Physiological Rationale and Current Evidence for Therapeutic Positioning of Critically Ill Patients

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**ABSTRACT**

Prolonged bed rest is common in critically ill patients, and therapeutic positioning is important to prevent further complications and to improve patient outcomes. Nurses use therapeutic positioning to prevent complications of immobility. This article reviews therapeutic positions including stationary positions (supine, semirecumbent with head of bed elevation, lateral, and prone) and active repositioning (manual, continuous lateral rotation, and kinetic therapy). The physiological rationale and current evidence for each position are described. Applicable evidence-based practice guidelines are summarized. Special considerations for therapeutic positioning of critically ill obese and elderly patients are also discussed.

**Keywords:** critically ill, positioning

Multiple factors relegate critically ill patients to strict bed rest including altered level of consciousness, drugs that prevent mobility (paralytics, sedatives), traumatic injuries, and surgical complications (open chest or abdominal cavities). However, bed rest is associated with multiple complications that are well documented in the literature (Table 1). Because critical care nurses are keenly aware of these complications, they use clinical judgment in their daily practice to place bedridden patients in the most optimal position to prevent these complications and to improve patient outcomes. The purpose of this article was to review options of therapeutic positioning in critically ill patients. The physiological rationale and current evidence for stationary and active repositioning are described. In addition, positioning of critically ill obese and elderly patients is discussed.

**Stationary Positions**

**Supine Position**

In the supine position, ventilation and perfusion are greater in dependent areas of the lungs than in the anterior areas. In healthy lungs, adequate matching of ventilation and perfusion (V/Q match) can be achieved in the supine position. In diseased lungs, prolonged placement in the supine position can alter the V/Q match. For example, excess fluid associated with pulmonary edema accumulates in the dependent areas of the lungs and interferes...
with diffusion of gases across the alveolar-capillary membranes. Perfusion, however, remains constant in the dependent areas. Therefore, there is a V/Q mismatch that results in an intrapulmonary shunt.

The supine position results in anatomical changes that alter ventilation and perfusion, especially in patients with enlarged hearts. In the supine position, the major part of the left lower lobe and a significant part of the right lower lobe are located beneath the heart. Enlarged hearts produce an increased pleural pressure in the dependent areas and contribute to alveolar collapse. Studies using isotope ventilation-perfusion scans in patients with cardiomegaly and no evidence of pulmonary pathology have shown a 40% to 50% reduction in left lower lobe ventilation in a prolonged supine position with no concomitant reduction in regional perfusion. Patients with acute respiratory distress syndrome (ARDS) who are mechanically ventilated while in the supine position develop atelectasis in the dependent areas of the lungs. Ventilation is impaired by airway secretions, lung edema, and cardiac and abdominal compression of the lungs while perfusion is maintained, and this results in intrapulmonary shunt and severe hypoxemia.

### Semirecumbent Position With Head of Bed Elevation

Head of bed (HOB) elevation is an important component of the semirecumbent position that must be considered for patients who are receiving enteral nutrition to prevent aspiration of gastric contents and ventilator-associated pneumonia (VAP). Several studies using radiolabeled enteral feeding solutions in mechanically ventilated patients have reported that aspiration of gastric contents occurs to a greater degree when patients are in the supine position than when they are in the semirecumbent position with the HOB elevated to 30° to 45°. Drakulovic and colleagues conducted a prospective, randomized clinical trial to compare continuous HOB elevation of 45° to no elevation in the early mechanical ventilation period and found a significantly greater incidence of VAP in patients who did not have HOB elevation. More recently, this work was extended by Grap and colleagues, who found that VAP was more likely to occur in patients who spent more initial mechanical ventilation time with HOB elevation of less than 30°.

Because of these studies, multiple clinical practice guidelines have stated that the semirecumbent position with HOB elevation of 30° to 45° should be used for critically ill patients to prevent aspiration pneumonia and VAP. These guidelines include those issued by the American Association of Critical-Care Nurses (AACN), the Centers for Disease Control and Prevention, the Society of Critical Care Medicine, the American Thoracic Society, and the Canadian Critical Care Society. In addition to the benefits of HOB elevation, critical care nurses need to be aware of the contraindications of this position and to apply appropriate judgment. Contraindications to HOB elevation, as identified in the AACN VAP Practice Alert Audit Tool, are summarized in Table 2.

### Table 1: Complications of Bed Rest

<table>
<thead>
<tr>
<th>Pulmonary</th>
<th>Atelectasis</th>
<th>Pneumonia</th>
<th>Hypoxemia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiovascular</td>
<td>Venous thromboembolism</td>
<td>Syncope because of diminished baroreceptor activity</td>
<td>Skin integrity</td>
</tr>
</tbody>
</table>

### Table 2: Contraindications to HOB Elevation in Critically Ill Patients

| Cardiovascular | Low cardiac index | Hypotension |
| Neurological | Ischemic stroke | Traumatic brain injury |
| Processes of care | Procedure in progress in which HOB elevation is inappropriate | Prone position | Medical order for no HOB elevation |

Abbreviation: HOB, head of bed.
It is important for critical care nurses to recognize that HOB elevation above 30° may increase the risk of pressure ulcer formation. In a study of 57 patients in a surgical intensive care unit (ICU), patients placed in semi-Fowler’s position had higher sacral tissue interface pressures when compared with those placed in other positions, regardless of the type of pressure redistribution surface selected. These results have been confirmed in a more recent study involving healthy volunteers. Defloor evaluated tissue interface pressures and found that pressures in the sacral area were higher when the HOB was elevated to 90° than when it was elevated to 60°. He found that the lowest tissue interface pressures occurred when patients were placed in a semi-Fowler’s position with the HOB elevated up to 30° and the knees elevated to 30°. The Wound, Ostomy and Continence Nurses Society recommends maintaining the HOB at 30° elevation for supine positions. There are very few studies to support the use of a specialized mattress to reduce elevated sacral pressures caused by HOB elevation, and the results are inconclusive.

The optimal semirecumbent HOB elevation position that reduces the development of aspiration pneumonia, VAP, and pressure ulcers is not known. Until there is further evidence, nurses must use their judgment on the HOB elevation that is best for each individual patient. That judgment should be guided by the level of evidence to support the degree of HOB elevation. And to that end, as Grap and Munro point out, the level of evidence for the use of lower HOB elevation to prevent sacral pressure ulcers (1 controlled trial, at least 2 descriptive case studies or expert opinion) is not as strong as that for HOB elevation to prevent aspiration pneumonia and VAP (clinical or epidemiological studies or strong theoretical rationale).

Although there is evidence to support HOB elevation for critically ill patients in the semirecumbent position, HOB elevation does not appear to be routinely implemented among intubated patients. In a pilot study in 1999, Grap and colleagues found that in 347 measurements of 52 critically ill medical patients, the mean backrest elevation was 22.9° and that patients were in the supine position 86% of the time, despite the presence of enteral feedings. In a subsequent study in 2003, involving 506 observations of 170 patients in several ICUs, the results were worse: Mean backrest elevation was 19°, 70% of the patients were in the supine position, and intubated patients had lower backrest elevations than did nonintubated patients. One explanation for nurses not complying with HOB elevation may be the inability to accurately estimate backrest elevation.

To address these issues, AACN issued a VAP Practice Alert in 2004. The Practice Alert included a procedure to audit backrest elevation, suggestions for audit frequency, and a data collection tool. These efforts seem to have had a positive effect. A recent survey of 1200 critical care nurses who attended the AACN National Teaching Institute as well as other national educational programs reported that they maintained the HOB elevations 30° to 45° most of the time. More than 85% of the respondents reported that they maintain HOB elevations 30° to 45° for their patients 86% of the time. The VAP Practice Alert was recently revised to include additional sources of evidence and the levels of evidence to support the Practice Alert Statements.

The VAP Practice Alert Audit Tool contains methods to estimate HOB elevation (Figure 1).

- Use the built-in angle measurement for HOB elevation if available.
- Use a simple protractor positioned on the horizontal frame of the bed and the frame of the backrest at the pivot point of the backrest.
- Calculate the angle of the backrest elevation by measuring the length of the backrest from the pivot area (A on diagram below) to the top of the backrest (B). Then measure from the top of the backrest (B) straight down to the horizontal frame of the bed (C). Divide the distance from B to C by the distance from A to B and take the arc sine of that product. Angle of backrest = arc sine of (A to B)/(B to C).

Example: The angle of backrest elevation for a backrest (A to B) which is 32 in, which is 16 in above the frame (B to C), is equal to the arc sine of 32/16 = 30 degrees.

**Figure 1:** Methods for Estimating HOB Elevation. HOB indicates head of bed elevation. Reprinted with permission from the American Association of Critical-Care Nurses.
Stationary Lateral Positions

The decision to place critically ill patients in the left or right lateral decubitus position is based on relevant lung pathology and hemodynamic stability. Studies have shown that when patients with unilateral lung disease (pneumonia, atelectasis) are placed with the consolidated lung in the dependent position, there is a mismatch of ventilation to perfusion that results in hypoxemia. Placement of the diseased lung in the dependent lateral position results in greater perfusion to a diseased poorly ventilated lung and impairs gas exchange. Therefore, patients with unilateral lung pathology should be placed in a lateral position with the “good” lung down. Even though this is the golden rule for patients with unilateral disease, there are contraindications to this position in certain lung pathologies. For example, in patients with pulmonary abscesses or pulmonary hemorrhage, it is important to keep the affected lung in the dependent position so that drainage will not migrate toward the healthy lung. In addition, patients with interstitial emphysema should be placed with the affected lung in the dependent position to prevent hyperinflation.

Although there is evidence to support lateral positioning in patients with unilateral pulmonary disease, less is known about the effects of lateral positioning on oxygenation in patients with bilateral pulmonary disease. At 10 to 30 minutes after a lateral position change, cardiac output and heart rate may not be the same as in the supine position, but these changes in most mechanically ventilated patients are not clinically significant. Early evidence demonstrated that cardiovascular changes can be highly individualized and may be most prominent in patients with low cardiac output and in patients who are hypothermic and/or receiving vasoactive medications. More recent evidence suggests that lateral positioning of critically ill patients who are hypoxemic or have low cardiac output does not further endanger tissue oxygenation.

Prone Position

Research demonstrates that prone positioning in critically ill patients with acute lung injury and/or ARDS improves pulmonary gas exchange and reduces the rate of VAP. The physiological mechanisms responsible for improvement in pulmonary gas exchange have not been fully elucidated. Possible mechanisms may include better drainage of pulmonary secretions, reopening of atelectatic units in the dorsal regions of the lungs, and minimizing ventilator-induced lung injury. The optimal response and beneficial effect of prone positioning may occur during the early edematous phase of ARDS when atelectasis and lung edema predominate. Despite these improvements in pulmonary gas exchange, recent studies reported no survival benefit for the use of the prone position in ARDS. The rationale for this lack of a survival benefit is not clear but it should be noted that the average range of tidal volume given to patients in these studies was 9 mL/kg, which may have contributed to ventilator-induced lung injury.

Alsaghir and Martin recently conducted a systematic review and meta-analysis to assess the effect of the prone position, as compared to the supine position, on improvement in oxygenation, number of days on the ventilator, VAP, and mortality. They included 5 randomized controlled trials comparing greater than 6 hours of prone position in adult patients with ARDS. Prone positioning showed significant and persistent improvement in PaO2/FIO2 in all phases of ARDS. However, significant statistical heterogeneity of treatment effect was found, meaning that the results were highly variable across studies. Sources of clinical heterogeneity included when proning was initiated and the duration of the prone position. Treatment effect heterogeneity may mask substantial benefit for some, little benefit for others, and harm for a few. There were no significant differences in number of days on mechanical ventilation or the incidence of VAP. There were no significant differences in short-term or long-term mortality was reported, a couple of studies showed that prone position significantly reduced mortality in patients with higher illness severity. Future randomized controlled trials focusing on early initiation of the prone position while controlling for time in the prone position are warranted.

Currently there are no clinical practice guidelines that recommend the use of prone positioning to decrease VAP. However, recent guidelines released by the Society of Critical Care Medicine recommend prone positioning in patients with ARDS who require potentially injurious levels of FIO2 or have elevated plateau pressures, who are at high risk for adverse consequences of positional changes, in facilities.
that have experience with such practices.\textsuperscript{19} Adverse consequences include dislodgement of the artificial airway and enteral feeding tubes, loss of venous access, development of facial edema and pressure ulcers, and difficulties with cardiopulmonary resuscitation. Potential contraindications to the use of the prone position, as summarized by Ball and colleagues,\textsuperscript{59} are listed in Table 5.

For critical care units that use prone positioning, evidence-based guidelines for bedside nurses should be in place. These guidelines should include indications and contraindications, preprone assessment and safety practices, strategies for placing the patient in the prone position, assessment guidelines for monitoring patient response to the prone position, and limb positioning while in the prone position. The reader is referred to several published clinical practice guidelines on the use of prone positioning in critically ill patients.\textsuperscript{59–61}

### Active Repositioning

Healthy individuals change positions, even during sleep, approximately every 12 minutes.\textsuperscript{62} A variety of sensory cues prompt a change in body position. These sensory cues prevent detrimental effects of prolonged periods of immobility. Individuals who have neurological or sensorimotor impairments must rely on others to reposition them to prevent hazards of immobility.

#### Manual Repositioning

Repositioning is conceptualized as turning the patient from side to side when lying in bed or on a similar surface.\textsuperscript{63–65} Within this context, the patient is placed in a side-lying position with the pelvis rotated approximately 30° from the supine position.\textsuperscript{65} The current standard of care is to reposition patients every 2 hours. This standard is based on 2 studies conducted in the early 1960s in healthy individuals.\textsuperscript{66,67} Repositioning every 2 hours is the nursing standard for all immobilized critically ill patients as documented in nursing textbooks\textsuperscript{68,69} and national guidelines.\textsuperscript{70} A survey of ICU physicians revealed that 83% of respondents agreed that the standard of ICU care is to turn patients every 2 hours.\textsuperscript{71} However, a prospective longitudinal observational study

### Table 3: Results of Meta-analysis on Effects of Prone Positioning on $\text{PaO}_2/\text{FiO}_2$, Days on Mechanical Ventilation, and Incidence of Ventilator-Associated Pneumonia\textsuperscript{a}

<table>
<thead>
<tr>
<th>Outcome Variables</th>
<th>Number of Studies</th>
<th>n</th>
<th>Weighted Mean Difference</th>
<th>95% CI</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{PaO}_2/\text{FiO}_2$ (12 h–2 d)</td>
<td>4</td>
<td>866</td>
<td>51.5</td>
<td>6.95–96.05</td>
<td>48, 55–57</td>
</tr>
<tr>
<td>$\text{PaO}_2/\text{FiO}_2$ (4 d)</td>
<td>3</td>
<td>754</td>
<td>43.87</td>
<td>13.86–73.88</td>
<td>48, 56, 57</td>
</tr>
<tr>
<td>$\text{PaO}_2/\text{FiO}_2$ (10 d)</td>
<td>4</td>
<td>833</td>
<td>24.89</td>
<td>15.3–34.48</td>
<td>48, 52, 56, 57</td>
</tr>
<tr>
<td>Days on mechanical ventilation</td>
<td>2</td>
<td>831</td>
<td>−.42 d</td>
<td>−1.56 to 0.72</td>
<td>48, 56</td>
</tr>
<tr>
<td>Incidence of VAP</td>
<td>3</td>
<td>967</td>
<td>0.78%</td>
<td>0.40–1.51</td>
<td>48, 56, 57</td>
</tr>
</tbody>
</table>

Abbreviations: CI, confidence interval; n, sample size; $\text{PaO}_2/\text{FiO}_2$, ratio of partial pressure of oxygen in arterial blood to the fraction of inspired oxygen; VAP, ventilator-associated pneumonia.
\textsuperscript{a}Data are from Alsaghir and Martin.\textsuperscript{54}

### Table 4: Results of Meta-analysis on Effects of Prone Positioning on Mortality\textsuperscript{a}

<table>
<thead>
<tr>
<th>Outcome Variables</th>
<th>Number of Studies</th>
<th>n</th>
<th>Odds Ratio</th>
<th>95% CI</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICU mortality</td>
<td>3</td>
<td>466</td>
<td>0.79</td>
<td>0.45–1.39</td>
<td>52, 55, 57</td>
</tr>
<tr>
<td>28- to 30-day mortality</td>
<td>3</td>
<td>1231</td>
<td>0.95</td>
<td>0.71–1.28</td>
<td>48, 52, 57</td>
</tr>
<tr>
<td>90-day mortality</td>
<td>4</td>
<td>1271</td>
<td>0.99</td>
<td>0.77–1.27</td>
<td>48, 52, 56, 57</td>
</tr>
<tr>
<td>Mortality with SAPS II &gt;50</td>
<td>2</td>
<td>113</td>
<td>0.29</td>
<td>0.12–0.70</td>
<td>52, 57</td>
</tr>
</tbody>
</table>

Abbreviations: CI, confidence interval; ICU, intensive care unit; n, sample size; SAPS, Simplified Acute Physiology Score.
\textsuperscript{a}Data are from Alsaghir and Martin.\textsuperscript{54}
conducted at 3 ICUs in 2 states demonstrated this standard was not met. In this same study, 74 patients were observed for an average of 7.7 hours. Ninety-seven percent of the patients did not receive the minimum standard of body repositioning every 2 hours. About half (47%) of the observed patients were in the supine position for 4 to 8 hours, and 23% of the patients were not repositioned for more than 8 hours. A more recent study in 40 ICUs in the United Kingdom revealed similar findings: Patients were in the supine position for 46% of the observations, with an average time of 4.85 hours between turns. If repositioning every 2 hours is the standard of care, these results prompt the question, why is the standard not being met?

There has been limited investigation into the reasons why patients are not repositioned. Nurses in long-term care facilities were surveyed and said the chief reasons for not routinely repositioning patients were lack of specific assignment to the task and a lack of time and staff. Although there have been no studies published that explain why critically ill patients are not repositioned every 2 hours, lack of time and staff are the most likely explanations. Additional factors may include patient intolerance, hemodynamic instability, and pain. Evidence exists to support that repositioning critically ill patients is painful. In AACN’s Thunder Project II, a study of 6201 critically ill patients revealed that turning was the most painful routine procedure performed for adults. A smaller, but more recent, study found similar results as critically ill patients reported turning to be the most painful routine procedure they experienced. This study and others highlight the problem: Not all patients receive preemptive pain relief before repositioning.

Strategies to remind staff of the need to turn, such as playing music over the intercom when patients are to be turned and posting signs on doors alerting staff of patient pressure ulcer risk, have been implemented with some short-term success. The reality is that rigid turning schedules in the ICU are difficult to maintain because of treatments, therapies, diagnostic tests, procedures, and nursing care that require the patient to be in a supine position.

Although the initial question may be to ask why the standard of every 2-hour turning is not met, perhaps the real question should be, does repositioning every 2 hours impact

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Table 5: Potential Contraindications to Prone Positioning

<table>
<thead>
<tr>
<th>Cardiovascular</th>
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<tbody>
<tr>
<td>Hemodynamic instability</td>
</tr>
<tr>
<td>Mean arterial pressure &lt; 60 mm Hg or systolic blood pressure &lt; 90 mm Hg, regardless of fluid resuscitation or inotropes</td>
</tr>
<tr>
<td>Recent cardiopulmonary arrest</td>
</tr>
<tr>
<td>Short-term bleeding</td>
</tr>
<tr>
<td>Ventricular assist devices</td>
</tr>
<tr>
<td>Intra-aortic balloon pump</td>
</tr>
<tr>
<td>Recent cardiothoracic surgery/unstable mediastinum</td>
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<table>
<thead>
<tr>
<th>Trauma</th>
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</thead>
<tbody>
<tr>
<td>Head injury</td>
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<tr>
<td>Spinal cord precautions/injury</td>
</tr>
<tr>
<td>Multiple trauma</td>
</tr>
<tr>
<td>External pelvic fixation or pelvic fractures</td>
</tr>
<tr>
<td>Rib fractures</td>
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<tr>
<td>Traction</td>
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<table>
<thead>
<tr>
<th>Neurological</th>
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<tbody>
<tr>
<td>Increased intracranial pressure</td>
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<tr>
<td>Seizures</td>
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<table>
<thead>
<tr>
<th>Head and neck</th>
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<tbody>
<tr>
<td>Increased intraocular pressure</td>
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<tr>
<td>Maxillofacial surgery</td>
</tr>
<tr>
<td>New tracheostomy (&lt;24 h)</td>
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<table>
<thead>
<tr>
<th>Respiratory</th>
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<tbody>
<tr>
<td>Asthma</td>
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<tr>
<td>Open chest</td>
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<table>
<thead>
<tr>
<th>Abdominal</th>
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<tbody>
<tr>
<td>Recent abdominal surgery</td>
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<tr>
<td>Recent stoma formation</td>
</tr>
<tr>
<td>Open abdomen</td>
</tr>
<tr>
<td>Large abdomen</td>
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<table>
<thead>
<tr>
<th>Musculoskeletal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kyphoscoliosis</td>
</tr>
<tr>
<td>Advanced osteoarthritis</td>
</tr>
<tr>
<td>Rheumatoid arthritis</td>
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<table>
<thead>
<tr>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pregnancy (second/third trimester)</td>
</tr>
<tr>
<td>Weight &lt; 135 kg</td>
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</table>
patient outcomes? The optimal interval for turning acutely or critically ill patients is not known. Only one study examined this issue. Defloor and colleagues investigated the effects of different turning intervals in a randomized controlled trial involving patients in 11 long-term care facilities. They found that turning patients every 4 hours combined with the use of a specialized foam mattress significantly reduced the incidence of pressure ulcers compared with turning every 2 hours on standard hospital mattresses. It would be difficult to advocate turning patients every 4 hours rather than every 2 hours based on this 1 study because there were several methodological issues with this study including lack of allocation of interventions, inadequate blinding of participants and data collectors, and lack of an intent to treat analysis.

**Rotation Therapy**

Rotation therapy, including continuous lateral rotation therapy (CLRT), involves the use of specialized beds to mechanically turn the patient from side to side. CLRT uses continuous turning of a patient up to 40° on each side with 6 to 8 turns an hour. The bed frame rotates the patient from side to side. Research demonstrates that patients must be rotated at least 18 hours a day to achieve maximum benefit. Four systematic reviews and meta-analyses have shown that rotation therapy decreases the relative risk of VAP but has no benefit on reducing ICU length of stay or decreasing mortality. Several methodological issues used in these studies must be highlighted. Many studies lack (or at least did not report) the use of rigorous methods to ensure adherence to manual turning routines in the control groups. It is not apparent that manual turning was strictly monitored or enforced. Given the results of 2 studies that revealed critically ill patients were not turned every 2 hours, rotation therapy studies may have been comparing specialty beds with a control group that was not turned adequately. Therefore, the reduction in VAP with the use of rotation therapy may actually be due to being turned, rather than the specialty bed itself. Future studies need to include protocols that demonstrate strict adherence to manual turning.

Despite the number of studies published on rotation therapy, it remains unclear which patients are the best candidates for this therapy. This may be in part because few studies have attempted to elucidate the underlying physiological mechanisms by which rotation therapy may decrease the development of VAP. Bein and colleagues investigated the effects of continuous rotational therapy on ventilation-perfusion in 10 patients with ARDS. By using the inert-gas elimination technique, they found that 20 minutes of rotation improved gas exchange by decreasing low ventilation to perfusion lung units. They also found that patients with more severe ARDS did not improve oxygenation ($P_{aO_2}/FIO_2$) with rotation therapy than did patients with less severe disease. They speculated that these results were due in part to the pathophysiological changes with ARDS over time as the lung evolves from a wet, heavy, atelectatic lung to a brittle fibrotic lung. In the early stage of ARDS, rotation therapy may be effective in altering the distribution of ventilation and perfusion. However, late ARDS pathophysiological changes render position changes ineffective. Further studies are needed to explain the physiological basis of rotation therapy.

Current clinical practice guidelines by the Centers for Disease Control and Prevention make no recommendations for the use of rotation therapy for the prevention of VAP in critically ill and immobilized patients. However, more recent guidelines published by the Canadian Critical Care Society recommend clinicians consider the use of kinetic beds to prevent VAP.

**Positioning of the Critically Ill Obese Patient**

Obesity is defined as a body mass index (BMI; weight [kg]/height [m$^2$]) greater than or equal to 30. According to recent data from the Centers for Disease Control and Prevention, more than 20% of American adults are obese and the number is expected to increase. Consequently, as the general population of obese individuals has increased, so too has the population of critically ill obese patients. Positioning these patients can be challenging. Currently, most positioning interventions for obese patients are only modifications of those used for nonobese patients. A task force of the National Association of Bariatric Nurses developed best practices for safe handling of obese patients. These guidelines recommend the establishment of unit-based multidisciplinary bariatric task forces to identify high risk tasks and to outline solutions
especially for repositioning patients in bed. Caregivers must be knowledgeable about available technology to assist with positioning, how to access it quickly, and the weight capacity of beds and reclining chairs. The VISN 8 Web site of the Department of Veteran Affairs has a valuable resource available on its Web site,94 the “Safe Bariatric Patient Handling Toolkit,” that contains assessment criteria, algorithms, equipment lists, and a policy template. A task that is challenging and places caregivers at high risk for injury is repositioning an obese patient up in bed for turning to the side. The use of manufactured slings can greatly reduce these risks and allow for repositioning the obese patient while in bed. An algorithm on repositioning obese patients in bed (side to side, up in bed) can be helpful for critical care nurses who care for these patients (Figure 2).

**Positioning Obese Patients to Promote Adequate Oxygenation**

In obese individuals, there are structural and functional changes that impact ventilation. A BMI greater than 30 kg/m² is directly associated with reductions in all lung volumes, particularly in expiratory reserve volume and functional reserve capacity.95 Adipose tissue deposits in the abdomen, diaphragm, and intercostal muscles can prevent proper chest wall expansion and diaphragmatic excursion.93 The airway may be narrowed from adipose tissue deposits in the upper airway, which can complicate airway management. These structural changes may lead the obese patient to experience a hypoventilation syndrome with chronic hypoxia or obstructive sleep apnea.91 Obese patients are at risk for more ventilator days than are nonobese patients and are more likely to aspirate gastric secretions because of increased gastric secretions, upper airway changes, and poor lung volumes.92 These patients are at greater risk for the development of atelectasis and pneumonia from shallow breathing patterns.95 Head of bed elevation of at least 30° improves ventilatory effort and tidal volume in patients with large abdomens and reduces the incidence of aspiration in mechanically ventilated patients.97 However, this HOB elevation is often associated with the patient “sinking” to the foot of the bed (Figure 2). This requires additional personnel to help reposition the patient to the head of the bed. Useful strategies to counteract this problem may include the use of an adjustable footboard against which the patient can push to move up in the bed, and an over-bed trapeze that the patient can grasp to leverage into a higher position.98

Special care must be taken when placing the obese patient with large pendulous abdomens in a lateral position. If allowed to hang over the side of the bed, they can have the effect of pulling the patient off the bed via gravity.99 Care must also be taken, in both men and women, to protect the breasts from compression injury.

The effects of the prone position in obese patients have not been thoroughly examined. The process of placing the obese patient in this position presents challenges and safety risks for the patient as well as members of the health care team. Adequate numbers of staff and appropriate equipment that can tolerate the weight shifts of obese patients are required.98 A recent case study of an obese patient with ARDS reported that the prone position improved alveolar ventilation.100 Rossetti and colleagues101 in a study conducted on ICU patients with ARDS found that patients with increased body weight had greater improvement in oxygenation than did those with less weight. Further research is necessary to strengthen and to support the use of the prone position for obese patients.

There are specific mattress products that offer CLRT for obese patients. These products reduce friction and shear and provide for turning to maximize respiratory function.92,98 They include air mattresses that have multiple air chambers that inflate and deflate to laterally rotate the patient. One example of this is the Plexus TruTurn Elite Therapeutic Turning Mattress (Gaymar Industries, Orchard Park, New York). Nurses should be cognizant of avoiding the use of the term “big boy bed” as this an unnecessary assault on the patient’s dignity.94

**Positioning Obese Patients to Promote Skin Integrity**

Obese patients are more susceptible to pressure ulcers than are nonobese patients for a variety of reasons including poorly vascularized adipose tissue, additional mass and skin surface area, limited mobility, improper equipment, and inadequate staff members and staff who lack training in caring for obese patients. Standard hospital beds may not provide enough pressure relief for the obese patient or may be so narrow that the rails cause pressure against arms, legs, and hips.90 Properly sized
Figure 2: Bariatric Reposition in Bed: Side-to-Side and Up in Bed. From the Safe Bariatric Patient Handling Toolkit (www.visn8.med.va.gov/patientsafetycenter/safePThandling/toolkitBariatrics.asp).
equipment reduces the risk of pressure ulcers through pressure reduction and promotion of independence, decreases staff workload, and increases satisfaction of the obese patient. Air and foam matrix mattresses minimize friction and shear and therefore reduce the development of pressure ulcers. Appropriate bed frames can be selected for safe mobilization and positioning of the bedridden patient. Trapèzes are useful for patient positioning because they allow patients to participate in their own care, reduce the number of staff required for transfer, and reduce the risk of friction and shear with repositioning. A bariatric ceiling lift with a seated sling can be used to transfer patients from bed to chair if the patient cannot fully or partially assist.

A multidisciplinary team effort is required to determine which positioning interventions are required for critically ill obese patients. This team effort should be expanded to encourage proper interventions to ensure safety for the patient and caregivers. A prospective, cross-sectional descriptive study reported that at least 2 staff members were needed to assist with positioning, and those with a BMI greater than 40 kg/m² were most likely to need at least 4 staff for positioning. On the basis of these results, the investigators recommend using BMI as a trigger for ordering rented or stored equipment to promote timely arrival and intervention.

Positioning Elderly Patients to Promote Adequate Oxygenation

There are structural and functional changes that occur with aging that impact ventilation and increase the risk of respiratory failure and VAP including reduction in expiratory force, diminished respiratory muscle strength, poor mucociliary clearance, increased upper airway colonization, swallow dysfunction, and diminished respiratory muscle strength. Elevation of the HOB should be at least 30° to minimize the incidence of VAP and to improve oxygenation. In a study of healthy elderly patients, Hardie and colleagues found that oxygenation was better in the sitting position than in the supine position; however, further studies in critically ill patients showing the same results are needed.

Positioning Elderly Patients to Promote Skin Integrity

Critically ill elderly patients are at high risk for the development of pressure ulcers. Furthermore, and ironically, some research suggests that obesity can reduce the incidence of pressure ulcers in elderly populations when compared with optimal weight patients and underweight patients. The authors of the preceding study postulate that adipose tissue could potentially provide a type of subcutaneous cushion dispersing pressure over more tissue. This research illustrates the point that it is imperative to provide individualized care to the elderly critical care patient when addressing risks for pressure ulcer development. Evidence exists to support the use of interventions for general patient populations to address these risks, such as patient turning in bed, CLRT, and positioning on a specialty surface; however, research into the elderly population’s response to these interventions is lacking.

Age-related decreased peripheral perfusion to the lower extremities in the elderly is a risk factor for the development of pressure ulcers on the heels of elderly patients on bed rest. Cushioning devices, such as foam heel protectors and pillows, are important in the prevention of heel ulcers.

Summary

Nurses use clinical judgment based on physiological and scientific evidence to position critically ill patients to prevent complications of immobility and to achieve optimal patient outcomes. Therapeutic positioning in stationary positions is done to optimize ventilation and perfusion and to promote effective pulmonary gas exchange. In patients with unilateral disease, optimal gas exchange occurs when the patient is placed with the “good lung down.” Less physiological and scientific evidence exists...
for optimal positioning of patients with bilateral disease. More research is needed. Strong evidence exists that HOB elevation prevents VAP. More research is needed to identify the optimal degree of HOB elevation that prevents VAP and development of pressure ulcers. Although research has demonstrated that prone positioning in patients with ARDS improves pulmonary gas exchange, the exact physiological mechanisms responsible for improvement in pulmonary gas exchange have not been elucidated. Even though prone positioning optimizes oxygenation, the use of this position has not been shown to impact mortality. The current standard of repositioning patients is every 2 hours, yet there is little physiological or scientific evidence to support this standard. Furthermore, it appears that the standard is often not met. Research is needed to provide evidence that turning frequency impacts outcomes. Research has shown that rotation therapy decreases VAP. However, methodological issues arise because of lack of rigorous methods to assess adherence to group assignments in randomized controlled trials comparing rotation therapy with conventional turning methods. More research is needed to understand physiological and scientific basis of optimal positioning in select critically ill patient populations, such as obese and elderly patients.

References


Physiological Rationale and Current Evidence for Therapeutic Positioning of Critically Ill Patients

Mark your answers clearly in the appropriate box. There is only one correct answer per question. You may photocopy this form.

A  B  C  D  A  B  C  D  A  B  C  D
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4.  ○  ○  ○  ○  8.  ○  ○  ○  ○  12.  ○  ○  ○  ○

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Physiological Rationale and Current Evidence for Therapeutic Positioning of Critically Ill Patients

Objectives:
Upon completion of this article, the reader will be able to:
1. Understand the role of therapeutic repositioning in preventing complications and improving critically ill patient outcomes.
2. Describe the physiological rationale for stationary and active repositioning.
3. Recognize special considerations for therapeutic repositioning of critically ill obese and elderly patients.

1. What complication of bed rest is caused by diminished baroreceptor activity?
   a. Hypoxemia
   b. Venous thromboembolism
   c. Syncope
   d. Atelectasis

2. How does prolonged placement in the supine position affect patients with diseased lungs?
   a. They have a normal ventilation/perfusion ratio.
   b. They develop alveolar dead space.
   c. They have a high ventilation/perfusion ratio.
   d. They develop an intrapulmonary shunt.

3. What head of bed (HOB) elevation do multiple clinical practice guidelines recommend for critically ill patients in the semirecumbent position?
   a. 10 to 25 degrees
   b. 30 to 45 degrees
   c. 50 to 65 degrees
   d. 75 to 90 degrees

4. Which is a contraindication to HOB elevation?
   a. Enteral nutrition
   b. Mechanical ventilation
   c. Hypertension
   d. Ischemic stroke

5. What is a possible risk of HOB elevation above 30 degrees?
   a. Low sacral tissue interface pressures
   b. Pressure ulcers
   c. Aspiration pneumonia
   d. Ventilator-associated pneumonia (VAP)

6. A patient with which diagnosis should be positioned with the unaffected lung in the dependent position?
   a. Pneumonia
   b. Interstitial emphysema
   c. Pulmonary abscess
   d. Pulmonary hemorrhage

7. Which position improves pulmonary gas exchange in patients with acute lung injury and/or acute respiratory distress syndrome?
   a. Supine
   b. Semirecumbent with HOB elevation
   c. Left lateral decubitus
   d. Prone

8. According to Alsaghir and Martin, what is an effect of prone positioning?
   a. Decreased number of mechanical ventilation days
   b. Decreased VAP incidence
   c. Improved PaO2/FIO2
   d. Decreased mortality

9. Which is a potential contraindication to prone positioning?
   a. New tracheostomy (<24 h)
   b. Weight of 130 kg
   c. Systolic blood pressure of 100 mm Hg
   d. Mean arterial pressure of 70 mm Hg

10. In AACN’s Thunder Project II, what was the most painful routine procedure performed in adults?
    a. Endotracheal tube suctioning
    b. Arterial blood gases
    c. Turning
    d. Venipuncture

11. In addition to expiratory reserve volume, what lung volume is primarily reduced in patients with a body mass index greater than 30 kg/m2?
    a. Functional reserve capacity
    b. Forced vital capacity
    c. Inspiratory reserve volume
    d. Residual volume

12. What structural and functional change of aging increases the risk of respiratory failure and VAP?
    a. Increased expiratory force
    b. Swallow dysfunction
    c. Decreased upper airway colonization
    d. Increased respiratory muscle strength