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Preventive Strategies for Nosocomial Pulmonary Infections in Mechanically Ventilated Patients

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The appropriate use of prevention strategies for ventilator-associated pneumonia can reduce morbidity and mortality and costs associated with this nosocomial infection.

Ventilator-associated pneumonia (VAP) is the specific type of nosocomial pneumonia (NP) that occurs after the first 48 hours of initiating mechanical ventilation (American Thoracic Society 1996). NP still remains a leading cause of death from hospital-acquired infections. Crude mortality rates range from 24% to 76% depending on the population and clinical setting studied (Fagon et al. 1989; Kollef 1993; Torres et al. 1990).

A variety of measures has been suggested for prevention of NP depending on the setting and the individual risk profile; non-antibiotic strategies are the main topic of this review (see table 1). These strategies have recently been reviewed by European, Canadian and American organizations and are outlined below (Dodek et al. 2004; Tablan et al. 2004; Torres & Carlet 2001).

Conventional Infection Control Measures

Hand Washing, Protective Gowns and Gloves -

Cross-contamination via the inoculation of bacteria into upper and lower airways is an exogenous mechanism in the aetiopathogenesis of NP especially in the ICU. Hand washing is an important yet underused measure to prevent nosocomial infections. As with hand washing, the use of protective gowns and gloves during patient contact has also been found to reduce the rate of acquired nosocomial infections (Pittet, Dharan, & Perneger 1998), but their use appears to be most effective when directed at specific antibioticresistant pathogens.

Chlorhexidine Oral Rinse -

Bacteria accumulated in dental plaque have been implicated as pathogens of VAP when aspirated to lower airways. Chlorhexidine is an antiseptic solution for the control of dental plaque that seems therefore reasonable to use in selected highrisk patients, given the easy administration and the reasonable costs (Fourrier et al. 2005).

Strategies Related to Gastrointestinal Tract

Stress-Ulcer Prophylaxis -

When gastric pH increases, the stomach can become a reservoir of nosocomial pathogens with the potential to colonise the upper respiratory tract. Mechanically ventilated patients are at risk of stress ulcers with gastrointestinal haemorrhage for which preventive treatment with H2-blockers, antacids or sucralfate is routinely employed. However, H2-blockers raise the intragastric pH. Use of sucralfate instead of H 2-blockers provides less efficient anti-ulcer prophylaxis, so that the risks have to be balanced for cost-effective treatment.

Nutritional Support, Gastric Overdistension and Nasogastric Tubes -

Malnutrition has been shown to be a major contributing factor to the development of pneumonia by impairing host defence. Providing adequate nutritional support to intensive care patients is therefore important for the prevention of NP. As a general recommendation, early enteral nutrition

should be provided to patients in intensive care, initially supplemented by parenteral nutrition when enteral nutrition can only be tolerated in low volumes.

However, it has been suggested that placement of a nasogastric tube in the stomach may facilitate the reflux of bacteria from the gut, introducing a risk factor for VAP. Gastric overdistension may facilitate the reflux of bacteria from the gut and should be avoided by reduction in the use of narcotics and anticholinergic agents, monitoring gastric residual volumes after intragastric feeding, use of gastric prokinetic agents (e.g. metoclopramide), and if necessary, supplying enteral feeding via nasojejunal intubation.

Strategies Related to Patient Placement

Semirecumbent Body Position of Patients –

In supine position aspiration of upper-airway secretions is common even in healthy adults. It has been documented in a randomised clinical trial that a persistent semirecumbent body position reduced the incidence of NP in intubated and mechanically ventilated patients, but without a significant decrease in morbidity or mortality (Drakulovic et al. 1999). If there is no contraindication to the manoeuvre, for patients receiving mechanical ventilation with an enteral tube in place, the head of the bed should be elevated at an angle of 30-45 degrees.

Postural Changes by Rotating Beds -

Kinetic therapy through rotating beds, which change the patient's position, may also prevent VAP by enhancing pulmonary drainage. Automated position changing during the first five days in the ICU reduces the incidence of early NP, (but does not significantly reduce the number of days of mechanical ventilation, length of ICU stay or hospital stay, or in-hospital mortality). Rotating beds are much more expensive than standard ICU beds however, which limits the use of these systems.

Strategies Related to the Artificial Airway

Respiratory Airway Care -

Not only gross but also micro-aspiration of the lower airway can facilitate the development of NP despite the presence of an artificial airway. It is therefore important to maintain an adequate tube cuff pressure to reduce micro-aspiration. Two types of suction-catheter systems are available: the open, single-use system and the closed, multiple use system; the risk of VAP appears to be similar with both systems.

Prolonged nasal intubation (> 48 hours) should be avoided because nosocomial sinusitis may predispose the patient to pneumonia through the aspiration of infected secretions from the nasal sinuses (Rouby et al. 1994). In cases where nasal intubation cannot be avoided (e.g. maxillar surgery), early tracheostomy may still be a cost-effective measure to prevent NP.

Design of Endotracheal Tubes -

Stagnant oropharyngeal secretions pooled above the cuff can easily gain access to lower airways when the pressure of the cuff decreases spontaneously, or if there is a temporary deflation of the cuff which provides a direct route for tracheal colonisation and bolus aspiration from the oropharynx. Endotracheal tubes with an extra lumen designed to continuously suction secretions pooled above endotracheal tube cuffs are available and have been found to decrease the incidence of early VAP (Valles et al. 1995).

Strategies Related to Mechanical Ventilation

Maintainance of Ventilator Equipment. Heart and Moisture Exchangers -

Although transmission of bacteria via the respiratory equipment was identified as a cause of pulmonary infections more than 15 years ago, current systems are rarely a major source of bacteria. The frequency of ventilator circuit change has not been shown to be beneficial (Dreyfuss et al. 1991). Heat and moisture exchangers reduce the incidence of VAP by minimising the development of condensate within ventilator circuits (Kirton et al. 1997), are well tolerated by most patients and are easy to use.

Adjustment of Sedation -

Aspiration is an important aetiopathological factor of NP in patients with coma and an altered level of consciousness. Accordingly, sedative agents (and thereby level of sedation and the duration of sedation) in patients with mechanical ventilation should be adjusted for the individual patient. A strategy based on daily interruption of sedative-drug infusions until the patients were awake decreased the duration of mechanical ventilation and the length of stay in the intensive care unit (Kress et al. 2000). The use of excessive sedation could be reduced in this way.

Non-Invasive Mechanical Ventilation -

Several recent investigations have attempted to directly examine the influence of eliminating tracheal intubation on the incidence of NP. These

studies suggest that prevention strategies should include efforts to eliminate or at least reduce the frequency of tracheal intubation (Antonelli et al. 1998).

Conclusion

The appropriate use of these techniques can reduce the incidence of VAP in ICU patients. Simple and effective methods without extra cost, such as hand washing or placing the patients in semirecumbent position should be part of routine practice. The use of more invasive and expensive preventive measures should only be used in patients who are at high risk of NP. The results of ongoing research may strengthen our preventive capabilities and help further limit the number of patients who currently develop VAP.

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