Head-of-Bed Elevation in Critically Ill Patients: A Review

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Guidelines for head-of-bed (HOB) elevation to prevent aspiration and pressure ulcers are in conflict. As indicated in Table 1, several expert sources recommend a 45° HOB elevation (unless medically contraindicated) to prevent aspiration while others recommend an HOB elevation between 30° and 45° (again, unless medically contraindicated). In contrast, pressure ulcer guidelines call for raising the HOB no more than 30° to avoid excessive pressure on the sacral region. Although the recommendations overlap, a 45° HOB elevation is generally favored to prevent aspiration in critically ill patients who are receiving mechanical ventilation and tube feedings. Clearly, the conflicting guidelines regarding aspiration and pressure ulcers are problematic for critical care clinicians who strive to prevent the suffering and increased costs associated with both conditions.

Clinicians are confused by conflicting guidelines about the use of head-of-bed elevation to prevent aspiration and pressure ulcers in critically ill patients. Research-based information in support of guidelines for head-of-bed elevation to prevent either condition is limited. However, positioning of the head of the bed has been studied more extensively for the prevention of aspiration than for the prevention of pressure ulcers, especially in critically ill patients. More research on pressure ulcers has been conducted in healthy persons or residents of nursing homes than in critically ill patients. Thus, the optimal elevation for the head of the bed to balance the risks for aspiration and pressure ulcers in critically ill patients who are receiving mechanical ventilation and tube feedings is unknown. Currently available information provides some indications of how to position patients; however, randomized controlled trials where both outcomes are evaluated simultaneously at various head-of-bed positions are needed. (Critical Care Nurse. 2013;33[3]:53-67)
Aspiration of gastric contents is a primary route of bacterial entry into the lungs and is an important factor in the development of ventilator-associated pneumonia (VAP). VAP is the most common nosocomial infection in critically ill patients and is an important cause of prolonged hospitalization and mortality. For example, a review of 89 observational and randomized trials regarding VAP showed that VAP developed in between 10% and 20% of patients receiving more than 48 hours of mechanical ventilation, and critically ill patients in whom VAP develops appear to be twice as likely to die as similar patients without VAP. Further, patients in whom VAP develops may incur at least $10,019 in additional hospital costs. Because VAP prevention is partially predicated on the prevention of aspiration, it is understandable why guidelines for both aspiration and VAP include an elevated HOB position. The Centers for Medicare and Medicaid Services (CMS) is considering adding VAP to the list of “never events”; if this happens, punitive reimbursement policies could follow.

Pressure ulcers are also associated with adverse outcomes and increased hospital costs. Fatalities from septicemia associated with untreated pressure ulcers are occasionally reported. However, a pressure ulcer is often a marker for coexisting illness and other risk factors for mortality. Among all hospitalized patients, prevalence rates of acquired pressure ulcers are highest in patients in
intensive care units (ICUs). In 2009, approximately 1 in 10 patients in adult ICUs in the United States had a pressure ulcer develop. Facility-acquired pressure ulcer rates were 8.8% in general cardiac care units, 9.4% in medical ICUs, 10.3% in general ICUs, and 10.4% in surgical ICUs; about 65% to 75% of the ulcers were more severe than stage I. The cost of treating pressure ulcers, especially stage III and IV ulcers, is substantial. The mean cost of care for an acute care patient with a stage III or IV pressure ulcer is reported by the CMS to be $43 180. In 2006, the CMS added stage III and IV pressure ulcers to the list of “never events.” Beginning in 2008, the CMS refused to pay for the care of a hospital-acquired pressure ulcer in stages III and IV unless it was determined to have been unavoidable. One component of the pressure ulcer guidelines issued by the National Pressure Ulcer Advisory Panel is a low HOB elevation (preferably <30º).

Pathophysiology of Aspiration

Aspiration is defined as the inhalation of oropharyngeal secretions or gastric contents into the airways beyond the vocal cords. Consequences of pulmonary aspiration depend on the volume and chemical composition of the aspirated material as well as on the presence or absence of infectious agents and the patient’s underlying condition. The associated lung injury is characterized by pulmonary inflammation, capillary leakage, and oxidative damage. Variable outcomes are possible, ranging from mild pneumonitis to acute respiratory distress and death.

Risk factors for pulmonary aspiration include conditions that depress the level of consciousness, a decreased gag reflex, tracheal intubation, presence of a gastric tube, and a full stomach. Critically ill patients undergoing mechanical ventilation who are receiving tube feedings are at especially high risk for the aspiration of regurgitated gastric contents. Reports of witnessed macroaspirations in critically ill patients range from less than 1% to 11.7%; far more common are clinically silent, small-volume aspirations. For example, McClave et al reported a 22.1% mean frequency of clinically silent microaspirations per patient (range, 0%-94%) in a group of 40 adult critically ill, tube-fed patients receiving mechanical ventilation.

Pathophysiology of Pressure Ulcers

The National Pressure Ulcer Advisory Panel has defined a pressure ulcer as localized injury of the skin and/or underlying tissue, usually over a bony prominence, as a result of pressure or pressure in combination with shearing force. Oxygen delivery to the skin is compromised when it is exposed to a pressure greater than the capillary closing pressure; if sustained, tissue necrosis results. An elevated HOB position results in an increased interface pressure between the sacrum and the bed’s surface; in addition, potential for injury of skin in the sacral region is increased when the HOB is elevated sufficiently to cause the patient to slide downward. The bony prominence most affected by pressure ulcers is the sacrum. For patients turned on their sides at regular intervals, damage of skin over the trochanters may occur (although it is unlikely when patients are turned to an angle ≤30º). Healing rates of pressure ulcers vary considerably and are dependent on comorbid conditions, clinical interventions, and severity of the ulcer.

Purpose

In this article, we review guidelines for HOB elevation to prevent aspiration and pressure ulcers, as well as the limited research-based information in support of the guidelines. Table 2 lists studies relevant to HOB elevation and aspiration (as well as aspiration-related conditions), and Table 3 lists studies relevant to HOB elevation and pressure ulcers.

Evidence to Support HOB Elevation to Prevent Aspiration

Much of the supportive evidence for a semirecumbent position to prevent aspiration was gathered several decades ago in studies with relatively small sample sizes. In randomized trials of critically ill patients, investigators compared the effect of a supine (0º HOB elevation) versus a 45º HOB elevation position on aspiration by adding a radioactive substance to gastric contents and subsequently scanning bronchial secretions for radioactivity. This method for testing for aspiration is highly reliable and demonstrates the extent to which HOB elevation is associated with aspiration. In another frequently cited and credible study, researchers assessed for microbiologically confirmed pneumonia when patients were flat in bed versus a 45º HOB elevation. Because of ethical concerns, it would not be possible today to assign critically ill patients to a supine position to study aspiration.

Increased compliance with keeping the HOB elevated ≥30º led to a decrease in rates of ventilator-associated pneumonia.
Table 2  Studies related to head-of-bed (HOB) elevation and aspiration or aspiration-related pneumonia

<table>
<thead>
<tr>
<th>Source</th>
<th>Sample</th>
<th>Design</th>
<th>Outcome</th>
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</thead>
<tbody>
<tr>
<td>Torres et al.30  Annals of Internal Medicine, 1992</td>
<td>19 patients with nasogastric tubes undergoing mechanical ventilation Mean age, 60 y</td>
<td>Randomized 2-period cross-over study</td>
<td>Aspiration of gastric contents</td>
</tr>
<tr>
<td>Orozco-Levi et al.31  American Journal of Respiratory and Critical Care Medicine, 1995</td>
<td>15 patients with nasogastric tubes undergoing mechanical ventilation Mean age, 56 y</td>
<td>Randomized 2-period cross-over study</td>
<td>Aspiration of gastric contents Gastroesophageal reflux (GER)</td>
</tr>
<tr>
<td>Ibanez et al.32  Journal of Parenteral and Enteral Nutrition, 1992</td>
<td>70 orotracheally intubated patients 50 received enteral nutrition while gastric contents labeled with technetium Tc 99m 20 had nasogastric tubes removed after instillation of technetium Tc 99m</td>
<td>Randomized 2-group study</td>
<td>GER</td>
</tr>
<tr>
<td>Drakulovic et al.33  Lancet, 1999</td>
<td>86 critically ill patients receiving mechanical ventilation 47 supine, 39 semirecumbent Enteral feedings used in 56%-60% of patients Mean age, 65 y</td>
<td>Randomized 2-group study</td>
<td>Microbiologically confirmed nosocomial pneumonia</td>
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<tr>
<td>Metheny et al.34  Critical Care Medicine, 2006</td>
<td>360 critically ill tube-fed patients undergoing mechanical ventilation Mean age, 52 y</td>
<td>Prospective descriptive study</td>
<td>Aspiration of gastric contents Pneumonia</td>
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<tr>
<td>Method</td>
<td>Results</td>
<td>Conclusions</td>
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<tr>
<td>Randomly assigned to supine (0°) or 45° HOB elevation during period 1 and other position during period 2</td>
<td>Mean radioactive counts higher in bronchial samples obtained with patient supine vs semirecumbent (4154 cpm vs 954 cpm, respectively, P &lt; .05). Aspiration increased over time when patient was supine (2592 cpm at 300 min vs 298 cpm at 30 min, P = .01). Same microorganisms isolated from stomach, pharynx, and bronchial samples in 68% of studies when patients supine, as compared with 32% when patients semirecumbent.</td>
<td>45° HOB elevation associated with less aspiration than supine position. Risk for aspiration increases over time when patient is supine.</td>
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<td>Technetium Tc 99m instilled into nasogastric tubes; bronchial secretions collected at 0, 30, 60, 120, 180, 240, and 300 min and tested for radioactivity (counts per minute [cpm])</td>
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<tr>
<td>Surveillance for clinical detection of pneumonia done daily; samples for microbiological diagnostic tests taken if infection clinically suspected</td>
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<tr>
<td>Standard pressure area care protocol applied in all patients (water-filled cushion placed under sacral region); method of monitoring for pressure ulcers not described</td>
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<tr>
<td>Random assignment to supine (0°) or semirecumbent (45° HOB elevation) position</td>
<td>Radioactivity of pharyngeal secretions higher with patients supine from hours 1-4, P &lt; .05; however, no difference noted at 5 hours. Radioactivity in bronchial secretions higher at 5 hours in supine patients compared with baseline (P &lt; .05) and semirecumbency (P &lt; .01). Results of microbiological cultures showed a sequence of colonization from the stomach to the pharynx in 6 patients (4 of them supine), and from the pharynx to the bronchi in 2 others (one supine and one semirecumbent).</td>
<td>GER is a frequent feature in patients with nasogastric tubes. GER occurs irrespective of body position in patients undergoing mechanical ventilation. A semirecumbent position lessens aspiration, but does not completely prevent it.</td>
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<tr>
<td>Samples of gastric, pharyngeal, and bronchial secretions obtained at baseline and hourly for 5 hours after nasogastric tube instillation of technetium Tc 99m</td>
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<td>Specimens were examined for radioactivity and microbiological cultures were obtained</td>
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<tr>
<td>Patients assigned to supine (0°) or semirecumbent group (45° HOB elevation)</td>
<td>In the 50 patients with nasogastric tubes, incidence of GER higher in supine patients (81%, 21/26) than in semirecumbent patients (67%, 16/24), P = .26. In the 20 patients without nasogastric tubes, GER was also more frequent in supine position (50%, 6/12) than in the semirecumbent position (12%, 1/8), P = .16. Overall, GER more frequent in patients with nasogastric tubes than in those without (74% vs 35%, P &lt; .001).</td>
<td>Incidence of GER is high in patients with orotracheal intubation and nasogastric tubes. Semirecumbency does not prevent GER, although GER tends to occur less often in semirecumbent patients.</td>
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<td>GER assessed by scintigraphy after gastric contents labeled with technetium Tc 99m via the nasogastric tube</td>
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<tr>
<td>Random assignment to supine (0°) or semirecumbent (45° HOB elevation) position</td>
<td>Microbiologically confirmed pneumonia occurred less often in the semirecumbent group than in the supine group (2/39 [5%] vs 11/47 [23%], respectively, P = .02). Highest risk for nosocomial pneumonia occurred in patients receiving tube feedings in the supine position. No adverse effects of the semirecumbent position were found; investigators emphasized use of protective measures to prevent pressure ulcers.</td>
<td>45° HOB elevation reduces frequency of pneumonia, especially in tube-fed patients.</td>
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<td>Correctness of assigned body position checked daily</td>
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<tr>
<td>Surveillance for clinical detection of pneumonia done daily; samples for microbiological diagnostic tests taken if infection clinically suspected</td>
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<td>Standard pressure area care protocol applied in all patients (water-filled cushion placed under sacral region); method of monitoring for pressure ulcers not described</td>
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<td>Observed 16 hours per day for 3 days; HOB elevation recorded hourly; other risk factors for aspiration also recorded</td>
<td>At least 1 aspiration event identified in 89% of participants. Patients with mean HOB elevation &lt;30° (n = 226) had higher percentage of aspiration than did the 134 patients with mean HOB ≥30° (35% vs 25%, P &lt; .001). Mean HOB elevation &lt;30° found significantly more often in patients with pneumonia than in those without (P = .02). Higher percentage of pepsin-positive secretions found in patients with pneumonia than in those without (42% vs 21%, P &lt; .001). Other significant risk factors were decreased level of consciousness, vomiting, and GER.</td>
<td>Microaspiration common in critically ill, tube-fed patients receiving mechanical ventilation. Frequent aspiration significantly increases risk for pneumonia. HOB elevation &lt;30° is a significant risk factor for aspiration and pneumonia.</td>
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Nonetheless, results from these studies are helpful in current practice because they clearly show that a 45º HOB elevation is superior to a “flat in bed” position in preventing aspiration. Recommendations in guidelines to prevent aspiration are largely based on these trials. No randomized controlled trials were identified that compare aspiration while patients are at a 30º HOB elevation versus a 0º elevation, or a 30º elevation versus a 45º elevation. Thus, although a 30º HOB elevation is commonly recommended in practice settings, there is no direct evidence that it is as effective as a 45º elevation in reducing aspiration. However, as indicated in Table 2, several descriptive studies34,35 suggest that an HOB elevation of 30º or greater is associated with fewer adverse outcomes (aspiration and pneumonia) than is a lower HOB elevation. It must be noted that evidence garnered from descriptive studies is not as strong as evidence obtained from a controlled trial where patients are randomly assigned to differing HOB elevations. Further, the descriptive studies34,37 described in Table 2 have typically included HOB elevation

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<th>Outcome</th>
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<tbody>
<tr>
<td>Metheny et al.,36 Nursing Research, 2010</td>
<td>474 critically ill, tube-fed patients receiving mechanical ventilation</td>
<td>Two-group quasi-experimental study</td>
<td>Aspiration of gastric contents</td>
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<td></td>
<td>Intervention group, 145; usual care group, 329 Mean age, 49-53 y</td>
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<td>Pneumonia</td>
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<tr>
<td>van Nieuwenhoven et al.,36 Critical Care Medicine, 2006</td>
<td>221 critically ill patients receiving mechanical ventilation</td>
<td>Prospective multicenter randomized 2-group trial</td>
<td>Ventilator-associated pneumonia (VAP) Pressure ulcers</td>
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<td></td>
<td>Standard care group, 109; semirecumbent group, 112 (Mean ages 63-65 y)</td>
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<tr>
<td>Keeley,37 Nursing in Critical Care, 2007</td>
<td>30 critically ill patients receiving mechanical ventilation completed the study</td>
<td>Randomized controlled trial</td>
<td>VAP</td>
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<td>Treatment group, 17; control group, 13 Mean ages, 64-68 y</td>
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Table 2 Continued
in context with multiple other variables, thus making it difficult to determine the singular effect of HOB elevation on outcomes.

Following a systematic review of 3 of the trials,33,36,37 described in Table 2, a European panel concluded that it is uncertain whether a 45º HOB elevation is effective or harmful in regard to pneumonia and pressure ulcers.45 One aspect considered in the panel’s deliberations was the paucity of data to support the use of a 45º HOB elevation for a sustained period.45 The authors questioned whether a 45º HOB elevation for 24 hours a day might increase the risk for thromboembolism, hemodynamic instability, and pressure ulcers. Although these are reasonable concerns, the 3 studies reviewed by the panel did not assess for thromboembolism and hemodynamic instability and only 1 referred to pressure ulcers as an outcome (noting no difference at the end of 1 week between groups with mean HOB elevations of 16º and 23º). Based on their deliberations, the panel recommended an HOB elevation of 20º to 45º for patients receiving mechanical ventilation.
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<tbody>
<tr>
<td>Peterson et al.(^a) Critical Care Medicine, 2008</td>
<td>15 healthy adults Age range, 23-54 y</td>
<td>Descriptive observational study</td>
<td>Peak sacral interface pressures</td>
</tr>
<tr>
<td>Harada et al.(^b) Journal of Wound Ostomy Continence Nursing, 2002</td>
<td>10 healthy Japanese women Age range, 18-25 y</td>
<td>Comparative, quasi-experimental study with repeated measures</td>
<td>Body displacement Sacral interface pressure</td>
</tr>
<tr>
<td>Peterson et al.(^c) Journal of Advanced Nursing, 2010</td>
<td>15 healthy adults Age range, 23-54 y</td>
<td>Descriptive observational study</td>
<td>Interface pressures in the sacral, trochanteric, and buttock regions Effectiveness of turning in unloading pressure on at-risk tissues</td>
</tr>
<tr>
<td>Gray-Siracusa and Schrier,(^d) Journal of Nursing Care Quality, 2011</td>
<td>Total 1199 critically ill patients (554 in “before” group and 645 in “after” group)</td>
<td>Two-group (before-after) comparison study</td>
<td>Rate of hospital-acquired pressure ulcers</td>
</tr>
<tr>
<td>Nanjo et al.(^e) Journal of Wound Ostomy Continence Nursing, 2011</td>
<td>30 adult critically ill patients Mean age, 68 y</td>
<td>Qualitative exploratory study</td>
<td>Relationships among etiologic factors, characteristics of pressure ulcers, and interventional nursing care</td>
</tr>
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</table>
### Method

| Interface pressure profiles of the sacral area obtained for the 0°, 10°, 20°, 30°, 45°, 60°, and 75° HOB elevations | After repeated-measures analysis of variance, the HOB positions of 45°, 60°, and 75° all caused statistically significant increases in affected areas compared with the supine measurement ($P < .001$) |
| Measurements obtained using a thin pressure-sensing pad placed under the sacral region | With the same statistical test, the areas with $\geq 32$ mm Hg interface pressure at the HOB positions of 45°, 60°, and 75° were all significantly different from all other HOB positions |

### Results

| Subjects placed supine on standard hospital bed; HOB then raised to 30° according to 2 protocols: (1) supine for 10 minutes without leg elevation alternating with 10 minutes of side-lying, or (2) supine for 10 minutes with leg elevation at 10° alternating with side-lying every 10 minutes | Mean body displacement in 30° elevated HOB position without leg elevation at the end of 2 hours was 29 cm, whereas with leg elevation it was 18 cm ($P < .001$) |
| Difference over time between the top edge of the mattress and subjects' acromion measured every 10 minutes | No significant differences in sacral interface pressures with or without leg elevation at baseline (7.3 mm Hg and 11.9 mm Hg, respectively) |

### Conclusions

| Raising the HOB to ≥30° significantly increases the skin–support surface interface pressure, and a ≥45° HOB elevation significantly increases the area of skin exposed to a pressure >32 mm Hg | Leg elevation at 10° in the 30° HOB elevated position is effective for reducing body displacement; it is not effective for reducing sacral interface pressures |

### Method

| Interface pressure profiles obtained from sacral, trochanteric, and buttock regions while patients were supine, followed by lateral turning with pillow or wedge support and subsequent HOB elevation to 30° | Peak perisacral area interface pressures not significantly affected by lateral turning, but demonstrated a significant increase upon elevating the HOB to 30° ($P < .05$) |
| Turning performed by an experienced intensive care unit nurse | 93% of participants had skin areas with interface pressures ≥32 mm Hg throughout all positions (mean [SD], 60 [54] cm²), termed “triple jeopardy area” |

### Results

| Determined rate of hospital-acquired pressure ulcers during year before implementation of bundle intervention | Analysis of quarterly hospital-acquired pressure ulcer rates before and after shows no significant difference ($P = .11$) |
| Implemented 7-item pressure ulcer bundle; portions pertaining to HOB elevation included (1) elevating HOB to 45° for all patients receiving mechanical ventilation, and (2) maintaining HOB at 30° or less for patients who are not receiving mechanical ventilation, who are at lower risk | Before pressure ulcer bundle, quarterly survey results for hospital-acquired pressure ulcer rates were as follows: quarter 1 = 5.7%; quarter 2 = 0%; quarter 3 = 5.2%, and quarter 4 = 0% |

### Conclusions

| Standard turning by experienced intensive care unit nurses does not reliably unload all areas of high skin-bed interface pressures | Pressure ulcer bundle reduced the incidence of pressure ulcers but difference was not statistically significant |

### Method

| Determined rate of hospital-acquired pressure ulcers during year following implementation of pressure ulcer bundle | Pressure ulcer sites: Upper sacrum (n = 5) Lower sacrum (n = 14) Coccyx (n = 8) Ischium (n = 1) Heel/ankle (n = 2) |
| Determined rate of hospital-acquired pressure ulcers during year following implementation of pressure ulcer bundle | Possible etiological factors for specific pressure ulcer divided into 4 categories: (1) occurrence of pressure ulcer risk episodes, (2) failure of peripheral circulation, (3) periods of critical immobility, and (4) position change techniques inducing skin deformation |

### Results

| Details of 30 individual pressure ulcers described by sketching pressure ulcer photographs | Frequently repeated position changes, such as lateral tilt and repeated HOB elevation, may cause deformation of the sacral skin and possibly play a role in development of pressure ulcers |
| Characteristics of pressure ulcers divided into 4 categories: (1) location, (2) shape, (3) type of skin lesion, and (4) periwound skin | Semistructured interviews with 5 nurses who cared for patients in study; topics included position and positioning methods, criteria for deciding how to position a particular patient, and typical interventions to prevent pressure ulcers |
| After identification of pressure ulcer characteristics, in-depth review of medical records to evaluate the pressure ulcers’ development process | Continued |
Evidence to Support a Low HOB Elevation to Prevent Pressure Ulcers

Overall, less research is available about the effect of HOB elevation on pressure ulcer development than on aspiration; further, relatively few studies have been conducted in a critical care setting. Three of the studies described in Table 3 were conducted with healthy persons and show that interface pressure between the skin and bed surface is increased as the HOB angle is increased. One of the studies also suggests that sliding down in bed is more likely at a 30° HOB angle than when the bed is flat. No randomized controlled trials were identified that compared the effect of various HOB elevations on development of pressure ulcers. However, 1 group of investigators compared pressure ulcer outcomes before and after the implementation of a pressure ulcer bundle (1 component of which was manipulation of the HOB angle) in a critical care setting. A trend toward reduction in pressure ulcer rates was noted, although statistical significance was not achieved. Two other studies described in Table 3 are examples of projects that demonstrate the benefit of pressure-relieving surfaces in preventing pressure ulcers.

Compliance With Guidelines in Critical Care Settings

Among contraindications to an elevated HOB position are recent lumbar spine injury, hemodynamic instability, trauma of the pelvic region, and severe sacral pressure ulcers. Even when there are no contraindications to an elevated HOB position, it is not consistently applied. (See the study by van Nieuwenhoven et al in Table 2.) A variety of strategies have been studied in regard to increasing use of an elevated HOB position. For example, Helman et al implemented a standardized order for placing patients in a 45º HOB elevated position, along with an educational program for nurses and physicians; however, compliance with the order was achieved in less than one-third of the observations. Nurses who participated in that study reported the following concerns:

- Increased probability of patient sliding down in bed
- More difficulty in turning patient from side to side
- Greater pressure exerted on patient’s sacral area
- Greater discomfort and interference with sleep

Using a lift sheet to reposition patients reduces shear pressure and lowers risk for pressure ulcers.

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<tr>
<th>Source</th>
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<th>Outcome</th>
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<tbody>
<tr>
<td>Sideranko et al.43</td>
<td>57 patients in a surgical intensive care unit</td>
<td>Repeated measures study</td>
<td>Sacral and heel pressures</td>
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<td>Development of pressure ulcers</td>
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<tr>
<td>Sanada et al.44</td>
<td>82 patients from general care area in hospital</td>
<td>Randomized controlled trial</td>
<td>Development of pressure ulcers</td>
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<td>Mean age range, 69.5-73.9 y</td>
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reported that the mean backrest elevation in a population of 170 critically patients was 19.2º. Although an elevated HOB position is especially warranted in tube-fed patients, there was no difference in backrest elevation between patients being fed and not being fed. In a 2005 study\textsuperscript{15} of 66 critically ill patients monitored during 275 patient days, investigators found that backrest elevations were less than 30º 72% of the time. More encouraging findings were reported in a later study\textsuperscript{49} conducted in a thoracic ICU; mean compliance with an HOB elevated position greater than 30º changed from 65% in 2007 to 99% in 2009; associated with this increased compliance was a significant decrease in the incidence of VAP.

HOB elevation is related to acuity level. For example, Evans\textsuperscript{48} found a significant negative correlation ($r^2 = -0.17$) between scores on the Acute Physiology and Chronic Health Evaluation II and HOB elevation in 113 critically ill patients. Evans\textsuperscript{48} also reported that patients receiving mechanical ventilation had a lower mean HOB elevation than did self-ventilating patients (19º vs 32º). In a study\textsuperscript{40} of 100 patients in a thoracic cardiovascular ICU, investigators found that patients with a mean arterial blood pressure of 64 mm Hg or less had a lower mean backrest elevation (17º) than did patients with a higher arterial pressure (24º). In a study of 438 patients, investigators\textsuperscript{41} reported that mean HOB elevations were lower in intubated patients (23º) than in nonintubated patients (33º, $P<.001$).

Delivery of standard nursing care often calls for temporary lowering of the HOB elevation. For example, because it is difficult to turn patients when the bed’s backrest is elevated, nurses usually lower the bed to 0º (in some instances, they may even put the bed in reverse Trendelenberg position while turning patients and pulling them up in bed). There are reports of nurses forgetting to elevate the backrest after completing the turning procedure (sometimes for a period up to 1 hour).\textsuperscript{52,53} Medical procedures (such as insertions of central catheters) can cause temporary interruptions in the desired HOB elevation. Transitory physiological conditions such as hemodynamic instability or low cerebral perfusion pressure also may mandate lowering of the HOB elevation.

Another possible reason for noncompliance with an elevated HOB position is difficulty in making accurate visual estimates of an HOB angle. For example, Hiner et al\textsuperscript{54} asked 175 clinicians to estimate a simulated HOB angle of 30º; the angle was perceived accurately by 50% of 89 nurses and 53% of 39 physicians; a higher percentage (86%) of 21 respiratory therapists identified the angle accurately. These findings are significant because some hospital beds do not have built-in electronic devices to determine the bed’s angle.
Pressure Ulcer Guidelines

No studies were located that measured adherence to a low (≤30°) HOB elevation to prevent pressure ulcers in critically ill patients. However, in a study involving 362 long-term care facilities in Missouri, researchers found that minimizing the HOB elevation to less than 30° was done by fewer than 20% of the facilities.

Conclusions

The optimal HOB elevation to balance the risks for aspiration and pressure ulcers is unknown. Thus, a need exists for randomized controlled trials where both outcomes (aspiration and pressure ulcers) are evaluated simultaneously at various HOB elevated positions, especially in a population of critically ill, tube-fed patients receiving mechanical ventilation. Some authors suggest that studies be conducted to compare the commonly recommended 30° to 45° HOB elevations to lower and more achievable levels (such as 10° to 30°). Until more research-based evidence is available, caregivers should consider guidelines from expert panels and ultimately make decisions about HOB elevation in the context of the patient’s overall condition. Given current information, the following recommendations may be helpful to critical care clinicians:

• Unless medically contraindicated, maintain an HOB elevation of 45° in patients who are receiving mechanical ventilation and tube feedings. If necessary for comfort, lower the HOB elevation to 30° periodically.
• For critically ill patients at less risk for aspiration (eg, patients who are not receiving mechanical ventilation), maintain an HOB elevation of at least 30° unless medically contraindicated.
• Use a pressure-relieving surface for all critically ill patients to reduce the skin-bed interface pressure associated with an elevated HOB position. Routinely assess the patient’s skin for signs of a developing pressure ulcer.
• To minimize shear pressure, use a lift sheet to reposition patients (instead of sliding the patient up in bed). CCN

References

Facts
There are conflicting guidelines about the use of head-of-bed (HOB) elevation to prevent aspiration and pressure ulcers in critically ill patients.

- Although the recommendations overlap, a 45° HOB elevation is generally favored to prevent aspiration in critically ill patients who are receiving mechanical ventilation and tube feedings. Because aspiration is a threat to oxygenation, it may be a more immediate concern than are pressure ulcers in critically ill patients.
- Aspiration of gastric contents is a primary route of bacterial entry into the lungs and is an important factor in the development of ventilator-associated pneumonia.
- Pressure ulcers are also associated with adverse outcomes and increased hospital costs. A pressure ulcer is often a marker for coexisting illness and other risk factors for mortality.
- Results from early studies are helpful in current practice because they clearly show that a 45° HOB elevation is superior to a “flat in bed” position in preventing aspiration.
- No randomized controlled trials were identified that compare aspiration while patients are at a 30° HOB elevation versus a 0° elevation, or a 30° elevation versus a 45° elevation. Thus, although a 30° HOB elevation is commonly recommended in practice settings, there is no direct evidence that it is as effective as a 45° elevation in reducing aspiration.
- Contraindications to an elevated HOB position are recent lumbar spine injury, hemodynamic instability, trauma of the pelvic region, and severe sacral pressure ulcers. Even when there are no contraindications to an elevated HOB position, it is not consistently applied.

Conclusions
Until more research-based evidence is available, caregivers should consider guidelines from expert panels and ultimately make decisions about HOB elevation in the context of the patient’s overall condition. Given current information, the following recommendations may be helpful to critical care clinicians:

- Standard nursing care often calls for temporary lowering of the HOB elevation. For example, because it is difficult to turn patients when the bed’s backrest is elevated, nurses usually lower the bed to 0°. There are reports of nurses forgetting to elevate the backrest after completing the turning procedure. Medical procedures also can cause temporary interruptions in the desired HOB elevation. Transitory physiological conditions such as hemodynamic instability or low cerebral perfusion pressure also may mandate lowering of the HOB elevation.

1. Which of the following statements regarding head-of-bed (HOB) elevation recommendations is true?  
   a. HOB positioning has been studied more extensively for the prevention of aspiration than for the prevention of pressure ulcers.  
   b. More research on pressure ulcers has been conducted on critically ill patients than in healthy persons.  
   c. The optimal HOB elevation to balance risks for aspiration and pressure ulcers is known.  
   d. There is sufficient research to support guidelines for HOB elevation to prevent aspiration and pressure ulcers.

2. Risk factors for pulmonary aspiration include all of the following except:  
   a. An empty stomach  
   b. Decreased gag reflex  
   c. Presence of a gastric tube  
   d. Tracheal intubation

3. Which of the following is defined as a pressure ulcer by the National Pressure Ulcer Advisory Panel?  
   a. Generalized injury of the skin  
   b. Injury that occurs only over a bony prominence  
   c. Localized injury of the skin that results from pressure  
   d. Tissue injury resulting from tearing force

4. Which of the following is the bony prominence most affected by pressure ulcers?  
   a. Heels  
   b. Occiput  
   c. Sacrum  
   d. Trochanters

5. Which of the following is a true statement regarding studies of 30° HOB elevation?  
   a. Evidence from descriptive studies is as strong as that obtained from a randomly assigned controlled trial.  
   b. Several studies suggest HOB elevation of greater than 30° is associated with fewer adverse respiratory outcomes.  
   c. Several trials have identified that 30° elevation is superior to HOB flat.  
   d. Thirty-degree HOB elevation is as effective as 45° elevation in reducing aspiration.

6. Which of the following is the optimal HOB elevation to balance the risks for aspiration and pressure ulcers?  
   a. Less than 30°  
   b. 30° to 45°  
   c. Greater than 45°  
   d. Unknown

7. Which of the following recommendations can be helpful to critical care clinicians?  
   a. Avoid use of lift sheets for repositioning critically ill patients to minimize shear pressure.  
   b. Maintain a HOB elevation of no more than 30° for mechanically ventilated patients receiving tube feedings.  
   c. Maintain a HOB elevation of at least 45° for critically ill patients who are not receiving mechanical ventilation.  
   d. Use a pressure-relieving surface to reduce the skin-bed interface pressure associated with HOB elevation.

8. Lung injury associated with aspiration is characterized by all of the following except:  
   a. Increased alveolar elasticity  
   b. Capillary leakage  
   c. Oxidative damage  
   d. Pulmonary inflammation

9. Nurses who participated in a study by Helman et al that implemented a standardized order for placing patients in a 45° elevated position reported which of the following?  
   a. Greater comfort and improved sleep  
   b. Greater pressure exerted on the patient’s lumbar region  
   c. Increased probability of the patient sliding down in bed  
   d. More difficulty moving the patient up in bed

10. Which of the following is a result reported in a 2006 study by Metheny et al?  
    a. At least one aspiration event was identified in each participant.  
    b. HOB elevation less than 30° does not significantly increase risk of aspiration.  
    c. Mean HOB elevation less than 30° was found significantly more often in patients with pneumonia.  
    d. There was no difference in percentage of aspiration depending on degree of HOB elevation.

11. Which of the following is a result reported in a 2010 study by Metheny et al?  
    a. HOB elevation and small-bowel tube feeding can significantly reduce the incidence of aspiration.  
    b. Pressure ulcers were higher in the intervention group than in the usual care group.  
    c. Statistically significant reduction in ventilator-associated pneumonia was not achieved between treatment groups.  
    d. There was no significant difference between the supine and semirecumbent groups in diagnosis of ventilator-associated pneumonia.

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**Program evaluation**

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