I. INTRODUCTION

Ventilator associated pneumonia (VAP) is a common nosocomial infection occurring in 9% to 27% of mechanically ventilated patients. It is associated with significant morbidity including increased ventilator days, increased intensive care unit (ICU) and hospital length of stay, and increased cost. Further, VAP has an attributable mortality rate of 20% to 40%. By definition, VAP is a pneumonia that occurs > 48 hours after initiation of mechanical ventilation. Depending on the length of mechanical ventilation and other risk factors such as previous antibiotic exposure, the bacterial pathogens responsible for the VAP differ in virulence and antimicrobial resistance.

The pathogenesis of VAP is typically microaspiration leading first to colonization and finally infection as host defense mechanisms become overwhelmed. Non-modifiable risk factors for VAP identify populations who have an increased incidence of VAP. These include age>60, COPD, ARDS, head trauma, and reintubation among others. Modifiable risk factors are interventions, treatments, and behaviors common to the ICU that positively or negatively affect the incidence of VAP. Examples are patient positioning, stress ulcer prophylaxis, and enteral nutrition practices. Through careful scrutiny and manipulation of these practices, the incidence of VAP can be reduced. This approach to prevention warrants significant effort.

Once the patient has developed VAP, the efforts should focus on early and accurate diagnosis of the process and identification of the responsible microorganism. Invasive diagnostic strategies may improve diagnostic efficiency. Early empiric broad-spectrum antibiotics improve mortality only when they are adequate to cover the pathogen ultimately found to be responsible for infection. Decisions regarding empiric antimicrobials require consideration of the patient’s risk factors for multi-drug resistant bacteria as the cause of VAP. Important risk factors include mechanical ventilation greater than 5 days and previous antibiotic exposure among others. The spectrum of coverage can be limited if possible after identification of the responsible pathogen. The duration of treatment is determined by the bacteria identified and the patient’s response to treatment.

II. PURPOSE

The pathogenesis of VAP involves the micro-aspiration of oropharyngeal and/or gastric secretions that have been contaminated/colonized with pathogenic organisms. Efforts to prevent VAP are focused on early extubation and preventing aspiration. Early and aggressive diagnosis and treatment help limit VAP related morbidity and mortality. An evidence-based guideline has been developed to implement practices aimed at the prevention, diagnosis, and treatment of ventilator associated pneumonia.
### III. PREVENTION/PROPHYLAXIS

#### A. Identify Patients at Risk:

**Pneumonia Risks**
- Intubation/Reintubation
- COPD
- Age > 60 years
- Aspiration
- Decreased LOC or GCS < 15
- Neuromuscular blockade
- Spinal cord injury /Spine instability/Head Trauma
- Enteral nutrition – especially pre-pyloric
- ECF/Nursing Home patients
- Prior antibiotic treatment within the last 90 days
- Hospitalization ≥ 5 Days
- Immunosuppressive disease or therapy
- ARDS
- Chronic Dialysis Patients
- Prior hospitalization within the last 90 days

#### B. Extubation: Early extubation, when appropriate will prevent VAP
- Institute Ventilator Liberation Pathway when appropriate
- Provide a sedation “holiday” for patients who are on continuous sedative infusion evidence demonstrates that daily interruption shortens the duration of mechanical ventilation

#### C. Semi-recumbent Positioning: The supine position is an independent risk factor VAP
- Patients with an artificial airway will have their HOB maintained ≥ 30 degrees at all times
- Reverse tendelenberg positioning may be used if HOB elevation is contraindicated. (ie. Spinal precautions)
- If clinical conditions preclude HOB ≥ 30 degrees, elevation to the level tolerated should be achieved.

#### D. Aspiration of Subglottic Secretions: Removing potentially contaminated secretions from above the tracheal cuff may reduce VAP
- Deep oropharyngeal (subglottic ) suctioning will be completed
  - Every (Q4) hours and as need
  - Prior to manipulation of the tracheal cuff air volume
  - Prior to retaping/repositioning of the endotracheal tube
  - Prior to extubation.
• Procedure: A suction catheter is passed into the posterior oropharynx and secretions are aspirated from above the tracheal balloon.

E. Routine Oral Care Colonization of oral mucosa and dental plaques with pathogenic bacteria places patients at risk for microaspiration. Regular oral care may decontaminate the oral cavity and reduce VAP
  • Oral Care Procedure
    o Brush teeth at least every 12 hours (Q12) with suction toothbrush and 1.5% peroxide solution.
    o Cleanse oral mucosa/tongue with oral suction sponge device every 2-4 hours using 1.5% peroxide solution.
    o Administer chlorhexidine gluconate (0.12%) by irrigation/suction to oral cavity every 8 hours
    o Apply water-based lip moisturizer to maintain skin integrity every 4 hours

F. Gastric drainage All mechanically ventilated patients will have gastric decompression via nasogastric tube, orogastric tube, or gastrosotomy tube
  • The use of nasogastric tubes is associated with a higher risk of nosocomial sinusitis
  • There may be an increase risk of VAP associated with nasal intubation/nosocomial sinusitis

G. Stress Bleeding Prophylaxis All mechanically ventilated patients require stress bleeding prophylaxis as outlined in the Stress Bleeding Prophylaxis clinical practice guideline.

H. Continuous Lateral Rotation Therapy/Oscillation Sleep Surfaces Immobility may lead to impaired clearance of bronchopulmonary secretions and pneumonia
  • The application of continuous lateral rotation may aid in preventing VAP in select populations including brain injured patients, patients with spinal cord injury, and certain post surgical patients

I. Selective Decontamination of the Digestive Tract (SDD) The aim of SDD is to eradicate pathogenic bacteria from the oropharynx and stomach through the use of topical and or systemic antibiotics. While this technique has been shown to reduce the incidence of VAP, there is no known mortality benefit.
  • This technique is not recommended due to its unknown long-term impact on microbial resistance patterns.

J. Prophylactic antibiotics The systemic antibiotics are not indicated to prevent VAP.
  • Witnessed or presumed aspiration of gastric contents is not an indication for systemic antibiotics in the absence of clinical signs of VAP.
G. Red Blood Cell Transfusion  Red blood cell transfusion has been independently associated with the development of VAP
   - Follow the anemia clinical practice guideline to decrease the risk of VAP

IV. VAP DIAGNOSIS

A. Clinical Criteria for VAP diagnosis
   - New or changing infiltrate on chest radiograph
   - Two of three of the following
     o Alteration in thermoregulation <36° or >38°
     o WBC > 10,000, or < 4,000
     o Purulent sputum

B. Organism Identification  A reliable tracheal aspirate Gram stain can be used to direct initial empiric antimicrobial therapy.
   - Semi-quantitative (non-invasive) tracheal aspirates can be used to guide initial antibiotics but may not be as reliable as invasive techniques
   - Invasive diagnostic techniques such as bronchoscopic bronchoalveolar lavage (BAL) should be used when available to aid in organism identification and to guide/adjust antibiotic therapy
     o Bronchoalveolar lavage diagnosis is typically based on a diagnostic threshold of $10^5$ cfu/ml.
     o Specimens collected within 72 hours of antibiotic changes should be considered diagnostic at $10^4$ cfu/ml.
   - A negative tracheal aspirate (absence of bacteria or inflammatory cells) in a patient without a recent (within 72 hours) change in antibiotics has a strong negative predictive value for VAP and should lead to a search for alternative sources of fever

V. TREATMENT

A. Empiric treatment  Begin empiric antibiotic therapy if clinical diagnostic criteria are met and/or BAL is positive
   - Choice of appropriate empiric antibiotics is guided by risk factors for the presence of multidrug-resistant organisms as the cause of VAP
     o Recent antibiotic treatment
     o Mechanical ventilation > 7 days
     o Prolonged hospitalization or recent hospitalization
- Pre-existing pulmonary pathology: COPD, bronchiectasis, cystic fibrosis
- Immunocompromised state
- Admission from an ECF/nursing home
  - Combination therapy is not indicated as empiric therapy of VAP
  - If no growth of cultures within 3 days, discontinue empiric treatment
  - If an organism is isolated and quantitative cultures are diagnostic of infection, antibiotic therapy should be adjusted appropriately to treat the organism with the narrowest possible spectrum

**B. Duration of treatment**
- Empiric antibiotics are discontinued after 3 days if no organisms are isolated
- Documented VAP should be treated for a total of 8 days in most cases
- Non-fermenting gram negative rods (Pseudomonas sp., Acinetobacter sp., Stenotrophomonas sp.) should be treated for 14 days to decrease the likelihood of recurrence
- Combination therapy is not indicated to treat VAP
References


Clinical Practice Guidelines (CPG) are meant to standardize and optimize care and decrease variability in practice. They are intended to be used as framework for the delivery of patient care in the surgical critical care units. CPG’s are a combination of evidence-based medicine and accepted practices in critical care medicine. CPG’s are intended to provide decision support for the management of the majority of patients, and are not proposed as directives, rules, or policies. They are not substitutes for clinical judgement. Deviations from the CPG’s are expected when deemed medically necessary; all exceptions should be documented in the medical record and require discussion between the Surgical Critical Care attending and the attending of the primary or consulting service.
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VAP Diagnostic/Treatment Algorithm

Suspected VAP
(Radiographic and Clinical signs)

Obtain Lower Respiratory Tract Sample for Culture (BAL or CombiCath)

Start Empiric Antimicrobials based on Risk Factors for MDR Organism

Follow Cultures and Clinical Response to Empiric Therapy (2-3 Days)

Clinical Improvement at 48-72 Hours

NO

Cultures -
Consider other sources of infection or other diagnoses

Cultures +
Adjust Antibiotic Therapy; Consider other Diagnoses

YES

Cultures -
Consider Discontinuing Antimicrobials

Cultures +
De-escalate antibiotics if possible; Treat 8 or 14 days and Reassess