Preventing Ventilator Associated Pneumonia: A Six Year Experience

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Objectives

The participant will be able to

1. Describe the prevalence, economic and human costs associated with VAP;

2. Discuss best practices implemented during this project to prevent VAPs;

3. Discuss patient outcomes and factors affecting progress;

4. Discuss future work to prevent VAP
- A 533 bed, 5 facility regional teaching health system
- Level 1 Trauma Center
- 68 Adult ICU Beds - 7 Units
Epidemiology of VAP

- VAP represents >25% of all ICU-acquired infections
- VAP cases occur at a rate of >100,000 cases of annually in the US
- VAP accounts for more than one-half the antibiotic use in the ICU
- Attributable mortality of VAP can be as high as 50%

Zilberberg M et al. Clinical Infectious Diseases 2010;51(S1):131-135
VAP: TIME COURSE
Mean Daily Risk Of VAP

Number Days Intubated

PERCENTAGE

0 - 5 6 - 10 11 - 15 16 - 20 21 - 25 26 - 30

PERCENTAGE

0 1 2 3 4 5

Number Days Intubated

Weber, J. 2006 APIC
Pathophysiology

Early VAP
- **Timing**
  - Within 5 days
- **Bacteriology**
  - *S. pneumoniae*
  - *H. influenzae*
  - MSSA
  - Susceptible GNB
- **Prognosis**
  - Less severe, little impact on outcome

Late VAP
- **Timing**
  - Beyond 5 days
- **Bacteriology**
  - *P. aeruginosa*
  - Acinetobacter
  - MRSA
  - Other multiresistant orgs
- **Prognosis**
  - High attributable mortality and morbidity

## Economic Impact

<table>
<thead>
<tr>
<th></th>
<th>Non-Infected Ventilator Patients</th>
<th>Patients with VAP</th>
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</thead>
<tbody>
<tr>
<td><strong>ICU LOS</strong></td>
<td>4 days</td>
<td>26 days</td>
</tr>
<tr>
<td><strong>Hospital LOS</strong></td>
<td>13 days</td>
<td>38 days</td>
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<tr>
<td><strong>Hospital Costs</strong></td>
<td>$21,620</td>
<td>$70,568</td>
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<tr>
<td><strong>Adjusted Attributable Cost for VAP</strong></td>
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<td>$12,000</td>
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Pathogenesis of VAP

Organisms causing VAP arise from endogenous and exogenous sources
Risk Factors For VAP

- Duration of intubation
- Emergent intubation
- Re-intubation
- Insufficient oral hygiene
- Elevated gastric PH
- Prior antibiotic therapy
- Nasogastric tube management

- Enteral nutrition
- Supine position
- Transport out of the ICU
- Cross contamination of ventilatory equipment
- Nasal intubation
- Lack of healthcare professional training in VAP prevention

Kollef M. Crit Care Med 2004;32:1396
Pathogenesis of VAP

Bacterial colonization of aerodigestive tract → Aspiration of secretions → Altered host defenses

Prevention strategies focus on:
- ↓ Colonization
- ↓ Aspiration
- ↓ Duration of Ventilation

Adapted from AACN VAP Practice Alert Presentation 2005
Adapted from AACN VAP Practice Alert
What are we doing to reduce VAPs?

How are we doing?
Trauma ICU
VAP Event Data
Jul 04-Sep 06

Extracted from Project Impact Data
Surgical ICU
VAP Event Data
Jul 04-Jun 06

Extracted from Project Impact Data
# Historical VAP Data

<table>
<thead>
<tr>
<th>Unit</th>
<th>Erlanger 1999 Infection Rate/1000 vent days</th>
<th>NHSN Rate/1000 vent days Pooled Mean</th>
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<tbody>
<tr>
<td>TICU</td>
<td>15.0</td>
<td>15.2</td>
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<tr>
<td>NNICU</td>
<td>20.0</td>
<td>11.2</td>
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<tr>
<td>MICU</td>
<td>16.5</td>
<td>4.9</td>
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<tr>
<td>SICU</td>
<td>NA</td>
<td>9.3</td>
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CDC’s NHSN- National Healthcare Safety Network
VAP Prevention Strategy

- **Formed a multidisciplinary team-2005**
  - Intensivist/Pulmonologist
  - Infection Preventionists (IP)
  - Director Critical Nursing
  - Trauma Surgeon/Critical Care
  - Critical Care Nurses - Multiple
  - Critical Care Nurse Manager
  - Respiratory Director
  - Respiratory Educator

- **Monthly team meetings**
Search for Best Practices - 2005

- Reviewed the literature and practice guidelines
- Developed standards of practice elements endorsed by medical staff leadership
- Agreed on a surveillance plan
Surveillance for VAP

- Utilize NNIS/NHSN definitions for surveillance for VAP
- Utilize NNIS/NHSN system to enter and analyze data
- Collect compliance data on process indicator priorities and report by unit
Creative Resourcing - 2006

- Initial VAP surveillance done in TICU, SICU, & MICU by Project Impact Nurses with IP support.
- VAP triggers identified by Respiratory therapy to IP from Neuro-ICU, CCU, and Burns for review.
- Education on identifying VAPs done by IPs.
- VAP final reviews and process indicators done by IP.
- Attempted to set up radiology trigger for case identification.
Interventions for Prevention of VAP

1. Education for all staff who manage ventilated patients
2. Daily Sedation Vacation (IHI)
3. Daily assessment for weaning (IHI)
4. Standardize mouth care and teeth brushed daily
5. HOB $\uparrow$ 30 degrees or greater (IHI)
6. Endotracheal tubes with subglottic suction port for all patients (except day surgery)

CDC Recommendations for Prevention of HA Pneumonia, 2002
Kollef M NEJM 1999: Vol 340:627-634
Interventions for Prevention of VAP

7. Patients receive orotracheal intubation
8. Check NG residuals Q4 hours
9. Use non-invasive ventilation and avoid re-intubation where possible
10. Protocol for Peptic ulcer Disease (IHI)
11. Protocol for DVT prevention (IHI)

CDC Recommendations for Prevention of HA Pneumonia, 2002
Kollef M NEJM 1999: Vol 340:627-634
Prioritizing Interventions

- **Education – Top priority**
  - Developed VAP video with test
  - Curriculum covered all elements of best practices
  - Required for all staff caring for ventilated patients including residents
  - Policy development: sedation vacation, revision of RT weaning protocol, standard of care for NG management.
Prioritizing Interventions

- Implementing the IHI Bundle
  - \( \uparrow \) HOB \( \geq 30 \) degrees
  - Weaning protocol
  - Sedation vacation
  - Implementation of PUD & DVT protocols
Beyond the IHI Bundle

- Hi-low Evac endotracheal tube – 2006 (Upgraded to TaperGuard 2009)
  - Anesthesia
  - Lifeforce – Air support
  - Emergency Medicine

- Assessing NG residual Q4hrs

- Orotracheal intubation
Failure of Initial Surveillance Plan 2006

Reasons for failure:

- Impact nurses deferred to trauma physician’s designation of VAP (VAP rate of 20 - 40 per 1000 vent days in TICU)
- Respiratory care unable to sustain staffing for surveillance
- IP unable to sustain efforts due to staffing (2.5 IP FTEs)
- Radiology chest film reads inconsistent & reports never initiated
Patient Safety Leadership Provides Resources - 2007

- Dedicated IP nurse to collect VAP data
- Dedicated nurse to collect process data, send VAP triggers to IP, and coach staff
- Management engineer and data analyst from Process Improvement to support VAP project

*Sometimes timing is everything!*
New Team Support - 2007

- New CNO – Executive Sponsor
- New Intensivist/Pulmonologist & project physician champion
- Addition of Hospitalist to team
VAP PI Team Work

- Meetings every other month – Excellent attendance!
- Focus on process data and strategies to improve compliance
- Continuous review of literature
- Ongoing review of new technology
Initial Process Data Collection

Total bundle compliance = 17%

July 2007 Data
EVERYBODY NEEDS A VACATION SOMETIME...

Reduce the risk of ventilator associated pneumonia (VAP). Make sure your patient has their daily “Sedation Vacation.”
2008 Best Practices Improve and VAPs Decrease

Overall Compliance with Best Practices

- Percent Compliance

VAPs (Non POA) Per CDC Guidelines
- VAPs per 1,000 Vent Days
- CDC 50th Percentile: VAPs per 1,000 Vent Days
Time to Celebrate!!!!!!

Congratulations ICUs
For zapping VAP !!!!
60 days with no VAPS
Compliance with Process Indicators Oct 07 – Dec 10

Significant improvement over time for overall bundle compliance
## VAP Process Indicators

**Based on random surveillance of intubated ICU pts**

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<thead>
<tr>
<th></th>
<th>Current Period (March 2011)</th>
<th>YTD (Jul 10 - Mar 11)</th>
<th>% Target</th>
<th>Monthly Trend (Jul 09 - Mar 11)</th>
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### VAP Process Indicators

- **Patients with Pneumonia Present on Admission**
  - Current Period (March 2011): 17
  - YTD (Jul 10 - Mar 11): 197

- **HI-LO Tube Used During Intubation**
  - Current Period (March 2011): 6
  - YTD (Jul 10 - Mar 11): 57

- **NG Residuals Assessed and Documented**
  - Current Period (March 2011): 72
  - YTD (Jul 10 - Mar 11): 124
Keys to Improvement of Processes

- Supported by executive leaders and medical staff
- IHI influence
- Nursing, Respiratory Care, and physicians are all engaged and taking ownership of processes
- Processes are hardwired in critical care standards of practice; No physician order needed to implement bundle
- Dedication of staffing resources
Other Improvements and Considerations

- Critical care consult for all ventilated patients within 48 hours
- Hardwire communication process between nursing and RT for sedation vacation
- Increased inventory and use of non-invasive ventilation devices (BIPAP)
- Trial of 24 hour mouth care kits (100K)
- Rewarding staff for efforts
- Discussed early trachs to decrease VAP – not clearly supported by the literature but does improve patient comfort
Ventilator Length Of Stay
Jan 07 – Dec 10
All Units

Average LOS

$R^2 = 0.3658$
Analysis of overall rate shows no statistical improvement over time
VAP Trends by Unit
VAP Organism Summary
2008-2010

N=117

- 48% (56) had no organism identified
- VAPs with organisms identified
  - 32% MSSA/MRSA
  - 15% Pseudomonas Aeruginosa
  - 11% Haemophilis
  - 10% S. Pneumo

Data reported to NHSN
Improved processes not translating to decreased VAPS???

- Limitations in identifying VAPs even with the same IPs surveying the unit
- Inconsistent compliance with basic IP (e.g. hand hygiene, disinfection of devices between patients)
- Nursing turnover in ICUs
- Continued low compliance with mouth care
- Poor compliance with assessment of NG residuals
- Lag time to good compliance with subglottic suction ETT (TaperGuard™)
Limitations in Identifying VAP

- Surveillance definitions and clinical diagnosis is neither sensitive nor specific
- Many clinical conditions mimic VAP (e.g. ARDS)
Diagnosis of VAP

**Clinical**
- fever
- tachycardia
- leukocytes
- increased RR or FIO2
- purulent secretions

**Chest X ray**
- new infiltrates
- new consolidation

**Microbiological**
- BAL

NOTE: Identification of VAPs using surveillance definitions by Infection Control can differ from clinical diagnosis
BAL...Gold Standard for Diagnosing VAP?

- BAL culture quality can be affected by
  - Prior antibiotic therapy
  - Contamination with endotracheal and oropharyngeal colonizers
  - Missing the segment of lung with active disease/highest concentration of organisms
  - Lack of data related to the effects of multiple bronchoscopes on single patient
Distribution of BAL Specimens

Top Locations for BAL All Units for Erlanger Hospital - Baroness Campus [TN] 1/1/2010 to 12/31/2010

- TICU: 108
- MSIC: 42
- MICU: 40
- SICU: 32
- HFMI: 24
- CCCU: 23
- CSIC: 21
- NNIC: 20
- 4000: 20
- NAY7S: 19
- NAY3X: 18
- IMCU: 18
- CMAY7: 14
- NAY7N: 11
- NAY6S: 11

Patients
84 ICU patients with abnormal chest x-rays and purulent sputum

- Evaluated by 7 physicians
- True diagnosis established by histology or quantitative bronchoscopy cultures
- 32% found to have VAP
- Physicians disagreed on presence or absence of VAP in 35/84 (42%) of patients
  - The “best” doc missed 28% of true VAPs
  - The “worst” doc missed 50% of true VAPs
  - Both labeled ~20% of patients without VAP as having VAP

Fagon et al. Chest 1993; 103:547-53; slide courtesy of Michael Klompas, MD, MPH,FRCP
From presentation given by Shelly Magill, MD, PhD, DHQP, CDC
Agreement Among Infection Preventionists - Fair

- 50 Ventilated patients with respiratory deterioration reviewed by 3 IPs: 2 using conventional approach (C) & 1 using quantitative approach (Q)
  - C-IP – 11VAPs
  - C-IP – 20 VAPs
  - Q-IP – 15 VAPs

- 62% agreement among IPs

Klomas, AJIC 2010:38:237
# Review of data with Trauma Surgery

**Jan 09 - Feb 09**

- *Trauma called 24 VAPS*
- *Infection Prevention called 8 VAPS*

<table>
<thead>
<tr>
<th>VAPs- Called by both Trauma and Infection Prevention</th>
<th>No-per IP &amp; Radiologist read (yes-infiltrate per Trauma)</th>
<th>Disease process on admission to unit (48hr rule) or prior to intubation-includes transfers</th>
<th>No CXR changes-but yes per + BAL</th>
<th>Did not meet IC/CDC surveillance criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total – 8 33%</td>
<td>Total- 8 33%</td>
<td>Total- 5 21%</td>
<td>Total-1 4%</td>
<td>Total -2 8%</td>
</tr>
</tbody>
</table>
Implications for Ongoing VAP Surveillance at Erlanger

- Rates are dependent upon:
  - The observer
  - Diagnostic tools used
    - Methods for sampling lower respiratory tract will impact VAP rates
  - Frequency of mimicking conditions in the ICU
    - Prevalence of ARDS or pulmonary edema ↑ rates.
  - Compliance with basic infection prevention practices

Adapted from slide from presentation by Shelly Magill, MD, PhD, DHQP, CDC
CDC Assessment of the Future of VAP Surveillance

- Recognize current definitions won’t work in current environment
  - Too burdensome and case finding too variable

- Recognize inaccuracies in VAP diagnosis in NHSN and in clinical settings
  - Validity is going to be a problem no matter what

Adapted from slide from presentation by Shelly Magill, MD, PhD, DHQP, CDC
New VAP Definition from CDC

- Focus on a surveillance definition that is objective, streamlined, reliable, and potentially automated
  - Not a clinical definition but ideally has clinical credibility
- Draft of ventilator-associated lower respiratory infection (VALORI) being reviewed by experts
- Pilot in near future
Future Plans @ Erlanger to Decrease VAP/ Improve Patient Outcomes

- Implement chlorhexidine gluconate (CHG) mouth rinsing in TICU and NNICU
- Implement CHG bathing in selected ICUs
- Implement Pressure EZ cuff monitoring device for all ventilated patients
- Improve assessment of re-intubation events
- Increase IP Staffing
  - Work with frontline to improve basic IP practices
  - To cover new organizational and process improvement and reporting priorities
Future Considerations

- Partner with Trauma services to improve IP case finding
- Partner with Radiology to develop a trigger from radiologic procedures
- Partner with Respiratory Care and critical care physicians to improve routine practice for spontaneous breathing trials for all vent patients and use of non-invasive ventilation
- Continue to search literature for new evidence based practices to decrease vent LOS
Thanks!!!

Questions???