Ventilator Associated Pneumonia

July 28, 2014

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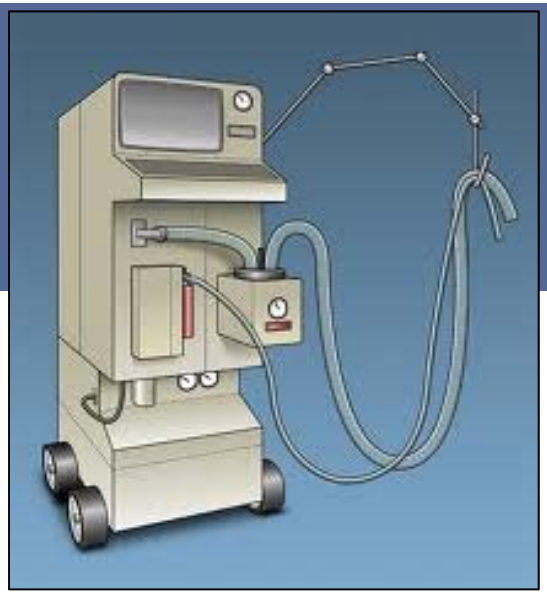
Objectives

- Understand basic terminology of Healthcare Associated Pneumonia (HAP/HCAP)
- Understand the impact of HAP
- Understand difficulties surrounding counting and surveillance of HAP
- Understand the basic pathophysiology of HAP
- Understand basic prevention methodologies used for HAP
- Special circumstances (outbreaks, pseudo-outbreaks)

Some definitions…..



- Healthcare acquired pneumonia
  - Ventilator associated pneumonia (VAP)
  - Non-ventilator associated pneumonia
- Ventilator settings
  - PEEP (positive end expiratory pressure)
    - Normal PEEP = 5
  - Fraction of inspired oxygen (FiO2)
  - Normal FiO2 = 27%

How big is the problem?

- SENIC Study in 1988
  - Estimated 275,000 cases of nosocomial pneumonia per year in US
  - Rate of 0.5 to 1.0 infections per 100 patients or 0.76 infections per 1,000 patient days.
  - Ventilator associated pneumonia
    - Incidence 9-65%
    - EPIC study in 1995:10K total pt
      - 4500 (45%) had at least 1 infection
        - Pneumonia 47% of all HAIs
        - Lower respiratory infections 17.8%
      - Pneumonia doubled the risk of death in ICU

How much do HAPs cost?

- Double rate of death in ICU
  - Mortality rate may exceed 10%
- Secondary bacteremia is common (4-38%)
- Increase ICU stay by 4-21 days
- Excess cost of $5,800 per event in the 1990s
  - Total cost $5,800 X 275,000 cases per year = $1.6 billion per year
- Currently not publicly reported in California
- CDC changed definitions in 2013 for potential use as public measure in the future.

How do we survey for pneumonia? With much difficulty….

- Definitions prior to 2013 were very subjective
  - Operator dependent
  - Variable definitions used in research yield vastly different rates
- Clinical diagnosis of pneumonia is difficult
  - Pneumonia vs. atalectasis
  - Aspiration pneumonia vs. aspiration pneumonitis
- 2013 CDC changed definition of VAP for adults
  - Based upon FiO2 and PEEP

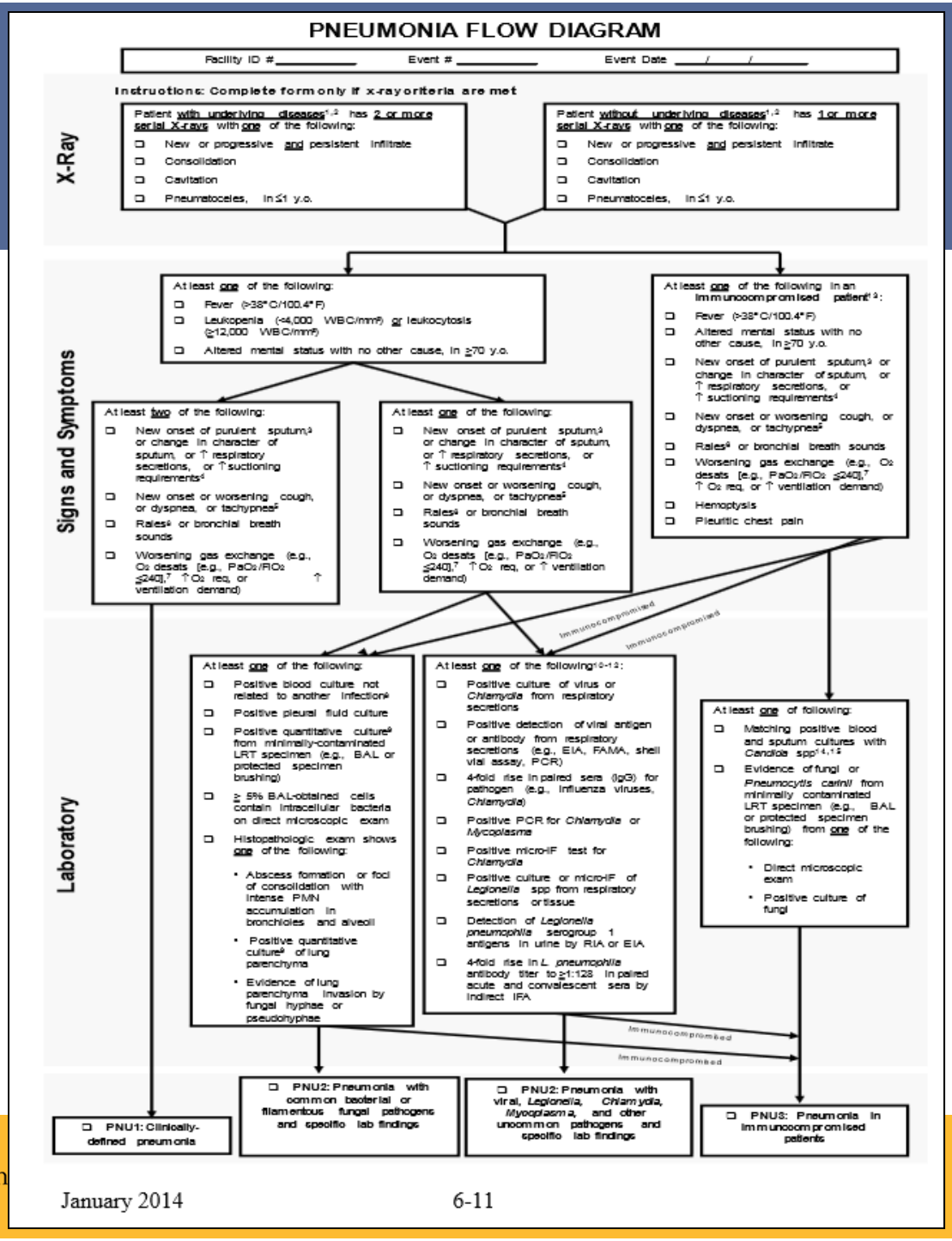
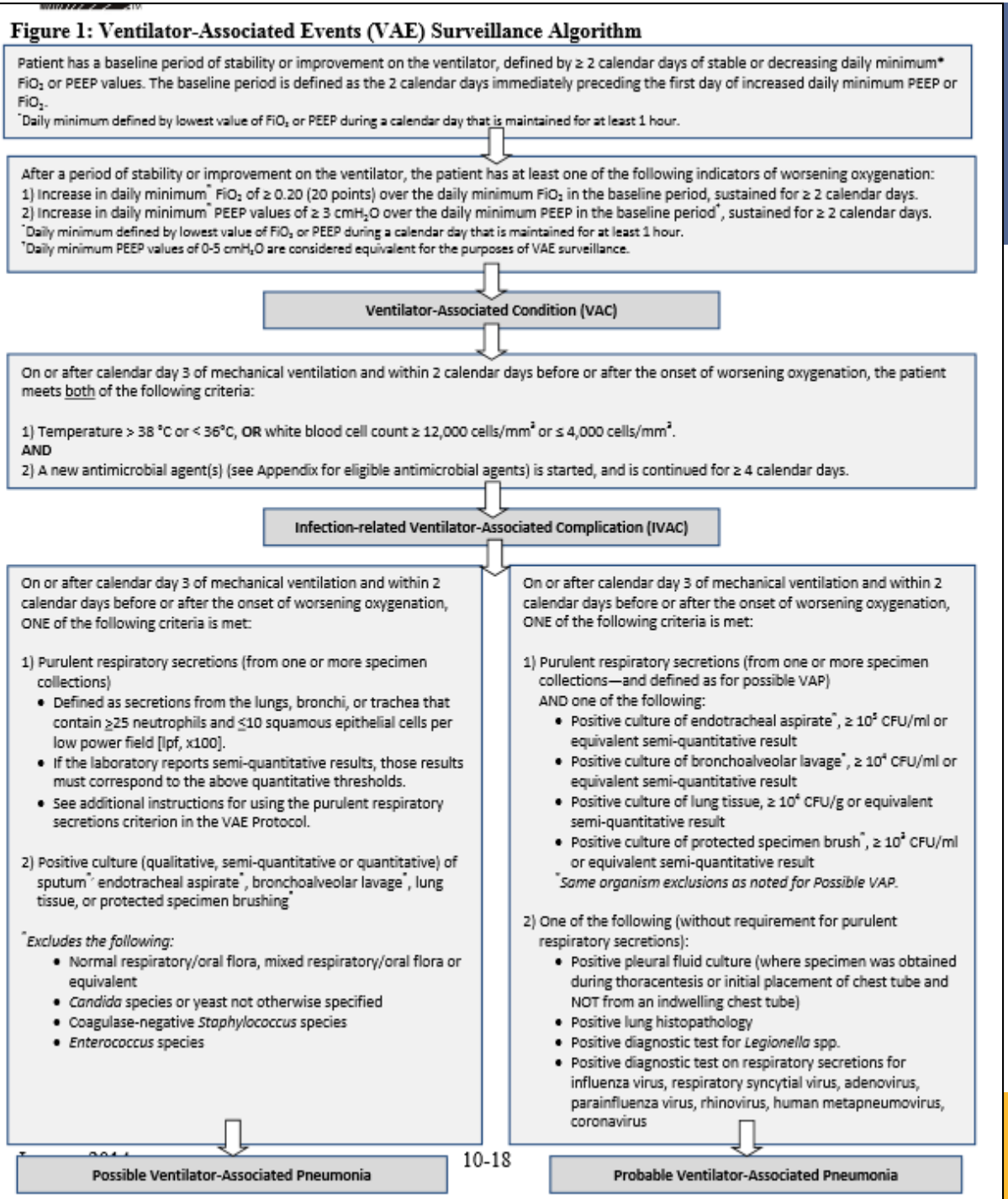

PNEUMONIA FLOW DIAGRAM
Facility ID #_____ Event # _____ Event Date ____/____/_____
Instruotions: Complete form only if x-ray oriteria are met
X-Ray
Patient with underlying diseases[1,2] has 2 or more serial X-rays with one of the following:
New or progressive and persistent infiltrate
Consolidation
Cavitation
Pneumatoceles, in ≤1 y.o.
Patient without underlying diseases[1,2] has 1 or more serial X-rays with one of the following:
New or progressive and persistent infiltrate
Consolidation
Cavitation
Pneumatoceles, in ≤1 y.o.
Signs and Symptoms
At least one of the following:
Fever (>38°C/100.4°F)
Leukopenia (<4,000 WBC/mm³) or leukocytosis (≥12,000 WBC/mm³)
Altered mental status with no other cause, in ≥70 y.o.
At least one of the following in an immunocompromised patient[1,2]:
Fever (>38°C/100.4°F)
Altered mental status with no other cause, in ≥70 y.o.
New onset of purulent sputum,[3] or change in character of sputum, or ↑ respiratory secretions, or ↑ suctioning requirements[4]
New onset or worsening cough, or dyspnea, or tachypnea[5]
Rales[6] or bronchial breath sounds
Worsening gas exchange (e.g., O2 desats [e.g., PaO2/FiO2 ≤240],[7] ↑ O2 req, or ↑ ventilation demand)
Hemoptysis
Pleuritic chest pain
At least two of the following:
New onset of purulent sputum,[3] or change in character of sputum, or ↑ respiratory secretions, or ↑ suctioning requirements[4]
New onset or worsening cough, or dyspnea, or tachypnea[5]
Rales[6] or bronchial breath sounds
Worsening gas exchange (e.g., O2 desats [e.g., PaO2/FiO2 ≤240],[7] ↑ O2 req, or ↑ ventilation demand)
At least one of the following:
New onset of purulent sputum,[3] or change in character of sputum, or ↑ respiratory secretions, or ↑ suctioning requirements[4]
New onset or worsening cough, or dyspnea, or tachypnea[5]
Rales[6] or bronchial breath sounds
Worsening gas exchange (e.g., O2 desats [e.g., PaO2/FiO2 ≤240],[7] ↑ O2 req, or ↑ ventilation demand)
immunocompromised
immunocompromised
Laboratory
At least one of the following:
Positive blood culture not related to another infection[8]
Positive pleural fluid culture
Positive quantitative culture[9] from minimally-contaminated LRT specimen (e.g., BAL or protected specimen brushing)
≥ 5% BAL-obtained cells contain intracellular bacteria on direct microscopic exam
Histopathologic exam shows one of the following:
Abscess formation or foci of consolidation with intense PMN accumulation in bronchioles and alveoli
Positive quantitative culture[9] of lung parenchyma
Evidence of lung parenchyma invasion by fungal hyphae or pseudohyphae
At least one of the following[10-12]:
Positive culture of virus or Chlamydia from respiratory secretions
Positive detection of viral antigen or antibody from respiratory secretions (e.g., EIA, FAMA, shell vial assay, PCR)
4-fold rise in paired sera (IgG) for pathogen (e.g., influenza viruses, Chlamydia)
Positive PCR for Chlamydia or Mycoplasma
Positive microIF test for Chlamydia
Positive culture or microIF of Legionella spp from respiratory secretions or tissue
Detection of Legionella pneumophila serogroup 1 antigens in urine by RIA or EIA
4-fold rise in L. pneumophila antibody titer to ≥1:128 in paired acute and convalescent sera by indirect IFA
At least one of following:
Matching positive blood and sputum cultures with Candida spp[13,14]
Evidence of fungi or Pneumocytis carinii from minimally contaminated LRT specimen (e.g., BAL or protected specimen brushing) from one of the following:
Direct microscopic exam
Positive culture of fungi
immunocompromised
immunocompromised
PNU1: Clinically-defined pneumonia
PNU2: Pneumonia with common bacterial or filamentous fungal pathogens and specific lab findings
PNU2: Pneumonia with viral, Legionella, Chlamydia, Mycoplasma, and other uncommon pathogens and specific lab findings
PNU3: Pneumonia in immunocompromised patients

Figure 1: Ventilator-Associated Events (VAE) Surveillance Algorithm



CDC Diagnosis of VAP in adults

- 2 day period of stability (stable or decreasing Fi)2 and PEEP)
- At least 2 days of worsening PEEP and FiO2

↓

- Elevated (or low) temp
- Antibiotic treatment for 4 or more days

↓

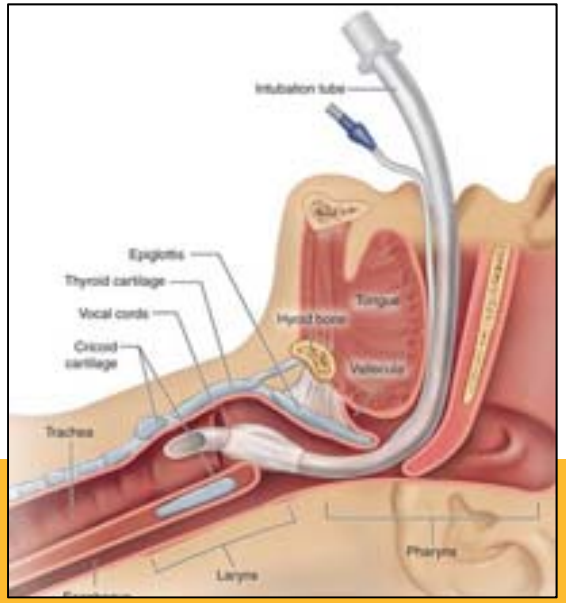
- Purulent secretions
- Positive sputum culture

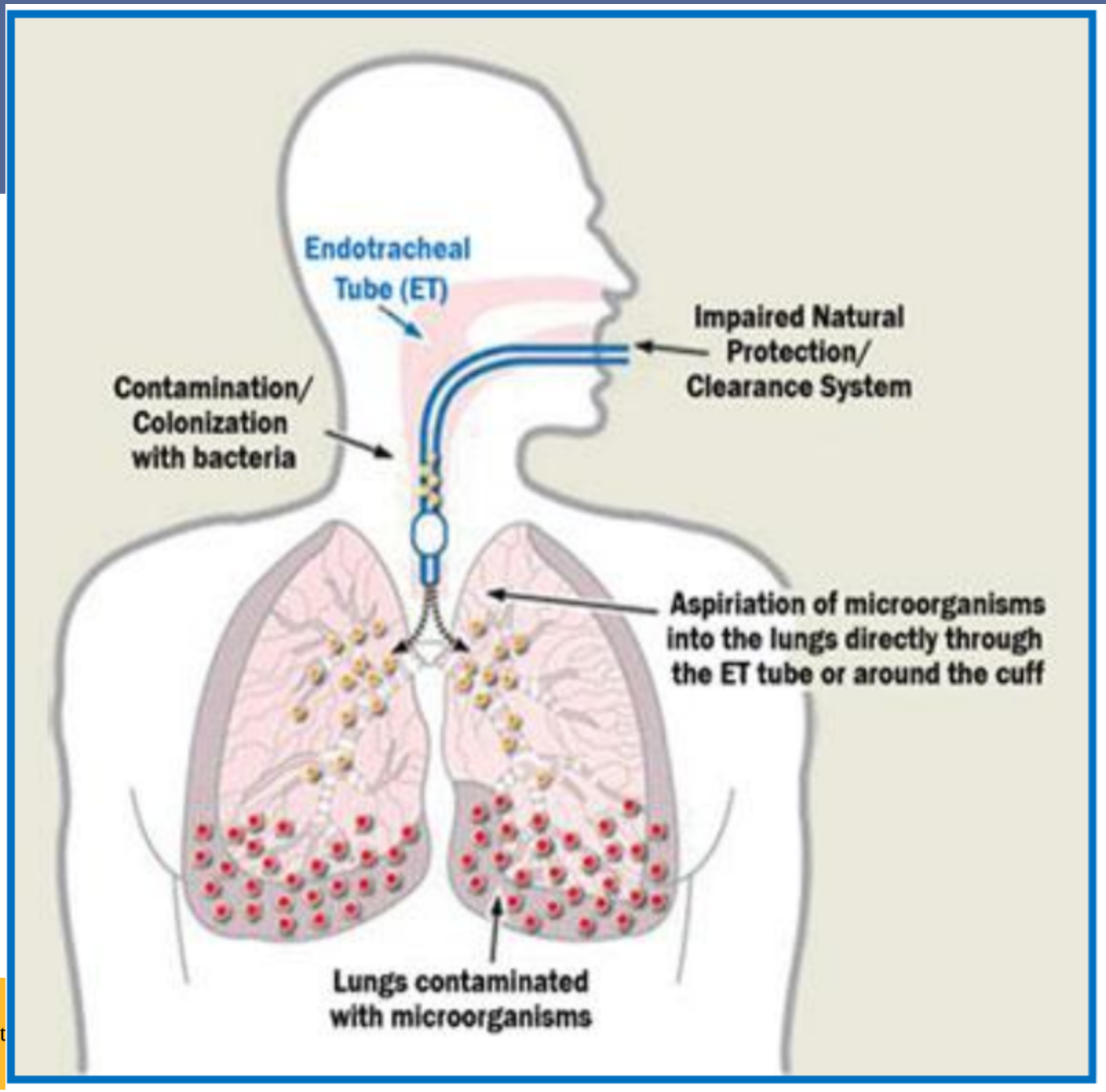
How do patients get hospital acquired penumonia?

- Endogenous routes
  - Gastric colonization—gastropulmonary route (4-24% cause)
    - Lower pH of gastric secretions in ill pts , meds
  - Oropharyngeal colonization (majority reservoir)
  - Intestinal colonization--rectopulmonary route (uncommon route)
    - Patients' skin or HCW hands
    - Gastro-duodenal reflux in ill patients
- Exogenous routes
  - Sinks, faucets, vent circuits, air handling systems
  - Tend to cause epidemics of GNRs, Legionella, Aspergillus, etc.

All pneumonia is aspiration pneumonia…

- Colonization of the upper respiratory tract w pathogens
  - Early infections (first 3 days)
    - Pneumococcus, Moraxella, H. flu
  - Later infections
    - GNRs : Pseudomonas, Acinetobacter, etc.
- Bypass of normal host defense mechanisms




Endotracheal
Tube (ET)
Impaired Natural
Protection/
Clearance System
Contamination/
Colonization
with bacteria
Aspiriation of microorganisms
into the lungs directly through
the ET tube or around the cuff
Lungs contaminated
with microorganisms

VAP Pathogens

- Staphylococcus aureus 24%
- Pseudomonas aeruginosa 16.3%
- Enterobacter 8.4%
- Acinetobacter 8.4%
- Klebsiella 7.5%
- E. coli 4.6 %

Risk factors for developing HAP

ICU acquired PNA

- Severity of illness
- COPD
- Trauma, Neuro disease, abdominal/chest surgery
- Age
- Coma/depressed consciousness
- Antacids (PPIs)
- NG tube
- Impaired cough reflex
- Bronchoscopy

Vent Assoc PNA

- Emergent intubation
- Duration of intubation (2%/d to 5 days)
- COPD
- Trauma, Neuro disease, abdominal/chest surgery
- Age
- Antacids (PPIs)
- NG tube
- Reintubation
- Supine position
- Paralytic agents
- Inadequate cuff pressure

Prevention of HAP/VAP

- Directly linked to risk factors:
  - Inoculation of bacteria into lungs (intubation, reintubation)
  - Cleanliness of patient and hand hygiene of HCW
  - Aspiration w poor mental status
  - Poorly maintained or dirty or faulty equipment
  - Continued intubation
  - Higher than normal gastric pH
  - Supine position
  - Poor mental status
  - Lack of mobility

Prevention of transmission of microorganisms to patients

- All medical devices should be cleaned and disinfected
  - Ventilator
  - Endotracheal tube
  - Laryngoscope (JC requirement)
    - High level disinfection
    - Sterile packaging until use
  - Nebulizers should be kept clean
  - Only use sterile medications and solutions for aerasolization
  - Clean anesthesia machines between cases
  - Pulmonary function testing equipment
  - Bronchoscopy equipment cleaned between procedures
  - Air handlers, humidifiers, etc.

Prevention of person to person transmission of microorganisms

- Standard precautions
  - Hand hygiene
  - Gloving/face mask/gowns
  - Change gloves between contaminated and clean activities
- Maintenance of the airway
  - Remove ET tube ASAP!
  - Aseptic vs. sterile gloves
  - Closed vs open suctioning
    - With open suctioning, use sterile, single use system
    - Use sterile fluid for suctioning

Increasing host defenses against infection

- Remove endotracheal tube ASAP!
- Pneumococcal vaccination
- Avoid steroids if possible
- Avoid unnecessary antibiotic use
- Avoid proton pump inhibitor (PPI) use if possible (sucralfate less problematic)

Preventing aspiration

- Use non-invasive ventilation if possible instead of intubation.
- Avoid re-intubation
- Consider subglottic suction catheter to remove secretions
- Ensure adquate ETT balloon inflation pressures
- Priro to extubating, suction subglottic secretions

Remove endotracheal tube ASAP

- Lower levels of sedation
- Sedation vacation daily
- Daily weaning trials
- Ambulation, out of bed to chair early with ETT

Preventing aspiration, cont.

- Prevent aspiration w enteral feeding
  - Elevate angle of bed 30-45%
  - Verify placement of feeding tube before use
- Prevent oropharyngeal aspiration
  - Chlorhexidine oral rinse
  - CHG bath treatment
  - Good dental hygiene

Preventing post-op pneumonia

- Ambulate early
- Encourage deep breathing with incentive spirometer
- Decrease sedation as much as possible
- ?chest physiotherapy

Putting it all together… the IHI ventilator bundle

- Elevation of the head of the bed 30-45%
- Daily sedation vacation
- Daily assessment for weaning
- Peptic ulcer prophylaxis
- Deep venous thrombosis prophylaxis
- Daily oral care with CHG

Outbreak vs. psedo-outbreak

- Outbreak
  - Increased incidence of organism or syndrome causing disease in multiple patients in a time window
- Pseudo-outbreak
  - Increased incidence of organism or syndrome causing disease (or not) in multiple patients, but due to enhanced detection or other factors not directly related to infection process.

Outbreaks of hospital acquired pneumonia

- Can be due to environmental contamination
  - Malfunctioning air handling equipment
  - Water sources
- Typically in immunosuppressed patients (transplant, Heme-Onc, COPD)

Up to 10 Legionnaires' cases now as UAB confirms another in outbreak

By Mike Oliver | moliver@al.com
Email the author | Follow on Twitter
on June 12, 2014 at 10:44 AM, updated June 13, 2014 at 8:47 AM

Print

Another patient has been confirmed to be part of the cluster of nine patients and at least one

UAB LEGIONELLA OUTBREAK

Wrinkle Trick Horrifies Surgeons

Suze Orman's Trick To

Outbreaks

- Due to contaminated equipment or medications, but may not cause disease, usually because low virulence.
- Often found on BAL.

- Example:
  - *Pseudomonas flourescens-putida* found in multiple patients who have undergone bronchoscopy
    - Equipment was cleaned with tap water from contaminated tap
    - Cultures were contaminated during procedure

Pseudo-outbreak

- Increase organism in ICU

Pseudo-outbreak

- Increase organism in ICU

- In March, new test for this organism was sent routinely on all sputum cultures…..

Summary of Prevention practices…

- Hand hygiene
- Daily CHG bathing
- Elevation of the head of the bed 30-45%
- Daily sedation vacation
- Daily assessment for weaning
- Daily oral care with CHG