Ventilator Associated Pneumonia

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Pathogenesis of Healthcare-Acquired Pneumonia Including VAP
Major Areas of Oropharyngeal Colonization

- Lips & gums
- Teeth
- Tissues
- Tongue
- Secretions
Genetic Study 1: Colonization of Dental Plaque

- Study of 49 critical care vented pts
- Quantitative cultures of dental plaque and protected BAL performed on pts who developed VAP
- Of 13 isolates recovered from PBAL fluid, nine respiratory pathogens matched genetically those recovered from the corresponding DPs of eight patients.

Study of 100 critical care vented pts
Quantitative cultures of dental plaque and protected BAL performed on pts who developed VAP

Findings: Bacterial isolates recovered from plaque were indistinguishable from isolates recovered from BAL fluid.

Pathogenesis of VAP

Prevention of VAP:
Modulation of Colonization –
Oral Care
Professional organizations are now recognizing comprehensive oral care as key to addressing VAP and HAP.

**APIC 2009 Guide to the Elimination of Ventilator-Associated Pneumonia**

**Key prevention strategies:**
- Perform routine antiseptic mouth care

Example mouth care and documentation form includes the following:
- Perform routine antiseptic mouth care
- Brush teeth q12
- Provide oral care every 2 to 4 hours with antiseptic
- Apply mouth moisturizer to oral mucosa and lips
- Suction orally as necessary

**AACN Procedure Manual for Critical Care – Oral Care Interventions; 2005, 2010**

- Assess oral cavity and lips every 8 hours, and perform oral care every 2 to 4 hours and as needed.
- With oral care, assess for buildup of plaque on teeth or potential infection related to oral abscess.
- Perform oral hygiene, using pediatric or adult (soft) toothbrush, at least twice a day. Gently brush patient’s teeth to clean and remove plaque from teeth.
- Use toothpaste or cleansing solution that assists in the breakdown of debris.
- Cleansing solution should contain additives that assist in the breakdown of mucus in the mouth. Sodium bicarbonate assists in the removal of debris accumulation on oral tissue and teeth.
- In addition to brushing twice daily, use oral swabs with a 1.5% hydrogen peroxide solution to clean mouth every 2 to 4 hours.
- Antiseptic oral rinses (chlorhexidine, cetylpyridinium chloride [CPC], added after brushing or done in conjunction with comprehensive oral care did achieve elimination of VAP.
- With each cleansing, apply a mouth moisturizer to the oral mucosa and lips to keep tissue moist.
- Suction oral cavity/pharynx frequently.

**CDC Guidelines for preventing Healthcare-Associated Pneumonia**

“… Develop and implement a comprehensive oral-hygiene program (that might include use of an antiseptic agent) for patients in acute-care settings or residents in long-term care facilities who are at risk for health-care associated pneumonia (II)”

**IHI Guidelines Recommendations**

Doctors and nurses can help prevent VAP by using a bundle of 5 “care steps.” The bundle of care steps are as follows:

- Elevation of the Head of the Bed
- Daily “Sedation Vacations” and Assessment of Readiness to Extubate
- Peptic Ulcer Disease Prophylaxis
- Deep Venous Thrombosis Prophylaxis
- Daily Oral Care with Chlorhexidine

**IHI Guidelines**

Updated IHI Bundle

1. Elevation of the head of the bed (HOB) to between 30 and 45 degrees
2. Daily “sedative interruption” and daily assessment of readiness to extubate
3. Peptic ulcer disease (PUD) prophylaxis
4. Deep venous thrombosis (DVT) prophylaxis (unless contraindicated)

In the spring of 2010, IHI faculty determined that there is support in the evidence for the addition of a fifth element in this work:

5. Daily oral care with chlorhexidine
Updated IHI Bundle

• “Develop a comprehensive oral care process that includes the use of 0.12% chlorhexidine oral rinse.”
- Q12 Brushing with pediatric brush
- Q2 to Q4 hour swabbing with half strength peroxide
- Use of muco solvents like sodium bicarbonate
- Moisturize the oral cavity
“Antiseptic oral rinses (chlorhexidine, cetylpyridinium chloride [CPC], added after brushing or done in conjunction with comprehensive oral care did achieve elimination of VAP”
“Oropharyngeal colonization as well as colonization of dental plaque have been identified as risk factors for VAP as there is high concordance between the bacteria isolated from the oropharyngeal cavity or the dental plaque and those recovered from tracheal aspirates.[59, 60] “
Oral Care

<table>
<thead>
<tr>
<th>SHEA, 2008</th>
<th>CDC, 2004</th>
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</thead>
<tbody>
<tr>
<td>Oral Care</td>
<td>“Develop and implement a comprehensive oral-hygiene program (that might include the use of an antiseptic agent) for patients in acute-care settings or residents in long-term care facilities who are at high risk of developing health-care-associated pneumonia” (II)</td>
</tr>
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Oral Care:

Linking Oral/Dental Colonization and Respiratory Infection
“Strategies to prevent VAP are likely to be successful only if based upon a sound understanding of pathogenesis and epidemiology. The major route for acquiring endemic VAP is oropharyngeal colonization by endogenous flora or by pathogens acquired exogenously from the intensive care unit environment, especially the hands or apparel of health-care workers, contaminated equipment, hospital water, or air. The stomach represents a potential site of secondary colonization and reservoir of nosocomial gram-negative bacilli.”

Resource 1: Linking Oral and Dental Colonization with Respiratory Infection

- A review of the published evidence linking oropharyngeal colonization and respiratory infection, including VAP (20 studies)
- Provides suggested oral and dental interventions, some beyond the scope of current guidelines

<table>
<thead>
<tr>
<th><strong>Suggested Intervention</strong></th>
<th><strong>Reasoning</strong></th>
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</thead>
<tbody>
<tr>
<td>Conduct a daily assessment of the lips, oral tissue, tongue, teeth, and saliva of each patient on a mechanical ventilator</td>
<td>Assessment allows for initial identification of oral hygiene problems and for continued observation of oral health</td>
</tr>
<tr>
<td>Use separate connection tubing for oral and tracheal suction</td>
<td>Opening a “closed” system may allow for the dissemination of respiratory pathogens into the environment surrounding the patient</td>
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<tr>
<td>Use a toothbrush as opposed to foam swabs or gauze to remove dental plaque</td>
<td>Dental plaque has been identified as a source of pathogenic bacteria associated with respiratory infection</td>
</tr>
<tr>
<td>Protocols should be implemented that assist patients at risk in maintaining adequate salivary production and tissue health</td>
<td>Saliva provides both mechanical and immunological effects which act to remove pathogens colonizing the oropharynx</td>
</tr>
<tr>
<td>Care should be taken when using oral care solutions: Use an alcohol-free, antiseptic rinse to prevent bacterial colonization of the oropharyngeal tract</td>
<td>Mouthwashes with alcohol cause excessive drying of oral tissues. Hydrogen peroxide has been shown to assist in clearing debris buildup and provide antibacterial properties</td>
</tr>
<tr>
<td>Avoid using lemon-glycerin swabs for oral care</td>
<td>Lemon-glycerin compounds are acidic and cause drying of oral tissues</td>
</tr>
</tbody>
</table>
**Suggested Intervention** | **Reasoning**
---|---
Toothpaste should contain additives which assist in the breakdown of mucous in the mouth | Additives such as sodium bicarbonate have been shown to assist in removing debris accumulations on oral tissues and teeth

Use a water-soluble moisturizer to assist in the maintenance of healthy lips and gums | Dryness and cracking of oral tissues and lips provides regions for bacterial proliferation. A water-soluble moisturizer allows tissue absorption and added hydration.

Yankauer catheters should be covered between uses on a patient | Yankauers used on a patient and left uncovered on the bed or other surface pose the risk of contaminating the patient’s environment with pathogens from the oropharyngeal tract

Remove secretions that accumulate in the subglottic area (above the endotracheal tube cuff) routinely and prior to removal of the endotracheal tube | Secretions forming in the subglottic area are rapidly colonized with pathogenic bacteria; aspiration of this colonized secretion has been shown to cause ventilator-associated pneumonia

Check for adequate endotracheal tube cuff pressure at least once per day | Inadequate cuff pressure is associated with aspiration of bacteria-laden secretions located above the cuff

Check the positioning of the endotracheal tube at least once per day | Over time, endotracheal tubes may begin to move up the trachea, leading to a possible unplanned extubation and concurrent aspiration of contaminated subglottic secretions
Resource 2: Linking Oral and Dental Colonization with Respiratory Infection

- Review of 11 case-control and cohort studies and 9 RCTs; meta-analysis of five of these studies
- Authors found an association between periodontal disease and pneumonia and a potential association between periodontal disease and COPD.
- Also found that the incidence of pneumonia was reduced by an average of 40% through mechanical and/or topical chemical disinfection or antibiotics.

Resource 3: Linking Oral and Dental Colonization with Respiratory Infection

- Based on Evidence Scales as used by Canadian Task Force on Preventive Health
- Review of 5 studies examining association between pneumonia and oral health:
  - Conclusion: fair evidence (Grade B recommendation)
- Review of 10 studies examining association between oral health interventions and the occurrence of pneumonia:
  - Conclusion: good evidence (Grade A recommendation)
- Overall Conclusion:
  - “Oral hygiene and frequent professional oral health care are useful for reducing the occurrence of pneumonia among high-risk elderly adults living in nursing homes and especially in ICUs”

Oral Care:

Toothbrushing

- Review of 8 studies
- 3 RCTs, 1 case control, 3 observational
- Toothbrushing in all
- 5 of 8 showed VAP decrease
- Some design issues, definition issues
Powered Toothbrush

- RCT using powered toothbrush vs. sponge toothette to determine effect on colonization of dental plaque by VAP bacteria and dental plaque removal
- Both used 4X day, 2 min.
- Chlorhexidine used 4X day in both groups
- Result:
  - Highly statistically significant greater reduction in dental plaque when using powered toothbrush vs. toothette (*half a unit of dental plaque index*)
  - Highly statistically significant greater reduction in total bacterial counts when using powered toothbrush vs. toothette (*ten-fold difference in bacterial counts*)
- Conclusion: the physical removal of bacteria-laden dental plaque may play an important role in VAP risk reduction
- Note: toothbrushing alone without CHG may not be effective (Scannapieco, FA. Crit Care 2007;13:R117.)

Oral Care:

Antibiotic/Antiseptic Decontamination
Resource 1: Oral Decontamination

**Antibiotics**
- Bergmans 2001: 9/87 vs 38/139
- Kollef 2006: 52/362 vs 62/347
- Legner 1994: 1/33 vs 4/34
- Rijs 2005: 13/47 vs 13/49
- Subtotal (95% CI): 529 vs 569
  - Test for heterogeneity: $\chi^2=7.39$, df=3, $P=0.06$, $I^2=59.4\%$
  - Test for overall effect: $z=1.35$, $P=0.18$

**Antiseptics**
- De Riso 1999: 3/173 vs 9/189
- Fournier 2000: 5/30 vs 15/30
- Fournier 2005: 13/114 vs 12/114
- Koeman 2006: 13/127 vs 23/130
- MacNaughton 2004: 21/101 vs 21/93
- Segers 2005: 35/485 vs 67/469
- Seguin 2006: 3/36 vs 25/62
- Subtotal (95% CI): 1066 vs 1078
  - Test for heterogeneity: $\chi^2=11.55$, df=6, $P=0.07$, $I^2=48.2\%$
  - Test for overall effect: $z=3.08$, $P=0.002$

**Total (95% CI):** 1595 vs 1647
  - Test for heterogeneity: $\chi^2=7.07$, df=10, $P=0.02$, $I^2=52.5\%$
  - Test for overall effect: $z=3.31$, $P=0.0009$

- 4 trials, 3242 pts, application of antibiotics: not significant
- 7 trials, 2144 pts, **oral application of antiseptics significantly reduced VAP**

Resource 2A: Oral Decontamination

- Meta-analysis of 14 RCT trials, 2,481 pts, assessing the effect of oral care with CHG or PI on VAP
- Findings: **CHG was effective in reducing VAP, whereas PI was not**

Resource 2B: Oral Decontamination

Sub-analysis reviewed effectiveness of 2%, 0.2%, and 0.12% CHG

Findings: CHG was most effective at 2% strength in reducing VAP

Oral Care:

Comprehensive Oral Care Study
Reducing VAP Through Advanced Oral-Dental Care: A 48-Month Study

- **Objective:** Determine the effectiveness of comprehensive oral and dental care system and protocol on the rate of VAP
- **MICU patients >18 yrs. on mechanical ventilation >48 hrs.**
- **Standards of care during the entire 48-month study included 7d vent circuit replacement, 24-hour HME filter replacement, 24-hour closed suction catheter replacement, semirecumbent position unless contraindicated, administration of stress ulcer prophylaxis, and use of a weaning protocol.

Reducing VAP Through Advanced Oral-Dental Care: A 48-Month Study

- Method
  - 12 mth pre-intervention period
    - 779 pts
    - Standard oral care
  - 12 mth intervention period
    - 759 patients
    - Oropharyngeal suctioning above cuff Q6h
    - Oral tissue and gum cleansing Q4h
    - Toothbrushing Q12h with 0.05% cetypyridinium chloride
    - Education & Monitoring
Identification of Needs

- A uniform education program for nurses and respiratory therapists
- Standards for oral assessment
- Standards for oral care
- Standards for dental care
- Standardization of oral care solutions
- Keeping a closed system CLOSED
- Reduce environmental exposure
Education

- Started Nov/Dec 2002
- Medical physicians, anesthesiologists, nurses, respiratory therapists
- Review topics:
  - Morbidity, mortality, cost
  - MICU rates vs. national benchmarks
  - Hand hygiene
  - Intubation procedures
  - Review of protocols for vent circuits, closed suction devices, HME filters
  - Medication administration
  - Care of equipment
  - HOB protocol
  - Weaning protocols
  - **Proposed oral care tools and protocol**
Reducing VAP Through Advanced Oral-Dental Care: A 48-Month Study

- **Results**
  - 33% reduction in VAP
  - 12 per 1000 vent days prior to intervention
  - 8 per 1000 vent days during intervention
  - Confirmation period had 2 quarters of 0 VAPs
  - Duration of vent from 7.2 to 5.1
  - Length of stay from 8.7 to 6.4
Comprehensive Oral Care Tools
Tools & Protocol
Maintaining a Closed System
Covered Yankauer

Policy: Use as needed
Yankauer

- Proper storage
- Keep Yankauer covered when not in use
- Assists in decreasing the risk of environmental contamination
- Replace every day and PRN
Suction Catheter

Policy: Every 4 hrs. or as needed

*the device manufacturer does not market or approve of its use below the vocal cords
Toothbrush with Sodium Bicarbonate

Policy: 2 X per day
Suction Swab with Moisturizer

Policy: Every 6 hrs.
Feeling fuzzy???

Photographs courtesy of D. Ryan
# Patient Demographics & Baseline Measurements

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Pre-intervention Period (n = 859)</th>
<th>Intervention Period (n = 755)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age ± SD</td>
<td>61.3 ± 12.2</td>
<td>63.1 ± 9.8</td>
<td>0.42</td>
</tr>
<tr>
<td>Males/females, no.</td>
<td>523/336</td>
<td>483/272</td>
<td>0.64</td>
</tr>
<tr>
<td>APACHE II</td>
<td>26.8 ± 8.8</td>
<td>27.3 ± 7.9</td>
<td>0.89</td>
</tr>
<tr>
<td>Reason for ICU admission, no. (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acute respiratory failure</td>
<td>404 (47)</td>
<td>325 (43)</td>
<td>0.57</td>
</tr>
<tr>
<td>Cardiovascular disease</td>
<td>189 (22)</td>
<td>181 (24)</td>
<td>0.33</td>
</tr>
<tr>
<td>Gastrointestinal disease</td>
<td>95 (11)</td>
<td>90 (12)</td>
<td>0.66</td>
</tr>
<tr>
<td>Renal disease</td>
<td>60 (7)</td>
<td>53 (7)</td>
<td>0.41</td>
</tr>
<tr>
<td>Sepsis</td>
<td>51 (6)</td>
<td>45 (6)</td>
<td>0.55</td>
</tr>
<tr>
<td>Trauma</td>
<td>26 (3)</td>
<td>15 (2)</td>
<td>0.27</td>
</tr>
<tr>
<td>Neurological disease</td>
<td>17 (2)</td>
<td>23 (3)</td>
<td>0.45</td>
</tr>
<tr>
<td>Other</td>
<td>17 (2)</td>
<td>23 (3)</td>
<td>0.45</td>
</tr>
</tbody>
</table>
Protocol Compliance


Daily assessment
Deep suctioning q4h
Tooth brushing 2xd
Oral tissue cleansing q6h
Kits at bedside
2-line connector used
Compliance in the Outcomes

- September 2009 AJIC
  - 80% compliance leads to drop in VAPs
- November 2009 AJCC
  - 85% compliance leads to drop in VAPs, Length of Stay in ICU and Time on the vent.
VAP Rates, MICU, 2001-2005

VAP cases per 1000 vent days

Pre-intervention Period
Intervention Period
Confirmatory Period

Mean annual rate

1.2 Near Zero!
Study Summary

- The implementation of a multifaceted protocol that includes daily oral assessment combined with specific tools used to decrease bacterial contamination of the oropharyngeal cavity significantly reduces VAP.
- Infection avoidance can be sustained for considerable periods of time.
- Zero VAP rates did not occur until implementation of the new intervention.
- Significant effects on ICU LOS and duration of mechanical ventilation.
- Cost avoidance from oral-dental interventions can be considerable.
Oral Care Key Points

- Baseline the problem
- Assess the needs
- Educate and implement
- Measure and celebrate!