Ventilator-associated pneumonia and oral care: A successful quality improvement project

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Background: Ventilator-associated pneumonia (VAP) is a nosocomial pneumonia that develops in patients on mechanical ventilation for ≥48 hours. VAP develops at an estimated rate of 1% to 3% per day of mechanical ventilation.
Methods: Quality improvement project. Mechanically ventilated patients received the following oral care every 4 hours: the teeth were brushed with cetylpyridinium chloride (changed to 0.12% chlorhexidine gluconate in 2007) using a suction toothbrush, the oral cavity was cleansed with suction swabs treated with hydrogen peroxide, a mouth moisturizer was applied, deep oropharyngeal suctioning was performed, and suction catheters were used to control secretions. The primary efficacy variable was a diagnosis of VAP in patients mechanically ventilated for ≥48 hours.
Results: The historical average rate of VAP in 2004 was 12.6 cases/1000 ventilator-days. After the inception of the quality improvement project, VAP rates decreased to 4.12 (VAP cases/days of ventilation × 1000) for May to December 2005, to 3.57 for 2006, and to 1.3 for 2007.
Conclusion: The use of an oral care protocol intervention and ventilator bundle led to an 89.7% reduction in the VAP rate in mechanically ventilated patients from 2004 to 2007.
Key Words: Ventilator-associated pneumonia; VAP; oral care; ventilator bundle.

(Am J Infect Control 2009;37:590-7.)

Ventilator-associated pneumonia (VAP) is the most common nosocomial infection in patients who are critically ill,[1] occurring at an estimated rate of 1% to 3% per day of mechanical ventilation.[2] VAP is defined as a nosocomial pneumonia that develops in a patient who has been on mechanical ventilatory support (intubated) for ≥48 hours.[3] The hospital mortality of patients with VAP is significantly higher than that of patients without VAP.[2] In addition to VAP being associated with increased morbidity and mortality, VAP is associated with higher medical care costs.

Bacterial infection of the lower respiratory tract typically occurs when the upper respiratory tract is colonized with pathogens, which is followed by aspiration of the oropharyngeal secretions.[4] Patients in the intensive care unit (ICU) are at particular risk of oropharyngeal colonization with pathogens because of exposure to pathogens endemic to the ICU environment, exposure to multiantibiotic regimens, impaired mucosal defenses (desiccation, decreased salivary secretion, and immunoglobulin A content), accumulation of secretions as a result of intubation, and the unique environment that the endotracheal tube creates for dispersing pathogenic bacteria.[4]

An organized approach to VAP prevention can reduce the rate of VAP. A ''ventilator bundle'' is a group of interventions for the intubated patient found to be effective in reducing the rate of VAP.[5-7] The interventions are recommended by the Institute for Healthcare Improvement (IHI) and include elevating the head of the bed, daily ''sedation vacations,'' daily assessment of readiness for extubation, and prophylaxis for peptic ulcer disease and deep venous thrombosis.[8] The ventilator bundle may be further enhanced by oral care, which may play a role in reducing the incidence of VAP.[4]

PROBLEM

At Mercy Medical Center in Springfield, MA, VAP rates have been calculated and recorded since January 1997 (8 years prior to the quality improvement intervention) and were not shown to meet the National Nosocomial Infections Surveillance System standard. The Center's annual average VAP rates (VAP cases/days of ventilation × 1000) ranged from a high of 19.19 in 1999 to a low of 10.01 in 2002. A performance improvement project was

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Conflicts of interest: None to report.
0196-6553/$36.00

doi:10.1016/j.ajic.2008.12.007

developed to address this negative clinical outcome and determine the effectiveness of combining an oral care protocol with a ventilator bundle to prevent VAP in intubated/mechanically ventilated patients in the ICU.

DESCRIPTION OF QUALITY IMPROVEMENT INTERVENTION

This quality improvement program was performed from May 2005 to December 2007 at Mercy Medical Center, a 182-bed, private, nonprofit, acute care hospital in Springfield, MA. This facility has a 12-bed ICU and a 9-bed coronary care unit. No such standardized protocol had been followed prior to institution of the VAP prevention protocol. The hospital ICU practice guidelines stated that patients were to receive ''oral care'' every 4 hours and as needed, but no further instructions were specified.

The project was not designed as a controlled study but rather as a quality improvement initiative; therefore, there was no control group or randomization. The hospital ICU practice guidelines were revised to incorporate instructions on the ventilator bundle and oral care. Education in the use of the ventilator bundle and oral care product and protocol was provided to nurses (registered nurses), respiratory therapists, and intensivists with an in-service given by an oral care product representative. Re-education was conducted a year later when an increase in VAP rates was noted, and additional training in appropriate utilization of the ventilator bundle was provided to nurses and physicians.

All mechanically ventilated patients admitted to the ICU between May 2005 and December 2007 were incorporated into the quality improvement program population unless they had a contraindication to the ventilator bundle or oral care intervention, such as massive oral trauma or prescriber orders that conflicted with implementation of the bundle and/or oral care every 4 hours.

Care consistent with the IHI-recommended ventilator bundle was provided to each patient.[8] This included daily breaks from sedation, daily assessment of readiness to extubate, prophylaxis for peptic ulcer disease and deep venous thrombosis, and elevation of the head of the bed. The head of the bed was kept elevated at $\geq$30 degrees (unless medically contraindicated), and the angle was monitored and verified with an angle marker on the bed. The compliance with the bundle elements was recorded.

In addition to the above ventilator bundle, patients received, at minimum, oral care every 4 hours and as needed. The instructions for oral care were as follows:

- Replace suction liner, tubing, and covered oral suction device every 24 hours.
- Brush teeth using suction toothbrush with cetylpyridinium chloride (CPC) (Antiplaque Solution; Sage Products, Cary, IL) twice a day on even hours and as needed (recommended at 08:00 and 20:00). Brush for approximately 1 to 2 minutes while applying suction at completion and as needed during the brushing. Gently brush the surface of the tongue. The initial oral care system with a product containing CPC was used every 12 hours; in January of 2007, CPC was substituted for a 0.12% chlorhexidine gluconate (CHG)-containing product (CHG Oral Rinse; Sage Products).
- Use suction swabs with a hydrogen peroxide (Perox-A-Mint; Sage Products) solution every 4 hours on even hours (12, 4, 8, . . ., with the exception of the twice-a-day brushing times) to clean the teeth and tongue.
- Use moisturizing swabs every 4 hours after completion of oral care. Apply mouth moisturizer to mucous membranes, buccal cavity, and lips.
- Perform deep oropharyngeal suctioning using a disposable oropharyngeal suction catheter every 12 hours to assist in removing oropharyngeal secretions that have pooled in the hypopharynx (with teeth brushing, recommended at 08:00 and 20:00).
- Use suction catheters to assist in controlling secretions prior to major position changes, extubation, cuff deflation, and repositioning of tube and as needed.

Family were also educated and informed about the ventilator bundle and oral care regimen and the goal of reducing ventilator-associated complications and VAP. If the patient self-extubated, the Critical Care Policy was followed. This policy states that, if ventilatory support is needed, noninvasive ventilation should be attempted before reintubation, and reintubation should be done only if it is necessary. All interventions, abnormal assessment findings, additional actions, patient and/or family teaching, and responses were documented by the staff. The time line for institution of the improvement initiatives is shown in Fig 1.

The hospital ICU protocol for ventilator setups underwent two changes unrelated to the quality improvement program during the course of the project. On October 1, 2005, the frequency of changes of ventilator in-line suction setups went from daily changes to changes as needed. In December 2006, a change was made to use heated wire circuits versus non-heated circuits.

KEY MEASURES FOR IMPROVEMENT

The primary outcome measure for improvement was the occurrence of VAP in patients who had been