Nursing Interventions to reduce VAP

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Incidence of VAP

- 90% of NI are VAP (occur within 48 hours of intubation) (Kollef 2004)
- 45% of all infections in European ICUs
- Incidence of VAP among intubated & mechanically ventilated patients ranges from 10% to 65% (Cason et al. 2007)
Significance of VAP

- Mortality ranges from 20 to 41%, (depending on infecting organism, antecedent antimicrobial therapy, and underlying diseases)
- Leading cause of mortality from nosocomial infections in hospitals

CDC Guideline for Prevention of Healthcare Associated Pneumonias 2004
Heyland et al, Am J Respir Crit Care Med 1999; 159:1249
Bercault et al, Crit Care Med 2001; 29:2303

Significance of VAP

- Prolongs the length of ICU stay by 4.3 days
- Increases risk of death
- Increases ventilatory support
- Increases hospital LOS by 4 to 9 days
- Increases cost > $11,000 per episode
- Estimates of VAP cost / year for nation > $1.2 billion

Craven, Chest 2000;117:186-1878 ; Rello et al, Chest 2002;122:3115
Safdar et al, Critical Care Medicine 2005;33:2184-83
Etiology of VAP

- **Early VAP**
  - Early onset: Pneumonia develops within 96 hours (4 days) of patient’s admission to the ICU or intubation for mechanical ventilation
- **Late VAP**
  - Late onset: Pneumonia develops after 96 hours (4 days) of patient’s admission to the ICU or intubation for mechanical ventilation
- **Very early onset**: within 48 hours after intubation

 CDC Guidelines for preventing health-care-associated pneumonia, 2003

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Etiology of VAP

- **Early onset VAP**
  - *Streptococcus pneumoniae*, *Haemophilus influenzae*, and *Moraxella catarrhalis*
- **Late-onset VAP**
  - *Staphylococcus aureus*, *Acinetobacter baumannii*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, and *Enterobacter*

(Pruitt & Jacobs 2006)
Risk factors for VAP

**Host related**
- Underlying medical conditions
- Immunosuppression
- Chronic obstructive lung disease
- Adult respiratory distress syndrome
- Patients’ body position
- Level of consciousness
- Number of intubations
- Medications

**Device related**
- Endotracheal tube
- Ventilator circuit
- Nasogastric or orogastric tubes

**Personnel related**
- Improper hand washing
- Failure to change gloves between contacts with patients
- Not wearing personal protective equipment when antibiotic resistant bacteria have been identified

Susceptibility to VAP

- Intubation → Altered Host Defenses → Tracheal Colonization → Increased Nosocomial Pneumonia
Pathogenesis of VAP

- Where do the bacteria come from?
  - Tracheal colonization - via oropharyngeal colonization or GI colonization
  - Ventilator system
- Oropharyngeal colonization
  - A transition in the colonization of dental plaques in patients in the ICU

(Scannapieco et al., 1999)

HOW VAP BEGINS

- Bacteria laden secretions slip past the open glottis into the trachea and pool in the subglottic space above the endotracheal tube cuff.
- Secretions and pathogens are aspirated around the cuff into the lower respiratory tract.

“...There is substantial evidence to suggest that ventilator-associated pneumonia is more likely the result of what is aspirated around the cuff of the endotracheal tube than what is inhaled from the ventilator circuits.”
Routes of colonization/infection in mechanically ventilated patients

- How do they get into the lung?
  - Breakdown of normal host defenses
  - Two main routes
    - Through the tube
    - Around the tube - microaspiration around ETT cuff
Primary Route of Bacterial Entry into Lower Respiratory Tract

- Micro or macro aspiration of oropharyngeal pathogens
- Leakage of secretions containing bacteria around the ET cuff

GI colonization
- Increased gastric pH leads to bacterial overgrowth
- Reflux can then lead to colonization of oropharynx
- Use of antacids and H₂ blockers associated with GI colonization

(Safdarp et al, 2005)
VAP Etiology

- Most are bacterial pathogens, with gram negative bacilli common
- *Pseudomonas aeruginosa*
  - Proteus spp
  - Acinetobacter spp
- *Staphlococcus aureus*
- Early VAP associated with non-multi-antibiotic-resistant organisms
- Late VAP associated with antibiotic-resistant organism

Supine patients

- Studies using radioactive labeling of gastric contents showed that radioactive counts were higher in larynx of supine patients
- One of the studies showed the same organisms in stomach, pharynx and endobronchial samples (*Hess DR., 2005)*
- VAP rate are higher in supine compared to semi-recumbent patients (*Drakulovic et al., 1999*)
Condensate

- Condensate in ventilator tubing becomes rapidly contaminated with bacteria from patient’s oropharynx
- 33% of inspiratory circuits were colonized within 2 hours and 80% within 24 hours

Prevention of VAP
Strategies for the prevention of VAP

Micek, Micek, Micek, Micek, & Skrupky, 2010 Journal of Pharmacy Practice 23(1) 25-32

Semi-recumbent positioning

- Reduces episodes of aspiration
- Lower rates of VAP in patients in semi-recumbent position
- Recommended by CDC and ATS/IDSA guidelines
HOB Elevation

HOB at 30-45°

CDC Guideline for Prevention of Healthcare Associated Pneumonia 2004
ATS/IDSA Guidelines for VAP 2005

- Ibanez et al. *JPEN* 1992;16:419-422
- Davis et al. *Crit Care* 2001;5:81-87
HOB Elevation Leads to Significant Deduction in VAP

Dravulovic et al. Lancet 1999;354:1851-1858

Is HOB Elevation Done?

Despite effectiveness of HOB elevation, compliance is poor

- Grap et al. Am J Crit Care 1999;8:475-480
Ventilator management

Condensate management

- Heat-moisture exchanger
  - Theoretical advantage=prevents bacterial colonization of tubing
  - Studies= Mixed results
  - Disadvantage=increases dead space and resistance to breathing

- Heated wire to elevate temp of inspired air
  - Advantage=Decreases condensate formation
  - Disadvantage=Blockage of ET tube by dried secretions

*CDC Guidelines for preventing health-care-associated pneumonia, 2003*
Condensate management

- Nurse and provider education regarding management of tubes with patient position change or manipulation of bed to ensure that condensate in tubing does not flow towards patient

Heat and moisture exchange filter versus heated humidification system

- Heat and moisture exchange (HME)
  - decrease in nurses’ workload
  - reduced financial costs
- Heated humidification system (HHS)
  - had a lower incidence of VAP than those with heat and moisture exchange (HME) filter
Ventilator circuit management

Several studies showed that circuit changes could be used safely for greater than 48 hours

Kollef et al., 1999

Continuous aspiration of subglottic secretions (CASS)

Kollef et al. 2008
Subglottic Secretion Drainage

- Subglottal drainage of secretions appeared to be effective in preventing early-onset VAP
- Intermittent subglottal aspiration and continuous aspiration of subglottal secretions (CASS)
- Patients with CASS had significantly reduced incidence of VAP

Continuous Removal of Subglottic Secretions

Use an ET tube with continuous suction through a dorsal lumen above the cuff to prevent drainage accumulation

CDC Guideline for Prevention of Healthcare Associated Pneumonias 2004
ATS / IDSA Guidelines for VAP 2005
Continuous Removal of Subglottic Secretions

- Smulders et al. *Chest* 2002;121:858-862
VAP reduction with subglottic suction

Smulders et al. Chest;121:858-862

Open suction system versus closed suction system

- Choices of suction system based on
  - handling
  - cost
  - individual patient's disease
  - until more data were available
Instillation of saline prior to suctioning

- Saline instillation prior to suctioning had an adverse effect on oxygen saturations.
- Routine installation of saline prior to suctioning helped to prevent VAP.
- Saline might decrease the risk of VAP by stimulating a cough and thinning secretions.
- Saline might increase bacterial dislodgement and lead to its migrating into the lower airways.

Intermittent suction of oral secretions before each positional change

- Significantly
  - reduce VAP occurrence and incidence
  - decrease the duration of mechanical ventilation and the length of ICU stay.
Frequency of equipment changes

- No Routine Changes
- Ventilator Tubing
- Ambu Bags
- Inner Cannulas of Trachs
- Not Enough Data

CDC Guideline for Prevention of Healthcare Associated Pneumonias 2004

Oral decontamination

- Use of chlorhexidine in intubated patients
  - Relative risk reduction of 30%
  - Effect most substantial for cardiac surgery patients
  - Likely delays rather than prevents VAP
Oral decontamination

- Antibiotics and antiseptics
  - Antibiotics were not found to be beneficial
  - Antiseptics were found to be beneficial in 6 out of 7 studies
    - Chlorhexidine studied in 6, five of which showed benefit
  - Mortality, ICU stay and duration of mechanical ventilation were not statistically significant

  Chan et al., 2003

Oral Care

- Dental plaque may be involved as a reservoir
- Surveys indicate most nurses use foam swabs rather than toothbrushes in intubated patients

CDC Guideline for Prevention of Healthcare Associated Pneumonias 2004
Oral Antiseptic Rinse

Oral hygiene in ICU
- tooth brushing
- mouth rinsing
- oral suctioning
- storage, rinsing and replacement of suction devices

Impact of oral care on VAP rates

Oral care kits out of stock
Aggressive oral care instituted
Oral kits restocked
Impact of oral care on VAP rates by year

SDD - selective decontamination of the digestive tract

- Multiple studies showing effectiveness
- NEJM January 2009
  - Study of 13 intensive care units in Netherlands showed statistically significant reduction of mortality of 3.5% in patients receiving SDD
  - Same study showed that patients receiving SOD (selective oropharyngeal decontamination) had decrease of 2.9%
Stress Ulcer Prophylaxis

- Sucralfate vs. PPI
  - In recent studies there was no VAP benefit in those receiving sucralfate and these patients also had higher incidence of GI bleed

_CDC Guidelines for preventing health-care-associated pneumonia, 2003._

Silver-lined ET tube

- Broad-spectrum antimicrobial activity in vitro
- Reduces bacterial adhesion to devices in vitro
- Blocks biofilm formation on the device in animal models
- Dog model- decreased severity of lung colonization
Silver-coated ETT

- Silver has the following advantages:
  - Non-toxic
  - Broad-spectrum antimicrobial activity in vitro \( (Petering, 1976) \)
  - Reduces bacterial adhesion to the device in vitro \( (Ahearn \ et \ al., \ 2000) \)
  - Block biofilm formation \( (Berra \ et \ al., \ 2004) \)

Inhaled prophylactic antibiotics

- Current controversial and more studies needed
- Major concern is development of antibiotic resistance
- No mortality benefit
Sedation protocol implementation

- Control phase without nurse-implemented sedation protocol followed by study phase with nurse-implemented sedation protocol
- Study phase had significantly shorter duration of MV (4.2 days) and lower incidence of VAP (6% vs. 15%)

Quenot et al., 2007

Other measures

- Early weaning
- Early Extubation
- Avoid Unplanned Extubation
What role does handwashing play in nosocomial pneumonia?

Wash hands or use an alcohol-based waterless antiseptic agent
- before and after suctioning
- touching ventilator equipment
- coming into contact with respiratory secretions

CDC Guideline for Prevention of Healthcare Associated Pneumonias 2004
AACN Practice Alert for VAP, 2007
Hand Hygiene

- Washing with soap and water
- Use of alcohol-based antiseptic agent (hand rub)

Equipment aimed at preventing VAP (undergoing trials)

- Silver-coated endotracheal tubes
- Low-volume, low-pressure cuff
- Constant pressure inflation device
- LoTrachTM
Evidence-Based
Clinical Practice Guideline
for the Prevention of VAP

The guidelines committee of the Canadian Critical Care,
Society and Canadian Critical Care Trials Group

Dodek et al., 2004

Summary of recommendations
for VAP prevention

- Physical strategies
  - Route of endotracheal intubation
    - the orotracheal route of intubation should be used when intubation is necessary
  - Systematic search for maxillary sinusitis
    - no recommendation
  - Frequency of ventilator circuit changes
    - new circuits for each patient
    - changes if the circuits become soiled or damaged, but no scheduled ventilator circuit changes
  - Type of airway humidification
    - no recommendation
  - Frequency of change of airway humidification
    - changes of heat and moisture exchangers with each patient, every 5-7 days and as clinically indicated
Summary of recommendations for VAP prevention

- **Type of endotracheal suctioning system (open vs closed)**
  - recommend the use of closed endotracheal suctioning system

- **Frequency of change of endotracheal suctioning system**
  - recommend closed endotracheal suctioning system be changed for each patient and as clinically indicated.

- **Subglottic secretion drainage**
  - recommend the use of subglottic secretion drainage in patients expected to be mechanically ventilated for N 72 hrs

- **Timing of tracheostomy**
  - no recommendation

- **Bacterial filters**
  - not recommend

Summary of recommendations for VAP prevention

- **Positional strategies**
  - The use of rotating beds should be considered
  - Semirecumbent positioning
    - The head of the bed be elevated to 45°
    - Where this is not possible, attempts to raise the head of the bed as much as possible should be considered
  - Prone positioning
    - No recommendation
Summary of recommendations for VAP prevention

- Pharmacological strategies
  - Prophylactic antibiotics: aerosolized antibiotics
    - no recommendation
  - Prophylactic antibiotics: nasal antibiotics
    - no recommendation.
  - Prophylactic antibiotics: intravenous antibiotics alone
    - no recommendation.
  - Prophylactic antibiotics: topical/topical plus intravenous antibiotics
    - no recommendation.

- Oral antiseptic: chlorhexidine
  - The use of the oral antiseptic chlorhexidine should be considered.

- Oral antiseptic: povidone-iodine
  - The use of the oral antiseptic povidone-iodine should be considered in patients with severe head injury

- Oral antiseptic
  - not recommend

- Prevention of maxillary sinusitis
  - no recommendation
VAP Bundle

- A “group of evidence-based practices that, when implemented together, should result in dramatic reductions in the incidence of ventilator associated pneumonia

  Berenholtz et al. (2002)

Ventilator bundle

- is the basis for focused team care
- enhancing the use of protocols and guidelines to bring about optimal patient outcomes

  (Evans, 2005)
VAP Bundled Interventions

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HOBED = Head of Bed Elevation; DVTTP = Deep Vein Thrombosis Prophylaxis; S-VAC + ETT-WC = Sedation vacation and Ventilator Weaning Trial; ULCER-P = Ulcer Prophylaxis; TUBING-ETT = Daily Endotracheal Tube Change.

VAP Care Bundle

- Sedation to be reviewed and, if appropriate, stopped each day
- All patients will be assessed for weaning and extubation each day
- Avoid the supine position, aiming to have the patient at least 30° head up
- Use chlorhexidine as part of daily mouth care
- Use subglottic secretion drainage in patients likely to be ventilated for more than 48 hours
Implementing Bundles into Practice

- Using a conceptual framework
- PDCA methodology
- The multidisciplinary team works together
- Knowledge translation requires behavior change

Outcome measures

- The clinical outcomes
  - VAP rate, frequency
  - Number of ventilator days
  - ICU length of stay (LOS)
  - Mortality rate
  - Hospital cost
- The process outcomes
  - Compliance rate
  - ICU throughput
Decreasing Ventilator-Associated Pneumonia in a Trauma ICU by Ventilator Bundle

(Cocanour et al., 2006)

Thank You & Good Luck