# Summary

The elevation of the head of bed (HOB) to a semirecumbent position (at least 30 degrees) is associated with a decreased incidence of aspiration and ventilator-associated pneumonia (VAP). The intervention is supported unanimously by all four leading guidelines, and newer publications in the field accept HOB elevation as an effective, low-cost, and low-risk intervention.

## Society for Healthcare Epidemiology of America

2008 – Society for Healthcare Epidemiology of America Guidelines: Strategies to prevent VAP in acute care hospitals: 2014 update1

* ***Recommends elevating the HOB (30–45 degrees) as a strategy to prevent aspiration.***

## ZAP the VAP: Ventilator-Associated Pneumonia

2008 – Canadian VAP Prevention Guidelines: Evidence-based, clinical practice guidelines for the prevention of VAP2

* ***Recommends elevating the HOB to 45 degrees or, when not possible, to the highest degree of elevation circumstances permit.***

## American Thoracic Society

2004 – Guidelines for the management of adults with hospital-acquired, ventilator-associated, and healthcare-associated pneumonia3

* ***Recommends the semirecumbent position (30–45 degrees) to reduce aspiration and VAP.***

## Centers for Disease Control and Prevention (CDC)

2003 – CDC Guidelines for preventing Health-Care-Associated Pneumonia; evidence-based, clinical practice guidelines for the prevention of healthcare-associated pneumonia, including VAP4

* ***Recommends semirecumbent position (30–45 degrees) for prevention of aspiration.***

|  |  |
| --- | --- |
| **Relevant Studies, 1990-2015** | |
| **Study Type and Author** | **Results** *–* **Details in Annotated Bibliography** |
| Observational Trial  (Rose, 2010)5 | **CON:** Study focused on adult patients requiring mechanical ventilation in Australia and New Zealand intensive care units. Findings showed that actual backrest elevation was less than recommended and predominantly influenced by clinical and patient condition, where more acute patients had a lower head of bed (HOB). Authors felt that more study is warranted to determine if the perceived difference in ventilator-associated pneumonia (VAP) rates is due to this phenomenon. |
| Randomized Controlled Trial (RCT)  (van Nieuwenhoven, 2006)6 | **CON:** Randomized controlled trial (RCT) to assess the feasibility of the semirecumbent position for adult mechanically ventilated patients in the intensive care unit (ICU). Patients must have required mechanical ventilation for more than 48 hours. The target for HOB elevation was 45 degrees. Unfortunately, the study failed to meet the target elevation of 45 degrees, and investigators compared 10-degree elevation versus 28-degree elevation. Comparison failed to show VAP reduction. |
| Quasi-experimental Study  (Resar, 2005) 7 | **PRO:** Quasi-experimental study. This study implemented the use of the Institute for Healthcare Improvement ventilator bundle. Findings showed that adherence to the bundle led to a significant reduction of VAP. One of the four interventions included in the bundle was HOB elevation to 30*–*45 degrees. |
| RCT  (Drakulovic, 1999)8 | **PRO:** RCT. 86 patients were randomly assigned to semirecumbent or supine position. Study focused on medical and respiratory patients who required mechanical ventilation in the intensive care unit. Findings showed the semirecumbent body position reduces frequency and risk of nosocomial pneumonia, especially in patients who receive enteral nutrition. Study was stopped early after planned interim analysis found significant differences between the two arms. |
| Observational Study  (Orozco-Levi, 1995)9 | **PRO:** Observational study focused on adult, critically ill patients requiring mechanical ventilation and nasogastric intubation. Study findings showed that irrespective of body position (supine or semirecumbent), patients with gastroesophageal reflex (GER) are at risk for gastric content aspiration. Additionally, the study concludes that while the semirecumbent position doesn’t completely protect from GER, it does protect against pulmonary aspiration of gastric contents. |
| Cohort Study  (Kollef 1993)10 | **PRO:** Cohort study focused on medical, surgical, and cardiothoracic patients that required mechanical ventilation for longer than 24 hours. Study findings showed four factors to be independently associated with VAP: an organ system failure index ≥3, patient age ≥60 years, prior antibiotic treatment, and supine head positioning. |
| Crossover Trial  (Torres, 1992)11 | **PRO:** Crossover trial focused on patients requiring mechanical ventilation and intubation. Study findings conclude that the supine position and length of time the patient is kept in this position are potential risk factors for aspiration of gastric contents. |

|  |  |
| --- | --- |
| **Reviews and Meta-analyses, 1993–2011** | |
| **Study Type and Author** | **Results** *–* **Details in Annotated Bibliography** |
| Literature Review  (Li Bassi, 2011)12 | Literature review: Reviewed nine RCTs and two animal studies to evaluate the role of body positioning on VAP. Findings showed a decrease in VAP due to semirecumbent position and reduction in gastric aspiration. |
| Clinical Review  (Grap, 2010)13 | Clinical review: This review summarizes the epidemiology, pathophysiology, and risk factors associated with VAP and provides evidence-based recommendations for preventions. Review recommends the use of continuous backrest elevation of 30–45 degrees as an early prevention measure for VAP in the emergency department. |
| Systematic Review and Meta-analysis  (Alexiou, 2009)14 | Systematic review and meta-analysis:Study analyzed seven RCTs to evaluate the effect of body position of patients requiring mechanical ventilation. Study findings showed that patients in the semirecumbent position have a significantly lower rate of clinical diagnoses of VAP than patients positioned supinely. |
| Clinical Review  (Kollef, 2004)15 | Clinical review focused on clinical methods used for prevention of hospital-acquired pneumonia/VAP. With regard to HOB, the review recommends the implementation and use of semi-erect HOB positioning based on the findings of four randomized controlled trials. |
| Systematic Review  (Collard, 2003)16 | Systematic review focused on all interventions that are beneficial to the prevention of VAP. Regarding HOB elevation, review recommends the use of semirecumbent position based on findings of three RCTs. |

## Annotated Bibliography

1. Klompas M, Branson R, Eichenwald EC, et al. Strategies to prevent ventilator-associated pneumonia in acute care hospitals: 2014 update. Infect Control Hosp Epidemiol. 2014 Aug;35(8):915-36. PMID: 25026607.

2. Muscedere J, Dodek P, Keenan S, et al. Comprehensive evidence-based clinical practice guidelines for ventilator-associated pneumonia: Prevention. J Crit Care. 2008 Mar;23(1):126-37. PMID: 18359430.

3.American Thoracic Society, Infectious Diseases Society of America. Guidelines for the management of adults with hospital-acquired, ventilator-associated, and healthcare-associated pneumonia. Am J Respir Crit Care Med. 2005 Feb;171(4):388-416. PMID: 21481251.

4. Tablan OC, Anderson LJ, Besser R, et al. Guidelines for preventing healthcare-associated pneumonia, 2003: Recommendations of CDC and the healthcare infection control practices advisory committee. MMWR Recomm Rep. 2004 Mar;53:1-36. PMID: 15048056.

5. Rose L, Baldwin I, Crawford T, et al. Semirecumbent positioning in ventilator-dependent patients: A multicenter, observational study. Am J Crit Care. 2010 Nov;19(6):100-8. PMID: 21041187.

**CON:** Observational trial – Study focused on the angle of the head of bed in adult patients requiring mechanical ventilation in Australia and New Zealand intensive care units (ICUs). **Findings showed that actual backrest elevation was less than recommended and was predominantly influenced by clinical and patient condition, where more acute patients had a lower head of bed (HOB).** Authors felt that more study is warranted to determine if the perceived difference in ventilator-associated pneumonia rates is due to this phenomena.

6. van Nieuwenhoven CA, Vandenbroucke-Grauls C, van Tiel FH, et al. Feasibility and effects of the semirecumbent position to prevent ventilator-associated pneumonia: A randomized study. Crit Care Med. 2006 Feb;34(2):396-402. PMID: 16424720.

**CON:** Head of bed (HOB) at 45 degrees or supine – Assessment of the feasibility of the semirecumbent position for intensive care units. Study focused on 255 patients intubated within 24 hours of intensive care unit admission and required mechanical ventilation for more than 48 hours. 109 patients were assigned to the supine group and 112 to the semirecumbent group. An average elevation was 9.8 degrees and 16.1 degrees at day 1 and day 7, respectively, for the supine group and 28.1 degrees and 22.6 degrees at day 1 and day 7, respectively, for the semirecumbent group (p<0.001). The target semirecumbent position of 45 degrees was not achieved for 85 percent of the study time, and patients in the semirecumbent position more frequently changed position than did supine-positioned patients. Ventilator-associated pneumonia (VAP) was diagnosed in eight patients (6.5%) in the supine group and in 13 (10.7%) in the semirecumbent group (nonsupine, after a mean of 6 (range, 3–9) and 7 (range, 3–12) days, respectively. **Study findings show that target backrest elevation of 45 degrees for semirecumbent position was not reached and due to the achieved difference in treatment position did not prevent VAP.**

7. Resar R, Pronovost P, Haraden C, et al. Using a bundle approach to improve ventilator care processes and reduce ventilator-associated pneumonia. Jt Comm J Qual Patient Saf. 2005 May;31(5):243-8. PMID: 15960014.

**PRO:** Systematic review – This review did not specifically focus on HOB elevation, but reviewed use of the Institute for Healthcare Improvement ventilator bundle. Review focused on 21 teaching hospitals and 40 community hospitals that comprised 44 medical and 12 surgical ICUs. **Data from 35 units showed a decrease in VAP rates with increased adherence to ventilator bundle. One of four bundle items was head of bed elevation to 30–45 degrees.**

8. Drakulovic MB, Torres A, Bauer TT, et al. Supine body position as a risk factor for nosocomial pneumonia in mechanically ventilated patients: A randomised trial. Lancet. 1999 Nov;354(9193):1851-8. PMID: 10584721.

**PRO:** Supine vs. semirecumbent position–Study focused on 86 intubated and mechanically ventilated patients in the respiratory and medical ICUs. **The frequency of clinically suspected nosocomial pneumonia was lower in the semirecumbent group than in the supine group (3 of 39 [8%] vs. 16 of 47 [34%]; 95% confidence interval [CI] for difference 10.0–42.0, p=0.003). This was also true for microbiologically confirmed pneumonia (semirecumbent 2 of 39 [5%] vs. supine 11 of 47 [23%]; 4.2–31.8, p=0.018).** Supine body position (odds ratio [OR] 6.8 [1.7–26.7], p=0.006) and enteral nutrition (5.7 [1.5–22.8], p=0.013) were independent risk factors for nosocomial pneumonia, and the frequency was highest for patients receiving enteral nutrition in the supine body position (14/28, 50%). Mechanical ventilation for 7 days or more (10.9 [3.0–40.4], p=0.001) and a Glasgow coma scale score of less than 9 were additional risk factors. **The semirecumbent body position reduces frequency and risk of nosocomial pneumonia, especially in patients who receive enteral nutrition. The risk of nosocomial pneumonia is increased by long-duration mechanical ventilation and decreased consciousness.**

9. Orozco-Levi M, Torres A, Ferrer M, et al. Semirecumbent position protects from pulmonary aspiration but not completely from gastroesophageal reflux in mechanically ventilated patients. Am J Respir Crit Care Med. 1995 Oct;152(4 Pt 1):1387-90. PMID: 7551400.

**PRO:** Supine versus semirecumbent position – Study focused on 15 adult, critically ill patients requiring mechanical ventilation and nasogastric intubation. The main finding of this study is that gastroesophageal reflux (GER) is a frequent feature in patients placed with a nasogastric tube who need mechanical ventilation irrespective of body position. Radioactivity counting (RAc) was performed using a gamma counter with correction for decay. Irrespective of the body position, all patients showed at 3, 4, and 5 hours after the isotope instillation a significant increase in RAc of the oropharyngeal contents (p<0.05, each), indicating GER. Although RAc values in the pharynx were higher in supine from 1 through 4 hours (p<0.05), at the end of the study (5 hours) the values did not differ between each position. Likewise, the slopes of the regression lines of sequential oropharyngeal RAc values were not different between each position (0.39 ± 0.09 vs. 0.45 ± 0.11, respectively). **In contrast, RAc values in bronchial secretions were higher at 5 hours in the supine position compared with baseline (p<0.05) and to semirecumbency (p<0.01). In addition, GER does not seem to be completely prevented by semirecumbency. Therefore, semirecumbency protects mechanically ventilated patients from pulmonary aspiration, but not from GER.**

10. Kollef MH. Ventilator-associated pneumonia. A multivariate analysis. JAMA. 1993 Oct;270(16):1965-70. PMID: 15187525.

**PRO:** Multivariate analysis – Study focused on 227 patients requiring mechanical ventilation for more than 24 hours. VAP occurred in 43 patients (15.5%). Stepwise logistic regression analysis identified four **factors to be independently associated with VAP (p<0.05): an organ system failure index of 3 or greater (adjusted odds ratio [AOR]=10.2; 95% CI, 4.5 to 23; p<0.001); patient age of 60 years or older (AOR=5.1; 95% CI, 1.9 to 14.1 ; p=0.002); prior administration of antibiotics (AOR=3.1 ; 95% CI, 1.4 to 6.9; p=0.004); and supine head positioning during the first 24 hours of mechanical ventilation (AOR=2.9; 95% CI,1.3 to 6.8; p=0.013).** VAP occurred more often in cardiothoracic patients (21.6%) compared with medical patients (9.3%) (p=0.03). Patients with VAP also had a higher mortality (37.2%) than those without VAP (8.5%) (p<0.001). An organ system failure index of 3 or greater (AOR=16.1; 95% CI, 6.1 to 42; p<0.001), a premorbid lifestyle score of 2 or greater (AOR=3.1; 95% CI, 1.3 to 7.3; p=0.012), and supine head positioning during the first 24 hours of mechanical ventilation (AOR=3.1; 95% CI, 1.2 to 7.8; p=0.016) were independently associated with mortality. These data suggest potential interventions that might affect the incidence of VAP or outcome associated with VAP. Additionally, they indicate that different ICU populations may have different incidences of VAP.

11. Torres A, Serra-Batlles J, Ros E, et al. Pulmonary aspiration of gastric contents in patients receiving mechanical ventilation: The effect of body position. Ann Intern Med. 1992 Apr;116(7):540-3. PMID: 1543307.

**PRO:** Crossover trial – Study focused on 19 patients requiring mechanical ventilation and intubation in the respiratory ICU. The objective was to determine if the semirecumbent position decreases aspiration of gastric contents to the airways in intubated and mechanically ventilated patients. Findings showed mean radioactive counts in endobronchial secretions were higher in samples obtained while patients were in the supine position than in those obtained while patients were in the semirecumbent position (4,154 radiographic counts per minute [rcpm] compared with 954 rcpm; p=0.036). The aspiration pattern was time-dependent for each position: For the supine position, radioactivity was 298 rcpm at 30 min and 2,592 rcpm at 300 min (p=0.013); for the semirecumbent position, radioactivity was 103 rcpm at 30 min and 216 rcpm at 300 min (p=0.04). The same microorganisms were isolated from stomach, pharynx, and endobronchial samples in 32 percent of studies done while patients were semirecumbent and in 68 percent of studies done while patients were in the supine position. **Study findings concluded that the supine position and length of time the patient is kept in this position are potential risk factors for aspiration of gastric contents.**

12. Li Bassi G, Torres A. Ventilator-associated pneumonia: Role of positioning. Curr Opin Crit Care. 2011 Feb;17(1):57-63. PMID: 21169827.

**PRO:** Literature review – This review focused on analyzing nine RCTs and two animal laboratory studies to bring insight from laboratory and clinical investigation into ventilator-associated pneumonia pathogenesis and effect of body position. Study concluded that body position greatly affects several pathogenetic mechanisms of VAP. The current evidence recommends avoidance of supine horizontal position in order to prevent aspiration of colonized gastric contents. **The semirecumbent position has proven benefits and should be routinely used, but there is still limited evidence to recommend the lowest orientation of the bed at which the patient can be safely maintained.** Results from pioneering laboratory investigation call attention to new possible positions, or lateral Trendelenburg position, aimed to avoid pulmonary aspiration and to enhance mucus clearance in intubated patients.

13. Grap M, Munro C, Unoki T, et al. **Ventilator-associated pneumonia: The potential critical role of emergency medicine in prevention.**J Emer Med. 2012 Mar;42(3):353-62. PMID: 20692786.

**PRO:** Clinical review – This article summarized the epidemiology, pathophysiology, and specifically risk factors associated with VAP and provided evidence-based recommendations for its prevention. **Review recommended the use of continuous backrest elevation of 30–45 degrees as an early prevention measure in the emergency department.**

14. Alexiou VG, Ierodiakonou V, Dimopoulos G, et al. Impact of patient position on the incidence of ventilator-associated pneumonia: A meta-analysis of randomized controlled trials. J Crit Care. 2009 Dec;24(4):515-22. PMID: 19327314.

**PRO:** Meta-analysis – Study analyzed seven RCTs to evaluate the effect of body position on patients requiring mechanical ventilation. Data extracted from three RCTs studying the semirecumbent 45 degrees and four RCTs studying the prone position with a total of 337 and 1,018 patients, respectively. The odds of developing clinically diagnosed VAP was significantly lower among patients in the semirecumbent 45-degree position compared with patients in the supine position (odds ratio [OR] = 0.47; 95% confidence interval [CI], 0.27–0.82; 337 patients). **The comparison of the prone versus supine position group showed a moderate trend toward better outcomes regarding the incidence of clinically diagnosed VAP among patients in the prone position (OR = 0.80; 95% CI, 0.60–1.08; 1,018 patients). The subanalysis regarding the incidence of microbiologically documented VAP, the length of intensive care unit stay, and the duration of mechanical ventilation showed that patients in the semirecumbent 45-degree position have a moderate trend toward better clinical outcomes.** Patients positioned semirecumbently at 45 degrees have significantly lower incidence of clinically diagnosed VAP compared with patients positioned supinely.

15. Kollef MH. Prevention of hospital-associated pneumonia and ventilator-associated pneumonia. Crit Care Med. 2004 Jun;32(6):1396-1405. PMID: 8411554.

**PRO:** Multivariate analysis – Study focused on 227 patients requiring mechanical ventilation for >24 hours. VAP occurred in 43 patients (15.5%). Stepwise logistic regression analysis identified four **factors to be independently associated with VAP (p<0.05): an organ system failure index of 3 or greater (AOR=10.2; 95% CI, 4.5 to 23; p<0.001); patient age of 60 years or older (AOR=5.1 ; 95% CI, 1.9 to 14.1 ; p=0.002); prior administration of antibiotics (AOR=3.1 ; 95% CI, 1.4 to 6.9; p=0.004); and supine head positioning during the first 24 hours of mechanical ventilation (AOR=2.9; 95% CI,1.3 to 6.8; p=0.013).** VAP occurred more often in cardiothoracic patients (21.6%) compared with medical patients (9.3%) (p=0.03). Patients with VAP also had a higher mortality (37.2%) than those without VAP (8.5%) (p<0.001). An organ system failure index of 3 or greater (AOR=16.1; 95% CI, 6.1 to 42; p<0.001), a premorbid lifestyle score of 2 or greater (AOR=3.1; 95% CI, 1.3 to 7.3; p=0.012), and supine head positioning during the first 24 hours of mechanical ventilation (AOR=3.1 ; 95% CI, 1.2 to 7.8; p=0.016) were independently associated with mortality. These data suggest potential interventions that might affect the incidence of VAP or outcome associated with VAP. Additionally, they indicate that different intensive care unit populations may have different incidences of VAP.

16. Collard HR, Saint S, Matthay MA. Prevention of ventilator-associated pneumonia: An evidence-based systematic review. Ann Intern Med. 2003 Mar;138(6):494-501. PMID: 12639084.

**PRO:** Systematic review of methods for prevention of VAP – The preventive practices with the strongest supportive evidence were semirecumbent positioning, sucralfate instead of H2-antagonists for stress ulcer prophylaxis, and selective digestive tract decontamination. Aspiration of subglottic secretions and oscillating beds may be useful in select populations. There is no evidence to support specific methods of enteral feeding or increased frequency of ventilator circuitry changes. After evaluation of potential benefits and risks, the authors recommended considering several specific interventions to reduce the incidence of VAP: semirecumbent positioning in all eligible patients, sucralfate rather than H2-antagonists in patients at low to moderate risk for gastrointestinal tract bleeding, and aspiration of subglottic secretions and oscillating beds in select patient populations. Three studies that evaluated comparative risks associated with semirecumbent positioning were reviewed. The main outcome for two of these was GER and aspiration events (considered surrogate outcomes for VAP). The main outcome for the third study was clinically defined VAP. The review concluded that semirecumbent patient positioning is a low-cost, low-risk approach to preventing VAP, and all three trials suggested that it is effective (grade IIa). Semirecumbent patient positioning should be considered in all eligible patients. Of importance, only one trial has looked at the clinical outcome of ventilator associated pneumonia. These findings should be confirmed by additional randomized clinical trials.

AHRQ Pub. No. 16(17)-0018-16-EF

January 2017