pleural pressures, which results in a greater propensity of the alveoli at end expiration to collapse. In the prone position, the heart and upper abdomen rest against the sternum, exerting less weight on the lung tissue. Less effect on pleural pressure occurs, which leaves the pleural pressures more negative, maintaining open alveoli.[22,26,29]
  - A third factor that contributes to the distribution of volume is heterogeneously or unevenly distributed diseased lung. The ARDS lung weight is increased twofold to threefold from normal. The increased weight is from edema and the resulting hydrostatic forces. The result is a progressive squeezing of gas along the vertical-dorsal axis. This decrease of regional inflation along the vertical axis results in dependent or dorsal lung collapse. In the prone position, these densities shift. The pattern almost completely reverts toward normal. The inflation gradient is less steep, and the difference results in a more homogeneous regional inflation. This inflation may be related to a redistribution of gas because of the change in hydrostatic forces caused by differences in pleural pressure, as described previously.[12,14,29]
- *Distribution of perfusion:* Similar to ventilation, regional distribution of perfusion is influenced by three factors: cardiac output, pulmonary vascular resistance, and gravity or body position.
  - In an upright individual, blood flow decreases as it moves from base to apex with virtually no flow at the apex. This decrease is caused by the influence of gravity on pulmonary vascular pressures within the lung
  - In zone 1, near the apex, alveolar pressure exceeds arterial pressure, creating little or no flow.
  - In zone 2, the pulmonary artery pressure exceeds alveolar pressure, which exceeds the venous pressure. Blood flow in this area occurs based on the differences in pressure between the arterial and alveolar bed.
  - In zone 3, the arterial pressure is greater than the venous pressure, which is greater than the alveolar pressure. In this zone, the influence of the alveolar pressure on blood flow is reduced, resulting in freedom of flow in this region.[41,42]
- In supine and lateral positions, apical region blood flow changes. No real change is seen in basilar units, but a greater dependent versus nondependent blood flow occurs. In the prone position, a marked reduction occurs, however, in the gravitational perfusion gradient, which suggests no gravity-dependent benefit to flow in the prone position.[26]
- On the basis of the current available data as outlined here, changes in oxygenation seem to be related to differences in the regional inflation/ventilation of the lung while prone and are not related to a redistribution of blood flow.[7,22,28] In a recent examination of the Guerin et al. trial data, it appears that the improvement in gas exchange did not predict survival. It was suggested that improved survival occurred by reducing ventilator-induced lung injury as it was first discussed in 1997. Prone positioning creates a more uniform distribution of end-expiratory lung volume or FRC and a more uniform tidal volume.[2]
- Suggested criteria for use of the prone position include the following:
  - Consider early use of the prone position for patients with ARDS with severe hypoxemia defined as a $Pao_2/Fio_2$ ratio <150 mm Hg, with a $Fio_2$ >60% with at least 5 cm of PEEP.[17]
- Precautions to manual pronation therapy include the following[4,10,28,31,36,37]:
  - Patient unable to tolerate a head-down position
  - Increased intracranial pressure

- Unstable spine (unless Stryker Frame [Stryker Medical], Kalamazoo, MI)
- Patient with hemodynamically unstable condition (as defined by a systolic blood pressure <90 mm Hg) with fluid and vasoactive support in place
- Weight 160 kg or greater (weigh the risk/benefit ratio for the patient and staff)
- Extracorporeal membrane oxygenator cannula placement problems
- With use of a support frame, patient weight >135 kg (300 lbs)
- Open chest or unstable chest wall
- Bronchopleural fistula
- Unstable pelvis
- Facial trauma
- Grossly distended abdomen or ischemic bowel
- Pregnancy
- Bifurcated endotracheal tube (ETT)

- Absolute contraindications for use of Automated Prone Positioning RotoProne Therapy System (Arjohuntleigh, Sweden) include the following:
  - Unstable cervical, thoracic, lumbar, pelvic, skull, or facial fractures
  - Cervical or skeletal traction
  - Uncontrolled intracranial pressure
  - Patient weight <40 kg (88 lbs)
  - Patient weight >159 kg (350 lbs)
  - Patient height >6 ft 6 inches
- The use of the prone position is discontinued when the patient no longer shows a positive response to the position change or mechanical ventilation support has been optimized. In the Guerin et al protocol, prone positioning was stopped when the following criteria were met[17]:
  - Improvement in oxygenation, defined as $Pao_2/Fio_2$ ratio <150 mm Hg, with an $Fio_2$ >60% with ≤10 cm of PEEP (these criteria had to be met in the supine position at least 4 hours after the end of the last prone session)
  - A $Pao_2/Fio_2$ ratio of more than 20% relative to the ratio in the supine position before two consecutive prone sessions
  - Complications occurring during a prone session leading to its immediate interruption, including nonscheduled extubation, main stem bronchus intubation, ETT obstruction, hemoptysis, oxygen saturation <85% for greater than 10 minutes or a $Pao_2$ of <55 mm Hg for more than 5 minutes. When the $Fio_2$ was at 100%, cardiac arrest, a heart rate of <30 bpm for more than 1 minute, systolic blood pressure of <60 mm Hg for more than 5 minutes, and any other life-threatening reason
- With use of the RotoProne Therapy System Surface, weaning from the prone position is recommended. Increase supine time while decreasing time in the prone position until the patient is able to tolerate 12 to 24 hours in the supine position with no decrease in oxygenation response. The patient can then be taken off the RotoProne and placed on an appropriate surface to achieve patient goals.

# EQUIPMENT

- Pillows, gel or foam blocks, flat sheet
- Four or five staff members
- Resuscitation bag and mask, connected to an oxygen source
- Lift sheets (Figs. 19-1 and 19-2)

*or*

- RotoProne Therapy System for use in all patient populations (Fig. 19-3): weight limit per manufacturer's recommendations, 88 to 350 lbs (40 to 159 kg); height limit per manufacturer's recommendations, 54 to 78 inches (140 to 200 cm)

*or*

- Lateral rotation therapy bed with or without prone accessory kit

*or*

- Vollman Prone Positioner (VPP; Hill-Rom, Inc, Batesville, IN; Fig. 19-4): weight limit per manufacturer's recommendation, 300 lbs (no longer manufactured but may have been purchased in the past)
- Three staff members (with VPP)
- Stryker Frame for use in patients with unstable spines, if available: weight limit per manufacturer's recommendations

Additional equipment, to have available as needed, includes the following:

- Capnography monitor

# PATIENT AND FAMILY EDUCATION

- Explain to the patient and family the patient's lung/oxygenation problem and the reason for the use of the prone position. ***Rationale:*** This explanation decreases patient and family anxiety by providing information and clarification.
- Explain the care procedure to the patient and family, including positioning procedure, perceived benefit, frequency of assessments, expected response, and parameters for discontinuation of the positioning technique and equipment (if special bed or frame is initiated). ***Rationale:*** This communication provides an opportunity for the patient and family to verbalize concerns or ask questions about the procedure.

# PATIENT ASSESSMENT AND PREPARATION

## Patient Assessment

- Assess time interval from initial diagnosis to position change. ***Rationale:*** Prone positioning should be performed within the first 24 hours of the diagnosis of severe-hypoxemia ARDS. Prone positioning should occur for at least 16 hours in a 24-hour period.
- Assess the hemodynamic status of the patient to identify the ability to tolerate a position change.[31,39] Most critically ill patients take 5 to 10 minutes to equilibrate to a position change. Allow for this time period before determining lack of ability to tolerate the prone position.[39] ***Rationale:***

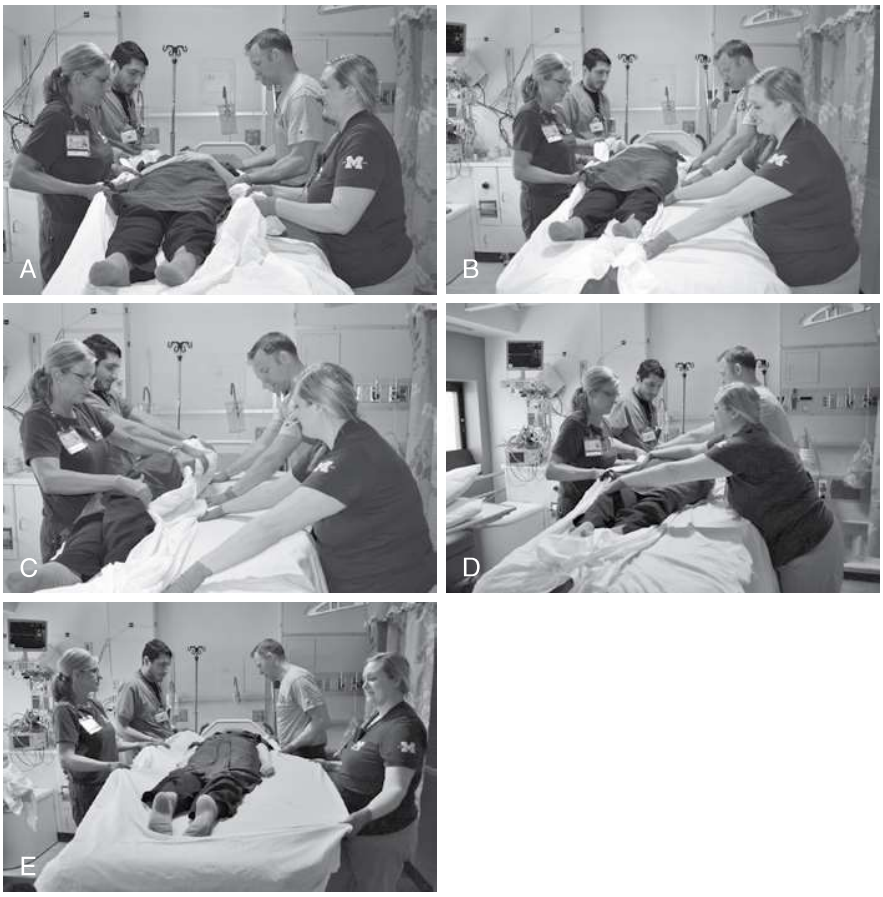


**Figure 19-1** The five-step method to prone a patient using a regular bed, flat sheet, and four staff. **A,** Using a flat sheet, pull the patient to one side of the bed using four staff members. **B,** Place the flat sheet around the arm that will pull through (the side you are turning toward). **C,** A second flat sheet is placed on the bed and tucked under the patient. This sheet will pull through as you are turning the patient. **D,** Using the sheet, turn the patient over and position the patient prone. The arm and sheet will pull across the bed. **E,** Pull and center the patient. Discard the sheet that was used to supine the patient. Straighten lines and tubes. *(From University of Michigan Surgical Intensive Care Technique.)*

Imbalances between oxygen supply and demand must be addressed before the pronation procedure to offset any increases in oxygen demand that may be created by the physical turning. The final decision to place a patient with a hemodynamically unstable condition in a prone position rests with the physician or advanced practice nurse who must weigh the risks against the potential benefits of the prone position.

- Assess mental status before use of the prone position. ***Rationale:*** Agitation, whether caused by delirium, anxiety, or pain, can have a negative effect with the prone position. Nevertheless, agitation is not a contraindication for use of the prone position. The healthcare team should strive to manage the agitation effectively to provide a safe environment for the use of the prone position.
- Assess size and weight load to determine the ability to turn within the narrow critical care bed frame and to weigh the potential risk of injury to the healthcare worker. ***Rationale:*** When manually turning a patient prone in a hospital bed, with or without a frame, one must determine whether a 180-degree turn can be accomplished within the confines of the space available. Critical care bed frames are narrow, which makes completion of the turn difficult on patients who weigh more than 160 kg. The team must consider the potential for injury to the healthcare workers when making the decision to turn morbidly obese patients prone. With use of a special bed made specifically for prone positioning, follow the weight and height limitations recommended by the manufacturer.
- Evaluate patient for any history of contraindications for particular arm positions while manually proned. ***Rationale:*** Identifies patients with arm or shoulder injuries that may preclude proning.

## Patient Preparation

- Verify that the patient is the correct patient using two identifiers. ***Rationale:*** Before performing a procedure, the nurse should ensure the correct identification of the patient for the intended intervention.
- Ensure that the patient and family understand preprocedural teachings. Answer questions as they arise and reinforce information as needed. ***Rationale:*** This communication evaluates and reinforces understanding of previously taught information.


**Figure 19-2** The five-step method to supine a patient using a flat sheet and four staff. **A,** Using a flat sheet, pull the patient to one side of the bed. **B,** Place the flat sheet around the arm that will pull through (the side you are turning toward). **C,** A second flat sheet is placed on the bed and tucked under the patient. This sheet will pull through as you are turning the patient. **D,** Using the sheet turn the patient over and position the patient prone. The arm and sheet will pull across the bed. **E,** Discard the sheet that was used to supine patient. **F,** Straighten lines and tubes. *(From University of Michigan Surgical Intensive Care Technique.)*

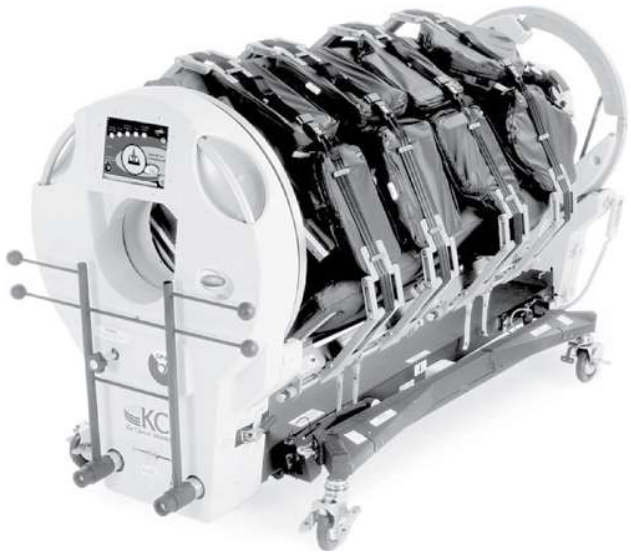

**Figure 19-3** The Rotoprone therapy system. *(Courtesy KCI Licensing, Inc, 2008.)*

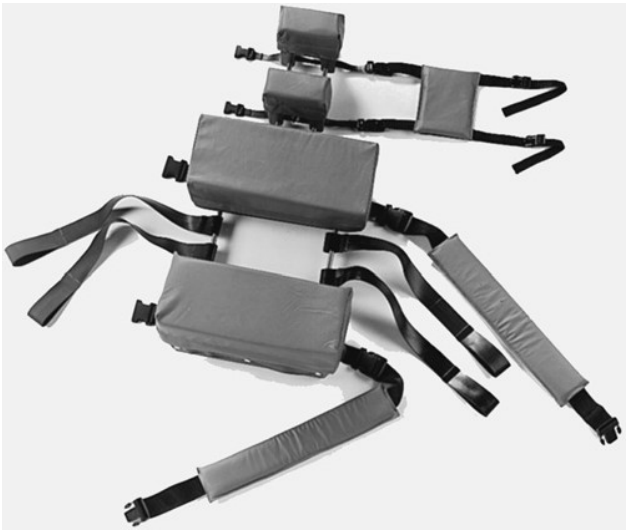

**Figure 19-4** Diagram of the Vollman Prone Positioner. *(From Hill-Rom, Inc, San Antonio, TX.)*

- Assess patient's mental condition. ***Rationale:*** Assessment of pain, anxiety/agitation and delirium using a reliable and valid scale and providing appropriate management before, during, and after the turn are key to accomplishing a safe procedure.
- If using gastric feedings, turn off the tube feeding 1 hour before the prone position turn. ***Rationale:*** This action assists with gastric emptying and reduces the risk of aspiration during the turning procedure.[38] Enteral feeding can be continued during prone position[34]; use of prokinetic agents or transpyloric feedings is recommended to prevent complications associated with vomiting.[30]
- Before positioning the patient prone, the following care activities should be performed. ***Rationale:*** These activities prevent areas of pressure and potential skin breakdown; avoid complications related to injury or accidental extubation; and promote the delivery of comprehensive care before, during, and after the pronation therapy.[31,36,37,40]
  - Order prone positioning.
  - Remove electrocardiogram (ECG) leads from the anterior chest wall.
  - Perform eye care, including lubrication and taping of the eyelids closed in a horizontal fashion (or per institutional policy).
  - Ensure the tongue is inside the patient's mouth. If the tongue is swollen or protruding, insert a dental mouth-prop. The dental mouth-prop fits between the teeth (upper and lower) holding the mouth open to prevent the teeth digging into the tongue. Other bite blocks may be used, but do not use bite blocks that fit over the tongue as this will cause undue pressure and increase risk of tongue breakdown.
  - Ensure the tape or ties of the ETT or tracheotomy tube are secure. Changing of the ties may be necessary on return to the supine position if they are not secure. If adhesive tape is used to secure the ETT, consider double taping or wrapping completely around the head because increased salivary drainage occurs in the prone position and may loosen the adhesive.[31,37] Commercial ETT securement devices are not recommended for use during prone positioning because of the possibility of increased skin breakdown and breakdown of adhesive from increased salivary drainage.[20]
  - Central and arterial lines should be sutured into place.
  - If a wound dressing on the anterior body is due to be changed during the prone-position sequence, perform the dressing change before the turn. If saturated on return from the prone position, the dressing needs to be changed.
  - Empty ileostomy/colostomy bags before positioning. Placement of the drainage bag to gravity drainage and padding around the stoma to prevent pressure directly on stoma are recommended.
  - Capnography monitoring is suggested to help ensure proper positioning of the ETT during the turning procedure and in the prone position.

**Procedure for Preparation for Manual Prone Therapy**

| Steps | Rationale | Special Considerations |
|---|---|---|
| 1. HH | | |
| 2. PE | | |
| 3. Two staff members are positioned on each side of the bed, with another staff member (often a respiratory therapist [RT]) positioned at the head of the bed. (**Level D***) Ideally, some of the staff should be experienced with proning and moving the patient back to supine in case of an emergency. | Four to five individuals are needed to position a patient safely prone without a frame. Additional stability and position of the personnel may be necessary, based on the size of the patient.[8,9,31,36,37,40] | The RT at the head of the bed is responsible for monitoring the ETT, ventilator tubing. The nurse adjacent to the RT monitors the intravenous (IV) lines located by the patient's head. For increased airway security, the RT or nurse should hold the ETT during the turn.[31,37] |
| 4. Correctly position all tubes and invasive lines. Remove ECG patches from the chest. | All IV tubing and invasive lines are adjusted to prevent kinking, disconnection, or contact with the body during the turning procedure and while the patient remains in the prone position. ECG patches can be a source of pressure when the patient is proned.[8,9] | If the patient is in skeletal traction, one individual needs to apply traction to the leg while the lines and weights are removed for the turn. If a skeletal pin comes into contact with the bed, a pillow needs to be placed in the correct position to alleviate pressure points. |

*Level D: Peer-reviewed professional and organizational standards with the support of clinical study recommendations.

*Procedure continues on following page*

**Procedure** **for Preparation for Manual Prone Therapy—*Continued***

| Steps | Rationale | Special Considerations |
|---|---|---|
| 5. Lines inserted in the upper torso are aligned with either shoulder, and the excess tubing is placed at the head of the bed. The only exception is for the chest tubes or other large-bore tubes (e.g., tubes used for extracorporeal membrane oxygenation). (**Level D***) | Disconnecting IV lines before the turn may help to prevent dislodgement but places the patient at an increased risk for infection. | |
| 6. Chest tubes and lines or tubes placed in the lower torso are aligned with either leg and extend off the end of the bed. (**Level D**) | Consider addition of an extension tube to lines that are too short to be placed at the head of bed or the end of the bed. | |
| 7. If the patient has an open abdomen, cover with a synthetic material or vacuum dressing before positioning. Identify a positioning strategy that allows the abdomen to be free of restriction. | Open abdomens are not a contraindication for use of the prone position. A cover with a synthetic material such as a Wound Vac, or support such as an abdominal binder, may be used effectively to secure the abdomen.[25] | |
| 8. Assess to make sure you have enough bed width to safely turn the patient 180 degrees. If on a low air-loss surface, maximally inflate.[36,40] (**Level E***) | Maximally inflating the air surface firms up the mattress, making the turn easier to perform. | Consider the use of a bariatric bed for patients >300–350 lbs. |
| 9. Preoxygenate the patient with a $Fio_2$ of 100% for 30 minutes before prone or supine positioning.[8] (**Level E**) | Maximize oxygenation before turning. | |
| 10. Discard used supplies and remove PE | | |
| 11. HH | | |

**Procedure** **for Manual Pronation Therapy: The Five-Step Method to Prone the Patient**[8,9] (see Fig. 19-1)

| Steps | Rationale | Special Considerations |
|---|---|---|
| 1. Start with flat sheet that is under the patient and pull the patient while still supine to the side of the bed away from the ventilator. Turn the patient in the direction of the mechanical ventilator. | The person on the side of the bed closest to the patient maintains body contact with the bed at all times to serve as a side rail and prevent a fall. (**Level C***) | |

*Level C: Qualitative studies, descriptive or correlational studies, integrative reviews, systematic reviews, or randomized controlled trials with inconsistent results.
*Level D: Peer-reviewed professional and organizational standards with the support of clinical study recommendations.
*Level E: Multiple case reports, theory-based evidence from expert opinions, or peer-reviewed professional organizational standards without clinical studies to support recommendations.

**Procedure** **for Manual Pronation Therapy: The Five-Step Method to Prone the Patient**[8,9] (see Fig. 19-1)—***Continued***

| Steps | Rationale | Special Considerations |
|---|---|---|
| 2. The flat sheet is placed around the arm that is located in the middle of the bed (encircle the arm, that will pull through) side you are turning toward. | This maneuver protects the arm and allows it to be pulled from under the patient after completing the turn. | |
| 3. A second flat sheet is placed on the bed and tucked under the patient and the covered arm. The patient is rolled as far as possible to the side of the bed to allow placement of the second sheet as far under the patient as possible. This sheet will pull through as you are turning the patient. | Both sheets will pull through after turning the patient. | |
| 4. Under direction of the person at the head of the bed, with a count of three, the patient is carefully turned back over by pulling the first sheet from the side of the bed back toward the middle of the bed. The wrapped arm is gently pulled from under the patient using the original sheet while pulling the second sheet under the patient. The original flat sheet is discarded. (**Level E***) | The first flat sheet is pulled through and away from the ventilator, pulling the arm with it. This sheet can be recycled and the second flat sheet pulled through away from the ventilator. Placing the new sheet (second sheet) under the patient allows you to be ready to return the patient to the supine position at any time. It also allows the patient to lay on a clean, absorbent surface. | Chest and/or pelvic support can be done by placing a pillow at the abdomen before completing the turn. |
| 5. The patient is now prone. Pull and center the patient. Straighten and reconnect lines and tubes. Position the head to prevent pressure areas. Place the patient in the reverse Trendelenburg position if not contraindicated. Place feet on pillows. (**Level E**) | Every attempt is made to prevent pressure areas to the face, around lines and tubes, and over bony prominences. The head should lie directly on the bed in a side lying position. Arms are positioned for comfort by either placing them aligned with the body or in a swimmers position, one up and one down. | Patients may have range-of-motion limitations to the shoulder area that may make keeping the arms in a flexed position difficult.<br>The patient should be repositioned every 2 hours, the same as a patient in the supine position. The head should also be rotated every 2 hours from side to side. |
| **Preparation for Returning a Patient to Supine Position** | | |
| 1. Repeat procedure steps 3–9 under Procedure for Preparation for Manual Prone Therapy above. | | |
| **The Five-Step Method for Returning to the Supine Position From the Prone Position**[8,9] (see Fig. 19-2) | | |
| 1. Start with a flat sheet that is under the patient and pull the patient while still prone to the side of the bed, away from the ventilator. Turn the patient in the direction of the mechanical ventilator. | The person on the side of the bed closest to the patient maintains body contact with the bed at all times to serve as a side rail and prevent a fall. (**Level C***) | The RT at the head of the bed is responsible for monitoring the ETT, ventilator tubing. The nurse adjacent to the RT monitors the intravenous lines located by the patient's head. For increased airway security, the RT or nurse should hold the ETT during the turn.[31,37] |

*Level C: Qualitative studies, descriptive or correlational studies, integrative reviews, systematic reviews, or randomized controlled trials with inconsistent results.
*Level E: Multiple case reports, theory-based evidence from expert opinions, or peer-reviewed professional organizational standards without clinical studies to support recommendations.

*Procedure continues on following page*

**Procedure** **for Manual Pronation Therapy: The Five-Step Method to Prone the Patient**[8,9] (see Fig. 19-1)—***Continued***

| Steps | Rationale | Special Considerations |
|---|---|---|
| 2. The flat sheet is placed around the arm that is located in the middle of the bed (encircle the arm that will pull through) while you are turning toward. | This maneuver protects the arm and allows it to be pulled from under the patient after completing the turn. | |
| 3. A second flat sheet is placed on the bed and tucked under the patient and the covered arm. The patient is rolled as far as possible to the side of the bed to allow placement of the second sheet as far under the patient as possible. This sheet will pull through as the patient is turned. | Both sheets will pull through after turning the patient. | |
| 4. Under direction of the person at the head of the bed, with a count of three, the patient is carefully turned back over by pulling the first sheet from the side of the bed back toward the middle of the bed. The wrapped arm is gently pulled from under the patient using the original sheet while pulling the second sheet under the patient. The original flat sheet is discarded. (**Level E***) | The first flat sheet is pulled through and away from the ventilator, pulling the arm with it. This sheet can be recycled and the second flat sheet is pulled through away from the ventilator. Placing the new sheet (second sheet) under the patient allows you to be ready to prone at any time. It also allows the patient to lay on a clean, absorbent surface. | Offloading of bony prominences can be accomplished by placing pillows under the back and buttocks. |
| 5. The patient is now supine. Pull and center the patient. Straighten and reconnect lines and tubes. | Every attempt is made to prevent pressure areas around lines, tubes, and boney prominences. | Position the head to prevent pressure areas. Elevate the head of the bed, 30–45 degrees to prevent a ventilator-associated event, if not contraindicated. Place legs on pillows to free float the heels and reduce edema. Place arms on pillows to reduce edema and prevent pressure. Place head on a pillow, if not contraindicated. Provide range of motion.<br>The patient should be repositioned every 2 hours unless contraindicated. |

*Level E: Multiple case reports, theory-based evidence from expert opinions, or peer-reviewed professional organizational standards without clinical studies to support recommendations.

**Procedure for Automated Pronation Therapy (Using the RotoProne Therapy System; see Fig. 19-3)**

| Steps | Rationale | Special Considerations |
|---|---|---|
| 1. HH | | |
| 2. PE | | |
| 3. After removing all pieces from the RotoProne Therapy System, move the patient from the intensive care unit bed to the RotoProne Therapy System. | The patient needs to be placed on the RotoProne surface to use this device for proning. | |
| 4. Position the patient in the center of the surface with head positioned in the attached head support. | To appropriately place packs on the patient for the prone procedure, he or she must be centered on the surface with his or her head in the head support. | Ears should be visible through the ear holes on the headpiece. |
| 5. Position all tubes and invasive lines: | | |
| A. Lines inserted in the upper torso are aligned with either shoulder and positioned at the head of the bed in the tube-management system.[8,9] **(Level C*)** | All intravenous tubing and invasive lines are adjusted to prevent kinking, disconnection, or contact with the body during the turning procedure and while the patient remains in the prone position.[8,9] | |
| B. Chest tubes and lines or tubes placed in the lower torso are aligned with either leg and extend through the center hole at the foot of the surface. | The addition of extension tubing to lines that are too short to be placed at the head of the bed or the end of the bed may be necessary. | |
| C. If the patient has an open abdomen, it should be supported with some type of supportive dressing. **(Level E*)** | Open abdominal wounds are not a contraindication for use of the prone position. A cover with a synthetic material and a support such as an abdominal binder or vacuum dressing may be used effectively to secure the abdomen.[25] | |
| 6. Follow manufacturer's recommendations for securing patient on therapy surface. **(Level M*)** | For safe operation of the product, manufacturer's recommendations should be followed. | |
| A. Place leg piece and side packs on surface. Tighten side packs by using the crank at the midpoint of the bed. The packs should fit snugly against the patient's sides. | Ensure the patient is snugly secured within side packs. If the side packs are not secured tightly before the turn, the patient may have shear or friction injuries develop during the turning process. This can also cause the bed to alarm. | |
| B. Place abdominal support mesh over the patient's abdomen. | Provides abdominal support when patient is in the prone position. | |
| C. Position additional pads on patient for support if needed. Place chest pad on chest so the top is level with the patient's shoulders. | All packs need to be positioned to prevent undue pressure on the patient's surfaces and to avoid malposition of joints (avoid hyperextension of knees and hips in prone position). | |

*Level C: Qualitative studies, descriptive or correlational studies, integrative reviews, systematic reviews, or randomized controlled trials with inconsistent results
*Level E: Multiple case reports, theory-based evidence from expert opinions, or peer-reviewed professional organizational standards without clinical studies to support recommendations.
*Level M: Manufacturer's recommendations only.

*Procedure continues on following page*

**Procedure** **for Automated Pronation Therapy (Using the RotoProne Therapy System; see Fig. 19-3)—*Continued***

| Steps | Rationale | Special Considerations |
|---|---|---|
| D. Tighten the headpiece snugly around the patient's head. | The patient's head needs to be secured during the turning procedure to prevent patient injury and tube dislodgement. | |
| E. Position all packs snugly over the patient (lower leg below knees, upper leg above knees, pelvic pack over iliac crest, and chest pack over chest/shoulder area) and buckle. | This action prevents direct pressure over bony prominences and provides sufficient distance between the chest and pelvis to allow the abdomen to be free of restriction, and prevents bowing of the back. The chest pack may need to be tightened over the patient last because constriction of the chest may restrict the patient's ventilatory effort and increase peak airway pressures. | |
| F. Place the face pack on the patient's face and attach to the head piece by inserting black locking straps on both sides. Ensure the top pad is above the eyebrows and the side pieces frame the mouth. | Face pads should be resting on the face; do not tighten because this will create undue pressure. | |
| 7. On the screen at the foot of the bed, set therapy on RotoProne Therapy System to prone toward the direction of the ventilator. | These maneuvers are performed to prevent disconnection of the ventilator tubing or kinking of the ETT during the turning procedure.[31,36,37,40] | |
| 8. Discard used supplies and remove PE. | | |
| 9. HH | | |
| **Turning Prone With the RotoProne Therapy System** | | |
| *All steps listed below are performed on the touch screen at the foot of the surface.* | | Use the touch screen buttons on screen at the foot of the surface, following manufacturer's instructions for turning the patient to the prone position. |
| 1. "Check tubing," "Check airway," "Check head support" (push each button on the screen after checking). | These safety checks are important to prevent complications during the turning procedure. | |
| 2. Push the "Rotate" button. | Must start rotation before turning prone. | |
| 3. Push the "Prone" button. | This will begin instructions for automated prone positioning of the patient. | |
| 4. Push the "Rotate and lower" button. Press and hold button until screen changes. | Surface must be in flat and low position before prone position can be achieved | |

**Procedure** **for Automated Pronation Therapy (Using the RotoProne Therapy System; see Fig. 19-3)—*Continued***

| Steps | Rationale | Special Considerations |
|---|---|---|
| 5. "Check tubing," "Check airway," "Check head support," "Check abdominal support," "Check arm slings" (push each button on the screen after checking). | These safety checks are important to prevent complications during the turning procedure. | |
| 6. Reconfirm the face pack and push the button on the touch screen. | Final safety check to assure the face pack is secure before positioning prone to prevent any patient injury. | **Important note:** ***The face pack is the only piece without a safety sensor.*** |
| 7. Press "Prone." Press and hold the button during the entire turning procedure. (This step can also be accomplished with pushing the "Prone/supine" button on the hand control.) (**Level M***) | This begins the automated prone positioning process. | Release the button if need arises to stop the turning procedure because of kinking or pulling on tubes. It may be helpful to have an additional person present during the actual turning procedure to monitor invasive lines and ventilator tubing to ensure all lines are positioned correctly. In the absence of an additional person, use of the handset at the head of the bed is recommended for turning the patient so all invasive lines and tubes are visible during turning. |
| 8. After the patient is in the prone position, the screen shows additional buttons to "Check tubing," "Check airway," "Check head support" (push each button after checking). | It is important to perform safety checks after the patient is in prone position to assure patient safety. | |
| 9. Press "Rotate." | Patient should rotate 62 degrees to each side while in the prone position as tolerated. | Degree of rotation and pause times on each side can be adjusted based on individual patient response to therapy. |
| 10. Push the "Surface position" button on screen. | This button allows changes in surface height and position. | |
| 11. Place the patient in the reverse Trendelenburg position by pressing the button on screen (push and hold until 11–12 degrees). (**Level M***) | The reverse Trendelenburg position is recommended to keep the head of the bed up to decrease edema and prevent complications associated with feeding or potential aspiration. | |
| 12. Open back hatches in the prone position. | All hatches can be opened to allow for full chest expansion. The foot hatch should be opened and propped open to prevent undue pressure on the heels. | |

*Level M: Manufacturer's recommendations only.

*Procedure continues on following page*

**Procedure** **for Automated Pronation Therapy (Using the RotoProne Therapy System; see Fig. 19-3)—*Continued***

| Steps | Rationale | Special Considerations |
|---|---|---|
| 13. Leave patient in the prone position for 3 hours 15 minutes with 62-degree rotation to each side. **(Level C*)** | Recommended time to remain in the prone position is 3 hours 15 minutes, alternating with 45 minutes supine to achieve a total of 19.5 hours prone time in a 24-hour period.[32] After prone time is completed, position the patient supine for 45 minutes as tolerated. The positioning schedule is based on whether the patient is able to sustain improvements in $Pao_2$ made while in the prone or supine position. | The healthcare team may decide to vary the recommended schedule based on individual patient-care needs. Adjustment of time intervals and rotation times based on the patient's response to therapy may be necessary. Changes to degree of rotation or pause times can be made by pushing the "therapy settings" button. If the need arises to quickly return the patient to the supine position, "CPR buttons" are located on the touch screen and below the screen at the foot of the bed. |
| 14. Discard supplies and remove PE. | | |
| 15. HH | | |
| **Turning Supine With the RotoProne Therapy System** | | |
| 1. HH | | |
| 2. PE | | |
| 3. Close any open hatches. | All hatches must be closed before moving to the supine position to prevent patient injury. The system will not operate until the hatches are closed. | Make sure all hatches are closed before returning the patient to the supine position. |
| 4. Push the "Supine" button. | Prepares the system to begin the supine function of the surface. | |
| 5. Push the "Rotate and lower" button and hold until screen changes. | Surface must be in the flat and low position before the turning procedure can be achieved | |
| 6. "Check tubing," "Check airway," "Check head support" (push each button after checking). | It is important to perform safety checks to assure patient safety | |
| 7. Press "Supine" and hold the button during the entire turning procedure. (This step can also be accomplished by pushing the "Prone/supine" button on the hand control.) **(Level M*)** | This begins the automated turning process to return the patient to the supine position. | Release the button if need arises to stop the turning procedure because of kinking or pulling on tubes. It may be helpful to have an additional person present during the actual turning procedure to monitor invasive lines and ventilator tubing to ensure all lines are positioned correctly. In the absence of an additional person, use of the handset at the head of the bed is recommended for turning the patient so all invasive lines and tubes are visible during turning. |
| 8. Insert the locking pin after the patient assumes the supine position. | Inserting the locking pin will secure the system in one position and the bed will not alarm when packs are removed from patient. | |

*Level C: Qualitative studies, descriptive or correlational studies, integrative reviews, systematic reviews, or randomized controlled trials with inconsistent results.
*Level M: Manufacturer's recommendations only.

**Procedure** **for Automated Pronation Therapy (Using the RotoProne Therapy System;** see Fig. 19-3)***—Continued***

| Steps | Rationale | Special Considerations |
|---|---|---|
| 9. Open packs over the patient as needed for patient care. | Allows for easy access to all areas on patient, prevents pressure, and allows for any skin care measures to be provided. | |
| 10. Carefully remove the face pack. | Face pack should be removed in the supine position to prevent undue pressure on the face; this also allows for eye care, oral care, and skin care to be provided as needed. | Care must be taken to prevent dislodging of any tubes positioned within or on the face pack. |
| 11. Rotate the patient supine as tolerated up to 45 minutes or an hour. To rotate patient supine, the bottom pack closest to the foot of the bed, and either the chest or the pelvic pack must be secured over the patient. | Placement of the bottom foot pack and either the chest or the pelvic pack is necessary for supine rotation. Rotation helps provide continued mobilization for oxygenation and reduction of pressure areas | While the patient is supine, complete all assessments and procedures scheduled. After completion, the patient may be rotated in supine position. Placement of the bottom foot pack and either the chest or the pelvic pack is necessary for supine rotation. With automated prone positioning, if the patient is unable to maintain the improvement in gas exchange seen with the prone position when returned to a supine position, the patient can be returned to the prone position. If the patient tolerates the supine position, the patient should optimally remain in the supine/lateral position for only 45 minutes to 1 hour before being repositioned prone. |
| 12. Place in reverse Trendelenburg position to get the head of the bed elevated to maximum 11–12 degrees by pushing the "Surface position" button then "Reverse Trendelenburg." (**Level M***) | The reverse Trendelenburg position is recommended to keep the head of the bed up to decrease edema and prevent complications associated with feeding or potential aspiration. | For increased facial edema, ice packs can also be used. These can be placed over the eyes or lips while in the supine position as needed. |
| 13. Discard used supplies and remove PE. | | |
| 14. HH | | |

**Procedure** **for Manual Pronation Therapy With the Vollman Prone Positioner (VPP)** (the device is no longer manufactured; see Fig. 19-4)

| Steps | Rationale | Special Considerations |
|---|---|---|
| 1. HH | | |
| 2. PE | | |
| 3. Bring the VPP to the bedside. | Readies the device for application | With use of the frame, ensure it has been cleaned with an appropriate hospital-approved disinfectant. |
| 4. Ensure that emergency equipment is available. | In the event of an emergency (i.e., accidental extubation or hemodynamic instability), availability of equipment allows for rapid patient stabilization. | |

*Level M: Manufacturer's recommendations only.

*Procedure continues on following page*

**Procedure for Manual Pronation Therapy With the Vollman Prone Positioner (VPP)** (the device is no longer manufactured; see Fig. 19-4)—***Continued***

| Steps | Rationale | Special Considerations |
|---|---|---|
| 5. Place a lift sheet under the patient to assist with turning. | A lift sheet allows for the use of correct body alignment during the turning procedure.[31,37] | A lift sheet is unnecessary if the patient is on a low air-loss surface and a support frame is used. |
| 6. One staff member is positioned on either side of the bed, with another staff member positioned at the head of the bed.[36,37,40] **(Level C*)** | Three staff members are needed for the turn: two perform the actual lifting and turning, and the third is positioned at the head of the bed.[36,37,40] | The individual at the head of the bed is responsible for monitoring the ETT, ventilator tubing, and monitoring/intravenous lines located by the patient's head.<br>For increased airway security, the individual at the head of the bed should hold the ETT during the turn.[31,37] |
| 7. Correctly position all tubes and invasive lines. | All intravenous tubing and invasive lines are adjusted to prevent kinking, disconnection, or contact with the body during the turning procedure and while the patient remains in the prone position. | If the patient is in skeletal traction, one individual needs to apply traction to the leg while the lines and weights are removed for the turn. If a skeletal pin comes into contact with the bed, a pillow needs to be placed in the correct position to alleviate pressure points. |
| A. Lines inserted in the upper torso are aligned with either shoulder, and the excess tubing is placed at the head of the bed. The only exception to this rule is for chest tubes or other large-bore tubes (e.g., tubes used for extracorporeal membrane oxygenation). | Disconnecting lines before the turn may help to prevent dislodgment but places the patient at an increased risk for infection. | |
| B. Chest tubes and lines or tubes placed in the lower torso are aligned with either leg and extend off the end of the bed. | Consider addition of an extension tube to lines that are too short to be placed at the head of the bed or the end of the bed. | |
| C. If the patient has an open abdomen, cover with a synthetic material or vacuum dressing before positioning and identify a positioning strategy that allows the abdomen to be free of restriction. | Open abdomens are not a contraindication for use of the prone position. A cover with a synthetic material and a support such as an abdominal binder may be used effectively to secure the abdomen.[25] | |
| 8. If on a low air-loss surface, maximally inflate. | Maximally inflating the air surface firms up the mattress, making the turn easier to perform. | |

*Level C: Qualitative studies, descriptive or correlational studies, integrative reviews, systematic reviews, or randomized controlled trials with inconsistent results.

**Procedure for Manual Pronation Therapy With the Vollman Prone Positioner (VPP) (the device is no longer manufactured; see Fig. 19-4)—*Continued***

| Steps | Rationale | Special Considerations |
|---|---|---|
| 9. Always turn the patient in the direction of the mechanical ventilator. | Helps to maximize the length of the tubing and prevents pulling, which may dislodge the position of the ETT. | |
| A. Turn the patient's head so that it faces away from the ventilator. Without disconnecting the ventilator tubing from the ETT, place the portion of the tubing that extends out from the ETT on the side of the patient's face that is turned away from the ventilator. | Helps to maximize the length of the tubing and prevents pulling which may dislodge the position of the ETT. | |
| B. Loop the remaining ventilator tubing above the patient's head.[36,37,40] **(Level C*)** | Helps to maximize the length of the tubing and prevents pulling, which may dislodge the position of the ETT. | |
| 10. The straps that secure the positioner to the body are placed under the patient's head, chest (axillary area), and pelvic region at this time. | Prepares the patient for placement of the VPP to minimize the amount of time during which the device is on top of the patient. | |
| **Placing the Vollman Prone Positioner** | | |
| 1. Attach the frame to the patient while the patient is in the supine position. Lay the frame gently on top of the patient. Align the chest piece to rest between the clavicle and sixth rib.[36,37,40] **(Level C)** | The chest piece is the only nonmovable part and serves as the marker piece for proper placement and alignment of the device.[36,40] | |
| 2. Adjust the pelvic piece to rest one-half inch above the iliac crest.[36,37,40] **(Level C)** | This placement prevents direct pressure over bony prominences and provides sufficient distance between the chest and pelvis to allow the abdomen to be free of restriction and prevents bowing of the back.[36,40] | |
| 3. Adjust the forehead and chin pieces to provide full facial support in a face-down or a side-lying position without interfering with the ETT. | Allows for correct support without interfering with the clinician's ability to access the ETT. | If the patient has limited neck range of motion or a short neck, the face-down position is optimal. Because readjusting the head to relieve pressure points is difficult, moving both headpieces up to the top of the frame is recommended. Only the head cushion supports the forehead, and the chin is suspended to reduce the risk of skin breakdown from pressure. |

*Level C: Qualitative studies, descriptive or correlational studies, integrative reviews, systematic reviews, or randomized controlled trials with inconsistent results.

*Procedure continues on following page*

**Procedure** **for Manual Pronation Therapy With the Vollman Prone Positioner (VPP) (the device is no longer manufactured; see Fig. 19-4)—*Continued***

| Steps | Rationale | Special Considerations |
|---|---|---|
| 4. Fasten the positioner to the patient with the soft adjustable straps. As the straps are tightened, the cushions compress. When fastened, lift the positioner to assess whether a secure fit has been obtained. Readjust as necessary. **(Level M*)** | If the device is not secured tightly before the turn, the patient may have shear or friction injuries develop on the chest and pelvic area during the turning process. | When the device is secured correctly, it appears uncomfortable and possibly painful. As a result, the practitioner has a tendency not to fasten the device as tightly as is needed to prevent injury. When secured correctly, the device creates a feeling of pressure and a sense of security for the patient during the turning process. |
| **Turning Prone With the Half-Step Technique** | | |
| 1. With a draw sheet, move the patient to the edge of the bed farthest away from the ventilator in preparation for the prone turn. The individual closest to the patient maintains body contact with the bed at all times, serving as a side rail to ensure a safe environment. **(Level C*)** | Provides sufficient room to rotate the body safely 180 degrees within the confines of a narrow critical care bed.[36,37,40] | |
| 2. Turning with the VPP: | | |
| A. Tuck the straps on the bar located between the chest and pelvic piece underneath the patient. **(Level C)** | Helps with forward motion when the turning process begins.[36,37,40] | |
| B. Tuck the patient's arm and hand that now rest in the center of the bed under the buttocks, after position alignment with the edge of the mattress is achieved. **(Level C)** | Helps with forward motion when the turning process begins.[36,37,40] | |
| C. Cross the leg closest to the edge of the bed over the opposite leg at the ankle.[36,37,40] **(Level C)** | Helps with forward motion when the turning process begins.[36,37,40] | |
| 3. Turn the patient to a 45-degree angle toward the ventilator. | Use of a wide base of support is extremely important to improve balance and prevent self-injury during the turning procedure.[36,40] | |
| A. The staff member on the ventilator side of the bed grips the upper steel bar. | Positions staff to be ready for the turn. | |
| B. The staff member on the opposite side of the bed grasps the straps attached to the lower steel bar. | Positions staff to be ready for the turn. | |
| C. With a three count, lift the patient by the frame into a prone position. | Count of three provides coordination of effort among the team members. | |

*Level C: Qualitative studies, descriptive or correlational studies, integrative reviews, systematic reviews, or randomized controlled trials with inconsistent results.
*Level M: Manufacturer's recommendations only.

**Procedure for Manual Pronation Therapy With the Vollman Prone Positioner (VPP) (the device is no longer manufactured;** see Fig. 19-4)**—*Continued***

| Steps | Rationale | Special Considerations |
|---|---|---|
| D. During the turning procedure, the staff member at the head of the bed ensures that all tubes and lines are secure and patent.[36,37] **(Level C*)** | Provides an extra measure of safety for the ETTs and invasive lines. | |
| 4. Loosen the straps at this time. If the patient is unstable, keeping the straps fastened securely is recommended to facilitate a safe quick return to the supine position in the event of an emergency. | The procedure for returning to the supine position takes less than 1 minute if the straps are fastened and a support frame is used. | |
| 5. Gently rotate the arms parallel to the body, then flex them into a position of comfort so that they are lying adjacent to the head. Minor adjustments of the patient's body may be necessary to obtain correct alignment when in the prone position. | To prevent damage to the brachial plexus. | Many patients have range-of-motion limitations to the shoulder area that may make keeping the arms in a flexed position difficult. Many ways can be used to position the arms for comfort. The arms can be left in a side-lying position, aligned with the body, or positioned one up and one down, similar to a swimmer position.[31] |
| 6. If on a low air-loss surface, release the maximal inflation. | A return to normal pressures on the surface helps to alleviate pressure at various bony prominences in the prone position. | If on a standard hospital mattress, the thigh-knee-calf area must be supported to minimize the risk of pressure injury and prevent discomfort.[31,36,37,40] |
| 7. Place a support or other pillow under the ankle area. | A support in this area allows for correct body alignment and prevents tension on the tendons in the foot and ankle region. | If the patient is tall enough, dangling the feet over the edge of the mattress may be a sufficient alternative to support the ankles and feet in correct alignment. |
| 8. Discard used supplies and remove PE. | | |
| 9. HH | | |
| **Returning to the Supine Position** | | |
| 1. HH | | |
| 2. PE | | |
| 3. Align the patient with the edge of the mattress closest to the ventilator. | Provides sufficient room to rotate the body safely 180 degrees within the confines of a narrow critical care bed.[36,40] | The patient turns toward the center of the mattress, away from the ventilator. |
| 4. Arrange the ventilator tubing to provide sufficient mobility and length to prevent pulling during the turning procedure. | The staff member at the head of the bed is responsible for monitoring placement of the ventilator tubing, monitoring wires, and invasive lines. | |
| 5. Straighten the patient's arms from a flexed position and bring them to rest on either side of the head. Remove leg and ankle pillow supports. If on a low air-loss surface, maximally inflate. | To prevent damage to the brachial plexus area and ready the patient for return to the supine position. | |

*Level C: Qualitative studies, descriptive or correlational studies, integrative reviews, systematic reviews, or randomized controlled trials with inconsistent results.

*Procedure continues on following page*

## Procedure for Manual Pronation Therapy With the Vollman Prone Positioner (VPP) (the device is no longer manufactured; see Fig. 19-4)—*Continued*

| Steps | Rationale | Special Considerations |
|---|---|---|
| 6. Cross the leg closest to the edge of the bed over the opposite leg at the ankle. | Prepares the patient for turning. | |
| 7. Stretch the arms parallel to the body and bring them into a downward position. | The process is used to prevent any brachial plexus injury. | |
| 8. With the VPP: fasten the straps tightly before repositioning. | If the device is not secured tightly before the turn, the patient may have shear or friction injuries develop on the chest and pelvic area during the turning process. | |
| 9. Turn the patient to a 45-degree angle with the steel bars, then roll the patient onto his or her back. | The steel bars on the positioning frame allow lifting as the patient is realigned into the center of the bed. | |
| 10. Unfasten the positioner and remove from the patient. The straps may be left under the patient in preparation for the next turn. | The device comes with two sets of straps. The straps were designed to be left underneath the patient to allow for ease of the next prone positioning cycle. | |
| 11. Discard used supplies and remove PE. | | |
| 12. HH | | |

## Expected Outcomes

- Increased oxygenation
- Improved secretion clearance
- Improved compliance of the lungs and alveolar recruitment
- Improved mortality

## Unexpected Outcomes

- Agitation
- Disconnection or dislodgment of tubes and lines
- Peripheral arm nerve injury
- Periorbital and conjunctival edema
- Skin injuries or pressure ulcers
- Eye pressure or injury

## Patient Monitoring and Care

| Steps | Rationale | Reportable Conditions |
|---|---|---|
| | | *These conditions should be reported if they persist despite nursing interventions.* |
| 1. Assess the patient's tolerance to the turning procedure:<br>• Respiratory rate and effort<br>• Heart rate and blood pressure | Oxygen saturation is not used as a measure of intolerance to the turning procedure because patients often have desaturation with a deep lateral turn; however, if the patient responds to the prone position, the condition stabilizes quickly when settled into the prone position. The lateral-turn decrease in oxygen saturation may deter the healthcare team from trying the prone position.<br>If respiratory rate and effort, heart rate, and blood pressure do not return to normal within 10 minutes of the turn, the patient may be displaying initial signs of intolerance.[37,39,43] | • Failure of the respiratory rate, respiratory effort, heart rate, and blood pressure to return to normal 5–10 minutes after the turn[39] |

## Patient Monitoring and Care —*Continued*

| Steps | Rationale | Reportable Conditions |
|---|---|---|
| 2. Assess the patient's response to the prone position:<br>• Pulse oximetry ($Spo_2$)<br>• Mixed venous oxygenation saturation ($Svo_2$) or central mixed venous oxygen saturation ($Scvo_2$) and hemodynamics<br>• Arterial blood gases 30 minutes after position change<br>• $Pao_2/Fio_2$ ratio | Of all patients with acute lung injury turned prone, more than 70% had improvement in oxygenation.[4,5,10,13,17,23–25,27,28,35,40] A response is defined by a $Pao_2/Fio_2$ ratio greater than 20% or a $Pao_2$ greater than 10 mm Hg.[29] The time response varies among patients. Some patients immediately respond, whereas others may take a longer time to show maximal response to the position change.<br>Hemodynamic measurements are accurate in the prone position compared with supine as long as the zero reference point is calibrated at the phlebostatic axis.[38] | • Decrease from baseline in the $Spo_2$ or failure of the $Svo_2$ or $Scvo_2$ to return to baseline after 5–10 minutes |
| 3. With manual proning, reposition the patient's head on an hourly basis in the prone position to prevent facial breakdown. While one staff member lifts the patient's head, a second staff member moves the headpieces to provide support for the head in a different position. **(Level D*)**<br>Not necessary with automated proning. Arms should be positioned for comfort by either placing them aligned with the body or in a swimmer's position, one up and one down. | The face and ears have minimal structural padding to reduce the risk of skin breakdown. Patients with short necks or limited neck range of motion have difficulty assuming a head side-lying position. These patients are more likely to have facial breakdown develop, making turning the patient more frequently or use of the previous technique necessary to prevent breakdown.[18,31,37] | • Skin breakdown |
| 4. Assess skin frequently for areas of nonblanchable redness or breakdown. Place a hydrocolloid dressing or 5-layer silicone dressing over areas where shearing and friction injuries are likely to occur (i.e., chest, pelvis, elbows, and knees). **(Level M*)** | Greater than 2 hours on a standard surface without changing position increases a patient's risk for breakdown. If the patient is on a pressure-reduction surface, the time remaining in a stationary position can be lengthened.[18]<br>The use of a hydrocolloid or a 5-layer silicone dressing may serve as a protective barrier, reducing the risk of pressure, shearing, and friction injuries.[18,31,37] If VPP is used and a skin injury occurs on the chest or pelvis, reassess tightness of the device before the prone position turn. The injury is most often related to a loose-fitting apparatus and is likely a shear injury versus pressure. | • Nonblanchable redness<br>• Shearing and friction injuries |

*Level D: Peer-reviewed professional and organizational standards with the support of clinical study recommendations.
*Level M: Manufacturer's recommendations only.

*Procedure continues on following page*

## Patient Monitoring and Care —*Continued*

| Steps | Rationale | Reportable Conditions |
|---|---|---|
| 5. Provide frequent oral care and suctioning of the airway as needed. | The prone position promotes postural drainage through the natural use of gravity. Drainage from the nares may be a clinical sign of an undetected sinus infection. | • Drainage from the nares<br>• Change in amount or character of secretions |
| 6. Maintain eye care to prevent corneal abrasions. | It is important to maintain lubrication via institutional standard protocol to prevent dryness leading to cornel abrasions. | • Changes in the conditions of the eyes |
| 7. Maintain tube feeding as tolerated. **(Level D*)**[33] **(Level C*)**[25] | The risk for aspiration is minimal in the prone position because the patient is already in a head-down, side-lying position that maximizes the use of gravity to move vomited matter safely. A reverse Trendelenburg position changes that relationship. It may reduce the risk of microaspiration and may increase the risk of a large emesis occurring.[38] Use of prokinetic agents or transpyloric feedings is recommended to prevent complications associated with vomiting.<br>Studies have shown increased risk of complications in the prone position in patients receiving gastric feedings. These studies recommend use of promotility agents or postpyloric feedings to reduce the risk of complications such as vomiting and enhance gastric emptying.[30] | • Evidence of tube feeding material when suctioning |
| 8. Scheduling frequency: the positioning schedule is based on the most recent RCT, which suggests at least 16 hours of prone positioning a day.[17]<br>A. Time spent in the supine position is based on the length of time the patient is able to sustain or maintain the improvement in gas exchange that occurred while prone. This time may be consecutive or sequential depending on the type of apparatus used and the risk of skin injury and hemodynamic instability experienced.[4,5,13,17,23,27,35,37] **(Level C)**<br>B. For automated proning with the RotoProne Therapy System, the suggested time in the prone position is 3 hours 15 minutes prone alternating with 45 minutes as tolerated in the supine position. | Although the literature demonstrates that longer times in the prone position within a 24-hour period is better, it remains important that the healthcare team weigh other physiological factors when a patient remains in any stationary position for an extended period. Following the principles of pressure relief used when positioning patients laterally or supine can minimize the potential for skin injury and edema formation. Longer time spent in a single position necessitates that the support surface provides greater pressure reduction or relief than a standard hospital mattress.[31,37] **(Level C)** | • Clinically significant decreases in oxygenation (>10 mm Hg) or oxygen saturation (<88%) |

*Level C: Qualitative studies, descriptive or correlational studies, integrative reviews, systematic reviews, or randomized controlled trials with inconsistent results.
*Level D: Peer-reviewed professional and organizational standards with the support of clinical study recommendations.

## Patient Monitoring and Care —*Continued*

| Steps | Rationale | Reportable Conditions |
|---|---|---|
| 9. Manual prone positioning should be discontinued if the following criteria have been met:<br>• Improvement in oxygenation defined as $Pao_2/Fio_2$ ratio <150 mm Hg, with an $Fio_2$ <60% with ≤10 cm of PEEP (these criteria had to be met in the supine position at least 4 hours after the end of the last prone session).<br>• $Pao_2/Fio_2$ ratio of more than 20% relative to the ratio in the supine position before two consecutive prone sessions.<br>10. With automated prone positioning, if the patient is unable to maintain the improvement in gas exchange seen with the prone position when returned to a supine position, the patient can be returned to the prone position. If the patient tolerates supine position, the patient should optimally remain in the supine/lateral position for only 45 minutes to 1 hour before being repositioned prone. | Use of lateral rotation therapy in conjunction with prone positioning is suggested so that when the patient is returned to a supine position, he or she is laterally rotated. The use of continuous lateral rotation therapy has been associated with a reduction in pulmonary complications.[15,24,31,37] | • Complications occurring during a prone session leading to its immediate interruption, including nonscheduled extubation, main-stem bronchus intubation, ETT obstruction, hemoptysis, oxygen saturation of <85% for >10 minutes or a $Pao_2$ of <55 mm Hg for more than 5 minutes. When the $Fio_2$ was at 100%, cardiac arrest, a heart rate of <30 bpm for more than 1 minute, systolic blood pressure of less than 60 for more than 5 minutes, and any other life-threatening reason.[17] **(Level B*)** |

*Level B: Well-designed, controlled studies with results that consistently support a specific action, intervention, or treatment.

## Documentation

*Documentation should include the following:*

- Patient and family education
- Ability to tolerate the turning procedure
- Length of time in the prone position
- Maximal oxygenation response in the prone position
- Oxygenation response when returned to the supine position
- Positioning schedule used
- Complications noted during or after the procedure
- Use of continuous lateral rotation therapy or other devices
- Amount and type of secretions
- Unexpected outcomes
- Nursing interventions

### References and Additional Readings

For a complete list of references and additional readings for this procedure, scan this QR code with any freely available smartphone code reader app, or visit http://booksite.elsevier.com/9780323376624.

## References


1. Abroung F, et al: The effect of prone positioning in acute respiratory distress syndrome or acute lung injury: a meta-analysis. Areas of uncertainty and recommendations for research. *Intensive Care Med* 34(6):1002–1011, 2008.
2. Albert RK, et al: Prone position-induced improvement in gas exchange does not predict improved survival in acute respiratory distress syndrome. *Am J Respir Crit Care Med* 189(4):494–496, 2014.
3. Alsaghir AH, Martian CM: Effect of prone positioning in patients with acute respiratory distress syndrome: a meta-analysis. *Crit Care Med* 36:603–609, 2008.
4. Chatte G, et al: Prone position in mechanically ventilated patients with severe acute respiratory failure. *Am J Respir Crit Care Med* 155:473–478, 1997.
5. Curley MA, et al: Effect of prone positioning on clinical outcomes in children with acute lung injury: a randomized controlled trial. *JAMA* 294:229–237, 2005.
6. Curley MAQ: Prone positioning of patients with acute respiratory distress syndrome: a systematic review. *Am J Crit Care* 8:397–405, 1999.
7. Dellinger RP, et al: Surviving sepsis campaign: international guidelines for management of severe sepsis and septic shock: 2012. *Crit Care Med* 41(2):580–637, 2013.
8. Dickinson S, Park P, Napolitano L: Prone positioning therapy in ARDS. ALI and ARDS; challenges and advances. *Crit Care Clin* 27(3):511–523, 2011.
9. Dirkes S, et al: Prone positioning: is it safe and effective? *Crit Care Nurse Q* 35(1):64–75, 2012.
10. Fridrich P, et al: The effects of long-term prone positioning in patients with trauma induced adult respiratory distress syndrome. *Anesth Analg* 83: 1206–1211, 1996.
11. Froese AB, Bryan AC: Effects of anesthesia and paralysis on diaphragmatic mechanics in man. *Anesthesiology* 41:242–255, 1974.
12. Gattinoni L, et al: Body position changes redistribute lung computed tomographic density in patients with acute respiratory failure. *Anesthesiology* 74:15–23, 1991.
13. Gattinoni L, et al: Effect of prone positioning on the survival of patients with acute respiratory failure. *N Engl J Med* 345:568–573, 2001.
14. Gattinoni L, et al: Relationships between lung computed tomographic density, gas exchange and PEEP in acute respiratory failure. *Anesthesiology* 69:824–832, 1988.
15. Goldhill DR, et al: Rotational bed therapy to prevent and treat respiratory complications: a review and meta-analysis. *Am J Crit Care* 16:50–62, 2007.
16. Guerin C, et al: Effects of systematic prone positioning in hypoxemic acute respiratory failure: a randomized controlled trial. *JAMA* 292:2379–2387, 2004.
17. Guérin C, et al: Prone positioning in severe acute respiratory distress syndrome. *N Engl J Med* 368(23):2159–2168, 2013.
18. Harcomb C: Nursing patient with ARDS in prone position,. *Nurs Stand* 18(19):33–39, 2004.
19. Kaneko K, et al: Regional distribution of ventilation and perfusion as a function of body position. *J Appl Physiol* 21:767–777, 1966.
20. Laux L, et al: Use of prone positioning in a patient with acute respiratory distress syndrome. *Crit Care Nurs Q* 31(2):178–183, 2008.
21. Lee JM, et al: The efficacy and safety of prone positional ventilation in acute respiratory distress syndrome: updated study-level meta-analysis of 11 randomized controlled trials. *Crit Care Med* 42(5):1252–1262, 2014.
22. Malbouisson LM, et al: Role of the heart in the loss of aeration characterizing lower lobes in acute respiratory distress syndrome. *Am J Respir Crit Care Med* 161: 2005–2012, 2005.
23. Mancebo J, et al: A multicenter trial of prolonged prone ventilation in severe acute respiratory distress syndrome. *Am J Respir Crit Care Med* 173:1233–1239, 2006.
24. Marklew A: Body positioning and its effect on oxygenation—a literature review. *Nurs Crit Care* 11(1):16–22, 2006.
25. Murray TA, Patterson LA: Prone positioning of trauma patients with acute respiratory distress syndrome and open abdominal incisions. *Crit Care Nurse* 22:52–56, 2002.
26. Mutoh T, et al: Prone position alters the effect of volume overload on regional pleural pressures and improves hypoxemia in pigs in vivo. *Am Rev Respir Dis* 146: 300–306, 1992.
27. Papazian L, et al: Comparison of prone positioning and high frequency oscillatory ventilation of patients with acute respiratory distress syndrome. *Crit Care Med* 33:2162–2171, 2005.
28. Pappert D, et al: Influence of positioning on ventilation-perfusion relationships in severe adult respiratory distress syndrome. *Chest* 106:1511–1516, 1994.
29. Pelosi P, Brazzi L, Gattinoni L: Prone position in ARDS. *Eur Respir J* 20:1017–1028, 2002.
30. Reignier J, et al: Early enteral nutrition in mechanically ventilated patients in the prone position. *Crit Care Med* 32(1):94–99, 2004.
31. Rowe C: Development of clinical guidelines for prone positioning in critically ill adults. *Nurs Crit Care* 9(2): 50–57, 2004.
32. Sebat F, et al: Benefits, complications of prone position and utility of automated proning bed in the treatment of acute lung injury (ALI). *Chest* 132(4):572S, 2007.
33. Sud S, et al: Effect of mechanical ventilation in the prone position on clinical outcomes in patients with acute respiratory failure: a systematic review and meta-analysis. *CMAJ* 178(9):1153–1161, 2008.
34. Van der Voort PH, Zandstra DF: Enteral feeding in the critically ill: comparison between supine and prone positions: a prospective crossover study in mechanically ventilated patients. *Crit Care* 5(4):216–220, 2001.
35. Voggenreiter G, et al: Prone positioning improves oxygenation in post-traumatic lung injury—a prospective randomized trial. *J Trauma* 59:333–341, 2005.
36. Vollman KM: *The effect of suspended prone positioning on $PaO_2$ and A-a gradients in adult patients with acute respiratory failure*, Master's Thesis, Long Beach, 1989, California State University.
37. Vollman KM: Prone positioning in the ARDS patient: the art and science. *Crit Care Nurs Clin North Am* 16(3):319–336, 2004.

38. Vollman KM: What are the practice guidelines for prone positioning of acutely ill patients? Specifically, what are the recommendations related to hemodynamic monitoring and tube feeding? *Crit Care Nurse* 21:84–86, 2001.
39. Vollman KM: Understanding critically ill patients' hemodynamic response to mobilization using the evidence to make it safe and feasible. *Crit Care Nurs Q* 36(1): 17–27, 2013.
40. Vollman KM, Bander JJ: Improved oxygenation utilizing a prone positioner in patients with acute respiratory distress syndrome. *Intensive Care Med* 22:1105–1111, 1996.
41. West JB: *Respiratory physiology: the essentials*, ed 3, Baltimore, 1985, Williams & Wilkins.
42. West JB, Dollery CT, Naimark A: Distribution of blood flow in isolated lung: relation to vascular and alveolar pressures. *J Appl Physiol* 19:713–724, 1964.
43. Winslow EH, et al: Effects of a lateral turn on mixed venous oxygen saturation and heart rate in critically ill adults. *Heart Lung* 19:555–561, 1990.