

Preventing Ventilator Associated Pneumonia

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This Presentation is Approved for
1 CRCE Credit Hour

Learning Objectives

- Explain the importance of ventilator-associated pneumonia (VAP)
- Describe the epidemiology of VAP
- Identify the risk factors for VAP
- Outline the pathogenesis of VAP
- Recommend diagnostic techniques for VAP
- Recommend preventative measures for VAP
- Recommended strategies for management of VAP

VAP Epidemiology

- Pneumonia has accounted for
 - ❖ 15% of all hospital-associated infections
 - ❖ 27% ICU infections
 - ❖ 24% CCU infections
 - ❖ 2nd most common nosocomial infection (after UTI)
- Primary risk factor – mechanical ventilation & endotracheal tube

FYI see link below to CDC website on VAP

VAP Epidemiology

- So what?
 - ❖ Costs of VAP
 - Prolonged intubation & ventilation
 - Patient discomfort
 - Greater ICU & hospital stay
 - Medications, e.g. antibiotics
 - Estimated cost/case = \$40,000
 - Estimated yearly cost = \$50 million/yr

VAP Epidemiology

- So what?
 - ❖ Federal government had decided that VAP is a result of error & would not pay
 - ❖ This decision has been reversed

VAP Etiologies & Pathogenesis

Normal Status

- Aerodigestive tract above vocal cords is heavily colonized
- Lower respiratory tract is normally sterile
- Normal adults aspirate during sleep, without complications

Defense Mechanisms

- Anatomic barriers
- Cough
- Mucociliary clearance
- Cellular & humoral immunity
- Alveolar macrophages

Compromise of Defenses

- Intratracheal tube
 - ❖ Provides a direct conduit for microorganisms
 - ❖ Impairs cough
 - ❖ Impairs mucociliary clearance
 - ❖ Airway injury

Compromise of Defenses

- Critical illness
- Comorbidities
- Malnutrition

Routes for Development

- Aspiration
 - ❖ Direct from oropharynx
 - ❖ Reflux from GI tract
- Extension of existing infection
- Inhalation of contaminants, e.g. aerosols
- Blood-borne from other sites

Causative Factors

- Aerodigestive colonization
- Contaminated respiratory therapy equipment & aerosols
- Contaminated tap water (pseudomonas, legionella)
- Contaminated ambient air (fungi, TB, SARS, coronavirus)

Causative Factors

- Biofilms on intratracheal tubes
- Sinusitis – infection spreads to lung
- Gastric colonization – reflux & aspiration

Risk Factors

- Duration of mechanical ventilation (longer intubation)
- Prolonged hospitalization before mechanical ventilation
- Smoking – impaired clearance
- COPD – impaired clearance

Risk Factors

- Age (extremes)
- Coma, neurosurgery, head trauma
- Steroids – immunosuppression
- Gross aspiration
- Prior antibiotics – resistant strains

Ventilator Circuitry & VAP

- Frequent circuit changes do not reduce risk for VAP
- Humidification type does not affect risk for VAP
- Closed suction does not reduce risk of VAP – does it increase it?
- Contaminated nebulizers increase risk of VAP
- Manual resuscitators, tracheostomy collars, t-pieces

Endotracheal Tubes & VAP

- Rather than VAP, it should be called, 'ETT associated pneumonia'
- Lower airways contaminated with oral secretions during intubation
- Leakage of oral, gastric secretions around tube cuff

Endotracheal Tubes & VAP

- Biofilm on lumen
- Results in re-inoculation with pathogen
- Instilled NSS for suctioning may increase re-inoculation?

Causative Organisms

- Often, a polymicrobial infection
- Pseudomonas aeruginosa (24%)
- Staphylococcus aureus (20%)
- Enterobacteriae (14%)
- Hemophilus influenza (10%)

Causative Organisms

- Pseudomonas aeruginosa (24%)
- Staphylococcus aureus (20%)
- Enterobacteriae (14%)
- Hemophilus influenza (10%)
- Streptococcus species (8%)
- Acinetobacter (8%)
- Streptococcus pneumoniae (4%)
- Enterobacter (3%)
- Other (4%)

Causative Organisms

- Early onset (4-7 D post-intubation)
 - ❖ Hemophilus species
 - ❖ Streptococci
 - ❖ Staphylococci
 - ❖ Enterobacter

Causative Organisms

- Late onset (>7 D post-intubation) – multiple drug-resistant pathogens
 - ❖ Pseudomonas
 - ❖ Methicillin-resistant staphylococcus aureus (MRSA)

VAP Diagnosis

VAP Diagnosis

- Diagnosis is difficult – no gold standard
- May be helpful
 - ❖ Clinical criteria
 - ❖ Sputum cultures, gram stains
 - ❖ Cytologic data – inflammatory cells
 - ❖ C-protein

VAP Diagnosis

- Not helpful
 - ❖ Blood cultures
 - ❖ Procalcitonin levels

Clinical Pulmonary Infection Score

- Each assessment scored 0-2 points
 - ❖ Assessments
 - Fever
 - Leukocyte count
 - Purulence of secretions
 - Oxygenation ($\text{PaO}_2/\text{FiO}_2$)
 - Radiographic abnormality
 - Sputum culture & gram stain

FYI see links below for an article on clinical pulmonary infection score & a clinical pulmonary infection score calculator

Bacteriologic Assessment

- Qualitative tracheal aspirates
 - ❖ Faster diagnosis
 - ❖ Greater sensitivity than BAL
 - ❖ Earlier treatment

Bacteriologic Assessment

- Quantitative diagnosis (bronchoscopic technique)
 - ❖ Advantages
 - Select specific area of CXR infiltrates (VAP frequently RLL)
 - May be more effective
 - May reduce unnecessary antibiotics

Bacteriologic Assessment

- Quantitative diagnosis (bronchoscopic technique)
 - ❖ Disadvantages
 - Invasive
 - Expense

Final Diagnosis

- Clinical assessment to decide when to initiate treatment
- Qualitative tracheal aspirates to select antibiotics

VAP Management

Antibiotic Therapy

- Issues with VAP
 - ❖ Lung tissue concentrations vary – does drug reach the microbe?
 - ❖ Local lung conditions reduce effectiveness of some drugs
 - ❖ ETT biofilm organisms are not exposed to systemic antibiotics

Antibiotic Therapy

- Issues with VAP
 - ❖ Organisms that cause VAP are becoming more drug-resistant
 - MRSA
 - Klebsiella
 - Pseudomonas

Antibiotic Therapy

- De-escalation strategy
 - ❖ Endorsed by American Thoracic Society (ATS)
 - ❖ Start with aggressive broad-spectrum regimen
 - ❖ Narrow the spectrum as data on susceptibility are available

Antibiotic Therapy

- Early onset, nonresistant strains
 - ❖ Ceftriaxone (Rocef)
 - ❖ Ciproflaxin (Cipro)
 - ❖ Levofloxacin (Levaquin)
 - ❖ Ampicillin
 - ❖ Ertapenem (Invanz)

Antibiotic Therapy

- Late onset, resistant strains – combinations may be indicated
 - ❖ Cefipime (Maxipime)
 - ❖ Imipenem (Primaxim)
 - ❖ Piperacillin
 - ❖ Ciproflaxin
 - ❖ Levofloxacin
 - ❖ Vancomycin – MRSA
 - ❖ Linezolid (Zyvox) – MRSA

Antibiotic Therapy

- Late onset, resistant strains – combinations of these may be indicated
 - ❖ Vancomycin – MRSA
 - ❖ Linezolid (Zyvox) – MRSA

Antibiotic Therapy

- Airway delivery
 - ❖ Evidence
 - Some benefits
 - Not recommended for routine use
 - ❖ Specific agents – for resistant strains
 - Aerosolized colistin – pseudomonas
 - Aerosolized gentamycin, tobramycin
 - Aerosolized amikacin
 - Instilled tobramycin

VAP Prevention

Environmental Sources

- Reusable ventilator probes & sensors
- Ventilator circuits, humidifiers
- Nebulizers
- Manual resuscitators
- Bronchoscopes – pseudomonas
- Hands, fingernails, stethoscopes – MRSA, etc.

Environmental Sources

- Infected patients
- Infected caregivers
- Ice & water – pseudomonas, legionella
- Ambient air – fungi, TB, SARS

Preventative Measures

- Adequate staffing – caregivers pressed for time are less likely to adhere to infection control guidelines

Preventative Measures

- Mouth care
 - ❖ Reduce colonization of oropharynx
 - ❖ Chlorhexidine mouth-swabbing appears to reduce VAP

FYI see link below to download article on chlorhexidine & VAP

Preventative Measures

- Caregiver interface
 - ❖ Alcohol-based hand rubs
 - ❖ Routine gloving between patients
 - ❖ Dedicated equipment – stethoscopes
 - ❖ Patient isolation – often done too late

Tracheal Tubes

- Agento™ silver-coated endotracheal tube

Tracheal Tubes

- Hi-Lo Evac™ tube

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See link below for abstract on
effectiveness of subglottic suctioning

Preventative Interventions

- ETT cuff pressures
 - ❖ 25-30 cm H₂O to prevent aspiration
 - ❖ Avoid MLT, which permits aspiration
- Early tracheotomy – not supported by research
- Noninvasive ventilation – decreased VAP risk, because there is no intubation
- Ventilator weaning protocols – earlier extubation

Preventative Interventions

- Metered-dose inhalers, instead of nebulizers for aerosolized drugs
- Resuscitators, etc.
 - ❖ Store in clean containers
 - ❖ Discard when contaminated

Preventative Interventions

- Prophylactic antibiotics
 - ❖ Aerosolized antibiotics prevent VAP in intubated patients with tracheobronchitis
 - ❖ Routine use is not supported by research
 - ❖ Excess antibiotics increase VAP risk
- Rotational beds – not supported by research

VAP Bundle

- Series of interventions related to ventilator care to reduce VAP
- Key components
 - ❖ Elevate head of the bed
 - ❖ Daily "sedation vacations" to expedite extubation
 - ❖ Peptic ulcer disease prophylaxis
 - ❖ Deep venous thrombosis prophylaxis

FYI see link below for link to IHI Bundle implementation

Summary & Review

- VAP epidemiology & costs
- Etiologies & pathogenesis
 - ❖ Compromised defenses
 - ❖ Causative factors
 - ❖ Risk factors
 - ❖ Ventilator circuitry
 - ❖ Endotracheal tubes
 - ❖ Causative microorganisms

Summary & Review

- VAP diagnosis
 - ❖ Clinical diagnosis
 - ❖ Qualitative tracheal aspirates
 - ❖ Bronchoscopic, quantitative technique
- VAP management
 - ❖ Early onset
 - ❖ Late onset

Summary & Review

- VAP prevention
 - ❖ Environmental sources
 - ❖ Preventative measures
 - Mouth care
 - Caregiver interface interventions
 - ETT care
 - VAP bundle

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