Clinical Practice Management Guideline for Ventilator-Associated Pneumonia: Diagnosis, Treatment & Prevention

Background
Ventilator-associated pneumonia (VAP), a pneumonia that develops 48hrs after initiation of mechanical ventilation, is the most prevalent infection encountered in the intensive care unit (ICU). This has led to countless of discussions about diagnosis, treatment, and prevention due to the associated morbidity, mortality, and cost.\textsuperscript{12-14} VAP occurs in roughly 20\% of ICU patients with mortality ranging from 20- 50\%.\textsuperscript{10-12, 14} To improve upon early diagnosis and treatment of these patients, the CDC published a set of guidelines to aid with early detection and treatment of patients who were at risk for developing VAP.\textsuperscript{2-3} Despite this, the diagnosis of VAP remained elusive, especially in the multi-trauma patient. Multiple studies have shown the futility of using scoring systems such as the Clinical Pulmonary Infection Score (CPIS) to diagnose and treat pneumonia in the trauma patient.\textsuperscript{16} The triggers used in these scoring systems can also be seen in patients with multiple traumatic injuries secondary to the inflammatory response, chest trauma (i.e. pulmonary contusions, atelectasis, lobar collapse), or as a result of resuscitation (i.e. pulmonary edema, worsening pulmonary contusions, TRALI, etc.). Using these methods will result in over-diagnosis of VAP with concomitant over-usage of antimicrobial agents and promote drug resistance.\textsuperscript{4-6}

As such, there is now data from a few centers to support the use of well-defined algorithms based on clinical & objective (via quantitative cultures) data to aid with the diagnosis & treatment of VAP. In addition, the CDC updated its guideline in Jan. 2016 in the form of an algorithm titled ‘Ventilator Associated Events’ which is reminiscent of the algorithms proposed by the aforementioned centers. Nonetheless, there are guidelines present, via the use of quantitative cultures, to aid with a more accurate diagnosis of VAP and appropriately targeted antimicrobial therapy.

Goals
1. To promptly identify patients at risk for developing, or have developed, VAP.
2. To demonstrate a method of diagnosing VAP.
3. To streamline treatment options for VAP by clinical & objective data.
4. To identify methods for prevention of VAP.
Work-up/Diagnosis

1. Impaired gas exchange is defined as oxygen desaturations requiring increased oxygen requirements (increased FiO₂) or ventilator demand. It also includes a decreasing P:F ratio (< 240). A patient with impaired gas exchanged in addition to THREE of the findings below should be worked up further for possible VAP:
   - Abnormal temperature (>38°C or <36°C).
   - Abnormal WBC (>12,000 cells/mm³ or <4,000 cells/mm³) or presence of >10% bands.
   - Macroscopically purulent sputum.
   - New or changing infiltrate on chest radiograph.

2. Bronchoscopy with bronchoalveolar lavage (BAL) should be performed. Specimen should be sent for quantitative culture only. Respiratory cultures are of no use for diagnosis and should not be obtained. Procedure should include five aliquots of 20 mL saline injected via the bronchoscope into the most worrisome lobar bronchus with aspiration into a sputum trap.⁴ One large bolus of 100 mL of sterile saline may also be used.¹¹ All mucus plugs need to be cleared prior to the procedure. Furthermore, the bronchoscope channel needs to be cleared with sterile saline PRIOR to obtaining the BAL sample to decrease the chances of false negative results. If bronchoscopy is not indicated, or available, a mini-BAL is adequate. As with the specimen obtained via bronchoscopy, this specimen is also sent for quantitative cultures.

3. A diagnosis of VAP is made if the BAL has > 10^5 cfu/mL (> 10^4 cfu/mL for mini-BAL) AND the patient has been on mechanical ventilation for more than TWO calendar days.⁴⁻⁵

Treatment

1. Antibiotics are not to be initiated until after the initial results have been posted unless it is in the setting of sepsis. This is in an attempt to promote antibiotic stewardship and decrease the risk of developing drug-resistant bacteria within the institution.⁶

2. Empiric antibiotics should be dictated by the current hospital antiбиograms.⁶⁻¹⁰

3. Antibiotics, once initiated, should be narrowed as soon as possible. Antibiotic treatment length is 7 days.¹⁰

4. Repeat BAL (via bronch or mini-BAL) should be performed on Day #4 of antibiotic therapy if patient continues to show clinical signs of VAP.
   a. If the BAL shows < 10^4 cfu/mL (10^3 cfu/mL for mini-BAL) of the same organism, antibiotics to be discontinued after 7 days as planned.
b. If the BAL shows $> 10^4$ cfu/mL ($10^3$ cfu/mL for mini-BAL) of the same organism, antibiotics should be continued for a total course of 14 days.

5. Quantitative cultures that grow Pseudomonas, ESBL, Stenotrophomonas or Acinetobacter (non-glucose fermenting gram negative bacilli) should be treated for a minimum of 14 days as shorter duration of treatment is associated with higher rates of recurrence with these organisms.\(^{10}\)

6. Antibiotic therapy should be discontinued if cx results are negative.\(^{6,10}\)

Prevention

While the above is meant to promptly diagnose and treat VAP, the presence of VAP still confers an increase in hospital length of stay and costs. The below guidelines are methods used to prevent the development of VAP.\(^{8,15}\)

<table>
<thead>
<tr>
<th>Subglottic suctioning</th>
<th>Change of circuit for each patient and if the circuit becomes soiled or damaged.</th>
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<tbody>
<tr>
<td>Frequent rotation</td>
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<td>Elevation of HOB at 45° (no lower than 30°)</td>
<td>Humidifier change every 5-7 days.</td>
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<td>Oral chlorhexidine gluconate</td>
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<td>Use of MDI vs. nebulizer when indicated</td>
<td>Closed endotracheal suctioning.</td>
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<td>Daily spontaneous breathing trials (when indicated)</td>
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<td>Avoidance of gastric distension</td>
<td>Maintaining cuff pressure &lt; 20cm H(_2)O.</td>
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<td>Discontinuation of stress ulcer prophylaxis when appropriate (unless a home medication). Consider using sulcrafate instead if GI tract is able to be used.</td>
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References
VAP Algorithm

1. **Concern for sepsis**
   - **NO**
     - Clinical Suspicion of VAP
     - Fiberoptic Bronchoscopy with BAL or mini-BAL
     - Initial Results
       - No growth to date
         - Continue to hold antibiotics
       - Insignificant growth (<100,000 cfu/mL)
       - Significant growth (>100,000 cfu/mL)
         - Start antibiotics specific for bacteria (narrow when applicable) Seven days of antibiotic treatment.

2. **YES**
   - Pan culture, including BAL. Start broad-spectrum antibiotics.

*If growing Pseudomonas, ESBL, Stenotrophomonas, or Acinetobactor treatment should be 14 days.