HEAD OF BED ELEVATION IN THE ICU

SUMMARY
Nosocomial pneumonia is commonplace in the intensive care unit (ICU) and is associated with pulmonary aspiration of contaminated gastric secretions. Semirecumbent patient positioning (head of bed elevation) significantly decreases the incidence of both pulmonary aspiration as well as subsequent development of bacterial pneumonia and may be associated with reduced ICU mortality.

RECOMMENDATIONS

- **Level 1**
  - **The head of a patient's bed should be elevated to a minimum of 30 degrees or greater, as clinically tolerated, at all times to reduce aspiration of contaminated oropharyngeal secretions and subsequent development of ventilator-associated pneumonia (VAP).**
- **Level 2**
  - **The head of a patient's bed should be elevated to a minimum of 30 degrees or greater, as clinically tolerated, at all times to reduce patient mortality.**
  - **In patients with closed head injury, the head of a patient's bed should be elevated to 30 degrees at all times to reduce intracranial pressure (ICP) and maintain cerebral perfusion pressure (CPP).**
- **Level 3**
  - **None**

INTRODUCTION

Nosocomial pneumonia is a leading cause of morbidity and mortality from hospital-acquired infections with an associated crude mortality rate of approximately 30 percent (1). These infections also place a strain on ICU resources with an associated average increase in ICU stay of 4.3 days (2). Prevention of ventilator-associated pneumonia (VAP) is now recognized by the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) as one of its "core measures" for monitoring and improving patient care among the critically ill (3).

The pathogenesis of VAP is generally recognized to consist of two steps: 1) bacterial colonization of the stomach and oropharynx, and 2) subsequent pulmonary aspiration of contaminated secretions (1). Mechanically ventilated patients are prone to gastric bacterial colonization due to the widespread use of histamine-2 (H_2) receptor blockers and proton pump inhibitors for the prevention of gastrointestinal stress ulceration. Indwelling nasogastric and nasoenteric feeding tubes decrease the competance of the lower esopheageal sphincter, increasing the potential for aspiration. Strategies to reduce the incidence of VAP are typically aimed at reducing the colonization of the aerodigestive tract, decreasing the incidence of aspiration, or both.

EVIDENCE DEFINITIONS

- **Class I:** Prospective randomized controlled trial.
- **Class II:** Prospective clinical study or retrospective analysis of reliable data. Includes observational, cohort, prevalence, or case control studies.
- **Class III:** Retrospective study. Includes database or registry reviews, large series of case reports, expert opinion.
- **Technology assessment:** A technology study which does not lend itself to classification in the above-mentioned format. Devices are evaluated in terms of their accuracy, reliability, therapeutic potential, or cost effectiveness.

LEVEL OF RECOMMENDATION DEFINITIONS

- **Level 1:** Convincingly justifiable based on available scientific information alone. Usually based on Class I data or strong Class II evidence if randomized testing is inappropriate. Conversely, low quality or contradictory Class I data may be insufficient to support a Level I recommendation.
- **Level 2:** Reasonably justifiable based on available scientific evidence and strongly supported by expert opinion. Usually supported by Class II data or a preponderance of Class III evidence.
- **Level 3:** Supported by available data, but scientific evidence is lacking. Generally supported by Class III data. Useful for educational purposes and in guiding future clinical research.

This guideline will focus on one such strategy: semirecumbent positioning or "head of bed" elevation. Maintenance of the head at greater than 30-45 degrees has been suggested as a clinically useful method for reducing a patient's risk of VAP and ICU mortality. A full discussion of the strategies for VAP prevention is beyond the scope of this guideline and the reader is referred to reference 2 for such details. Head of bed elevation also reduces intracranial pressure (ICP) and optimizes cerebral perfusion pressure (CPP) in patients with closed head injury (4)

LITERATURE REVIEW

Torres et al. performed a prospective, randomized, two-period crossover trial in 19 mechanically ventilated medical ICU patients in which gastric secretions were radiolabelled with Technetium-99m sulphur colloid (5). Patients were randomly placed in either the supine or semirecumbent (45-degree angle) position and the presence of radioactivity in bronchial secretions was subsequently assessed. All patients had nasogastric tubes in place. Forty-eight hours later, the study was repeated in each patient using the alternate position. All patients demonstrated an increase in radioactivity count illustrating that pulmonary aspiration of gastric secretions occurs, regardless of patient position. The radioactivity recovered in the endobronchial samples of semirecumbent patients, however, was significantly lower than that of supine patients ($p=0.036$) confirming that head of bed elevation is significantly protective. The authors concluded that supine positioning promotes the development of VAP and that semirecumbent positioning of mechanically ventilated patients is a simple and effective means to minimizing aspiration of gastric contents (Class II).

Kollef carried out a prospective descriptive cohort study of 277 mechanically ventilated patients of whom 43 developed VAP while 234 did not (6). Univariate and multivariate analyses were subsequently performed to identify risk factors that were independently associated with VAP and mortality. Age, organ failure, prior antibiotic administration, and supine head positioning (30-degree angle) during the first 24 hours of mechanical ventilation were all independently associated with VAP in multivariate analysis. Supine position and organ failure were independently associated with patient mortality in multivariate analysis. VAP occurred in 34% of supine patients and 11% of semirecumbent patients ($p<0.001$). ICU mortality was 30% in supine patients and 8.9% in semirecumbent patients ($p<0.001$) (Class II).

Drakulovic, Torres, et al. subsequently performed a prospective, randomized trial of supine vs. semirecumbent (45-degree angle) positioning in the prevention of nosocomial pneumonia among 86 mechanically ventilated medical ICU patients (7). The study was terminated early during a planned interim analysis due to the finding of a statistically significant difference in pneumonia between patient groups. Microbiologically confirmed pneumonia occurred in 5% of semirecumbent patients and 23% in supine patients ($p=0.018$; 95% CI 4-33%). The risk reduction associated with semirecumbent positioning was 78%. In a multivariate analysis of risk factors associated with development of pneumonia, enteral nutrition (odds ratio 11.8) and supine body position (odds ratio 6.1) were identified as significant independent risk factors. The study showed a trend towards a reduction in mortality (18% in semirecumbent patients and 28% in supine patients ($p=0.289$)), but the trial was not powered to detect such a difference if present (Class I).

Durward et al. performed a prospective evaluation of the impact of supine vs. various semirecumbent positions (15, 30, and 60 degrees) on ICP, CPP, and CVP in patients with a Glasgow Coma Score of ≤ 8 and traumatic closed head injury or near-drowning (4). ICP was highest in all patients in the supine position and decreased significantly at 15 and 30 degrees of elevation while maintaining CPP and cardiac index. Elevation to 60 degrees caused a fall in CPP and cardiac index, an increase in CVP, and a variable response in ICP (Class II).

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