

# Ventilator Associated Pneumonia (VAP)

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# Overview

- Define VAP
- Incidence
  - Attributable Morbidity and Mortality
- Pathogenesis
- Prevention
- Diagnosis and Management of VAP
  - Role of Bronchoscopy
  - Empiric Broad Spectrum Antibiotics

VAP is defined conceptually as...

*an inflammation of the lung parenchyma  
caused by infectious agents not present or  
incubating at the time of initiation of  
mechanical ventilation.*

Chastre & Fagon, 2002

# Consequences of VAP:

No longer just an  
“unfortunate” occurrence

- Viewed as medical error

(US Institute of Medicine)

- Excess costs of approximately  
\$US40,000/patient

(Centers for Disease Control, 2003)



# Ventilator-associated pneumonia

- 15% of all hospital acquired infections
- 2nd most common nosocomial infection
- Leading cause of morbidity among critically ill pts
  - associated with 20 -30% increased risk of mortality
- Difficult to study due to imprecise diagnosis
- Increased ICU stay 4.3-6.1 days

# Early VAP

- Timing
  - Within 4-7 days
- Bacteriology
  - *S. pneumoniae*
  - *H. influenzae*
  - MRSA
  - Susceptible GNB
- Prognosis
  - Less severe, little impact on outcome

# Late VAP

- Timing
  - Beyond 4-7 days
- Bacteriology
  - *P. aeruginosa*
  - Acinetobacter
  - MRSA
  - Other multiresistant orgs
- Prognosis
  - Attributable mortality and morbidity

# Risk factors for VAP

- Conditions requiring prolonged use of mechanical ventilatory support
  - Burns, trauma
  - CNS, respiratory & cardiac diseases
  - Reintubation within 24 hours
  - Potential exposure to contaminated respiratory devices &/or contact with contaminated hands
- Host Factors:
  - Extremes of age
  - Malnutrition
  - Immunosuppression

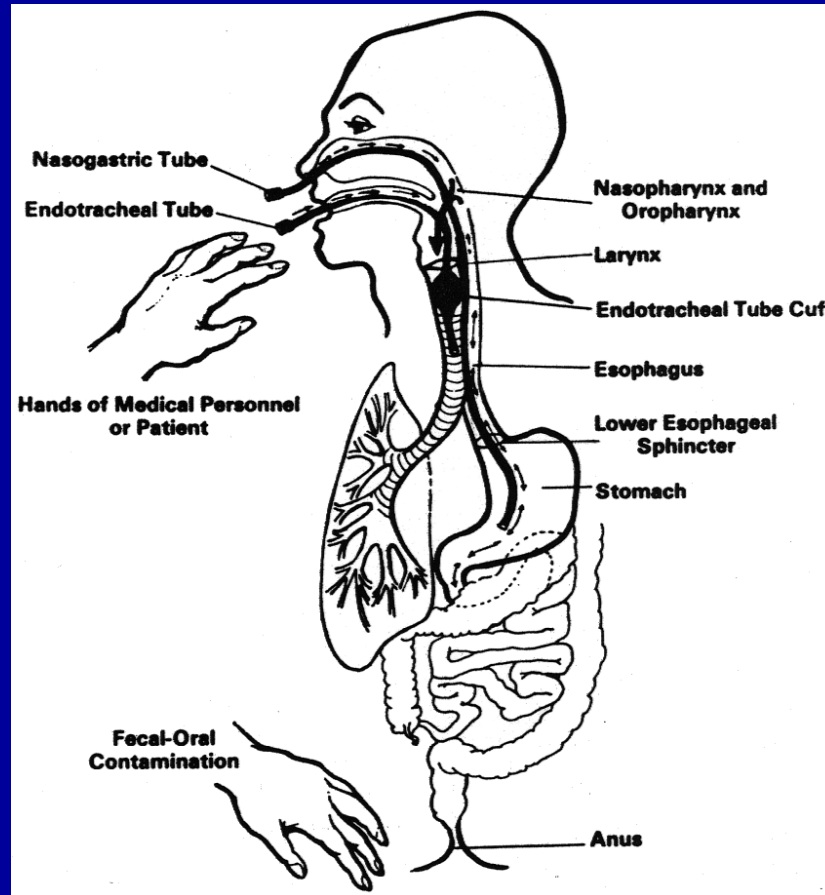
# Pathogenesis of VAP

- Results from microbial invasion of the normally sterile lower respiratory tract
- Caused by a defect in host defenses and/or a virulent or overwhelming invasion of organisms
- Intubation:
  - bypasses the natural barrier between oropharynx & trachea
  - drainage of tubing condensates into pt's airway
- Bronchoscopy, tracheal suctioning & manual ventilation
- Occurs in mostly supine positioned patients
- Use of paralytic agents

# Other sources of pathogens

- Paranasal sinuses
- Dental plaque
- Secretions pooled in the subglottic area
- Stomach
  - tracheobronchial colonization 25 - 40%
  - alkalization of stomach → reservoir of microbes
    - no clear consensus on this theory

# Pathogenesis of VAP



Organisms causing VAP arising from both endogenous and exogenous sources

# In summary...

- Tracheal colonization precedes VAP in some cases
- Stomach is a reservoir for pathogens:-
  - antimicrobial stomach therapy without decontaminating the oropharyngeal cavity has generally failed
- More than one potential pathway for colonization of the oropharynx and trachea:-
  - colonisation of dental plaque with resp pathogens
  - fecal-oral cross-infection and contaminated equipment
  - patient care activities transmit pathogens when infection control practices are substandard.

# Diagnostic recommendations:-

- Gram-stain & culture of ETT aspirates
- VAP should be suspected if 2 or more present:-
  - pt ventilated >3days (some earlier)
  - temp >38° C or <36° C
  - leukopenia or leukocytosis
  - purulent ET secretions
  - decreased oxygenation

# Problems with diagnosis

- Sensitive but not specific criteria include:-
  - new fever
  - elevated white blood cell count
  - new or changing infiltrates on CXR and/or
  - development of purulent sputum
- Not specific due to inconsistency in clinician evaluation of CXR and subjective descriptions of purulent sputum

# Difficulty in establishing a firm diagnosis...

- leads to a widely diverging VAP reported mortality rate
- this might be reflected in...
  - differences in the populations studied
  - differences in the diagnostic criteria used
- severe underlying illness predisposes pts to the development of pneumonia and ▲ mortality rates
- difficult to determine if these pts would have survived without VAP

# Other causes of VAP symptoms

- fever attributed incorrectly to pneumonia includes:
  - sinusitis, intra-abdominal infection and catheter sepsis
- causes of fever and pulmonary infiltrates in suspected VAP correct in only 42%
- multiple alternative sites of infection evident in pts with and without VAP
- many of these infections required:-
  - drainage procedures
  - antibiotic therapy different from VAP tmt or both.

# Etiology of VAP...

## Gram negative bacteria:

- Pseudomonas aeruginosa 24%
- Acinetobacter 8%
- Enterobacteriaceae 14%
  - Klebsiella, E coli, Proteus

## Gram positive bacteria:

- Staph aureus 21%
- Strept 8%

# Strategies to reduce incidence

- antimicrobial agents:-
  - protective up to 2-3 weeks
- stress ulcer prophylaxis:-
  - maintain gastric acidity
- nasogastric/enteral tube feeding:-
  - role of small-bore tube is unclear
  - use post-pyloric feeding in high risk patients
    - depressed gag reflex, delayed gastric emptying, gastro-esophageal reflux and severe bronchospasm

# The Ventilator Bundle

...is a package of evidence-based interventions that, when implemented together for all patients on mechanical ventilation, results in dramatic reduction in the incidence of ventilator-associated pneumonia.

# The Ventilator Bundle

- The power of a “bundle” is that it brings together evidence-based practices that individually improve care, but when applied together result in substantially greater improvement.
- The science behind the bundle is so well established that it should be considered a “standard of care”.
- The focus of measurement is then completion of the entire bundle as a single intervention, rather than completion of its individual components.

# Adult “Ventilator Bundle”

- Preventing VAP
  - **Elevation of the head of bed to 30 and 45 degrees**
    - Reduction in the risk of aspiration of gastric contents and improved ventilation
  - **Daily “sedation vacation” & daily extubation readiness testing (ERT)**
    - Reduce the duration of mechanical ventilation and the risk of VAP
- Preventing other complications associated with mechanical ventilation
  - **Peptic ulcer disease prophylaxis**
  - **Deep vein thrombosis prophylaxis**

# Head of the Bed 30-45°

Randomized controlled trial: 86 adult intubated patients on mechanical ventilation assigned to semi-recumbent (45°) or supine position

	<u>Semi-recumbent:</u>	<u>Supine:</u>
Suspected VAP:	8%	34%
(CI for difference 10-42%: p=0.003)		
Confirmed VAP:	5%	23%
(CI for difference 4-32%: p=0.018)		

Drakulovic MB. *Lancet*.1999;354:1851-1858.

# Sedation Vacation

*128 adults on mechanical ventilation  
randomized to daily interruption of sedation  
until the patient was awake.*

→Duration of ventilation:

4.9 days vs. 7.3 days (p=0.004)

Kress JP. *N Engl J Med.* 2000; 342: 1471-1477.

# Other strategies to reduce incidence

## ✓ Modifiable risk factors

- Wean intubation and mechanical ventilation
- ETT 96% partial colonization & 84% completely coated with bacteria
- hi-vol, low-pressure cuffs reduce rate to 20%
- maintain adequate intracuff pressure

## Issues related to reintubation, trache & suctioning

- 92% in retubed pts compared with 12% control
- early trache not shown to reduce VAP
- separate lumen for hourly subglottic suctioning not yet proven

## ✓ Prevent ventilator circuits' condensate from entering ETT or in-line medication nebulizers .... Use closed ETT suctioning and eliminate saline instillation

## ✓ Avoid neuromuscular blockade

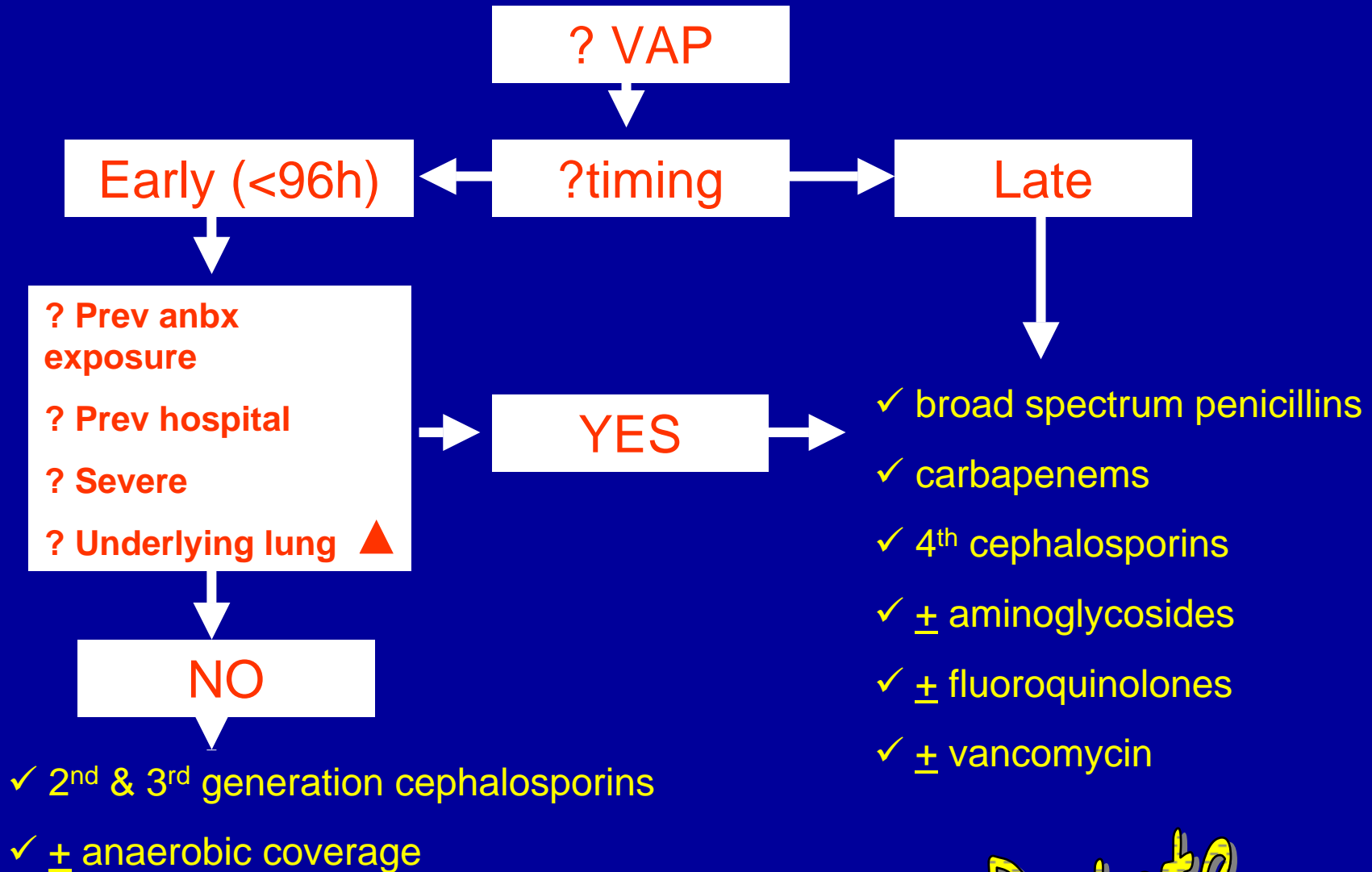
# Other strategies to reduce incidence of VAP cont'd...

- **position of patient:-**
  - semirecumbent position significantly reduces incidence of VAP
- **respiratory equipment:-**
  - discard contaminated nebulizers & suction equip
  - sinusitis
    - increases the risk so ? treat
    - slightly increased in nasal tubes compared to oral tubes
- **patient transport:-**
  - 24% of patients developed VAP compared with 4%

# Management of VAP...

- successful treatment is difficult & complex
- lack of adequate sampling techniques
- prevalence of infecting organisms depends on:-
  - country, hospital & ward
- tmt is based on risk category:-
  - specific risk factors with mild-moderate pneumonia
  - severe pneumonia
- antibiotic rotation associated with decline in VAP

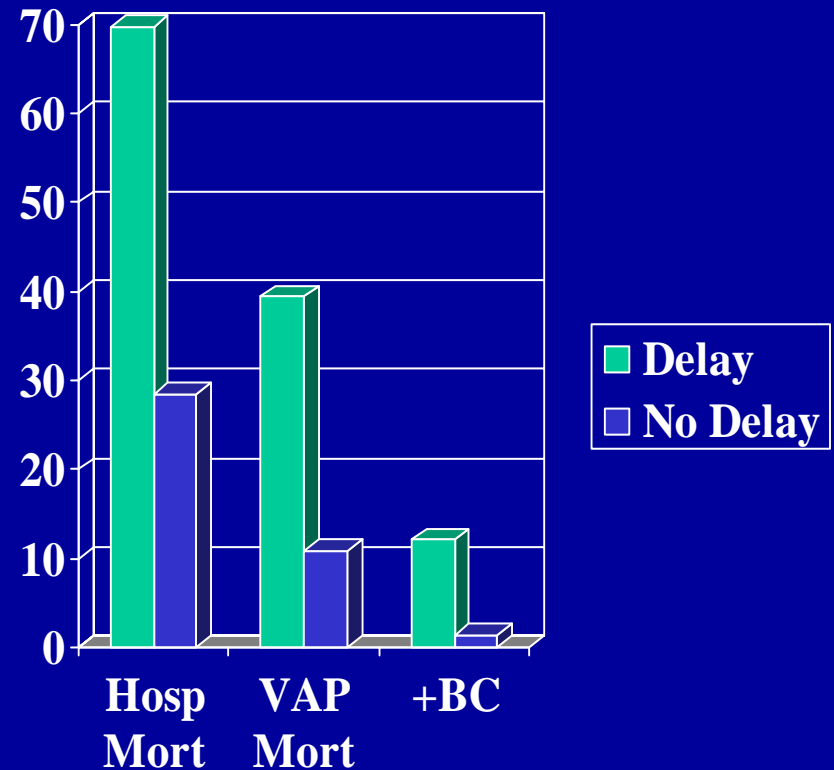
# Empiric Antibiotic Selection



Rotate

# Impact of Delays in Initiation of Appropriate Antibiotics

- Prospective, observational study
- 107 ICU patients with VAP
- >30% had delayed (>24 hrs) appropriate ab's
- Most common reasons for delay
  - Delay in writing order (25)
  - Resistant bacteria (6)
  - Delays in processing order (2)



# A Case Against Empiric, Broad-Spectrum Antibiotics

- Overuse or indiscriminant use of broad-spectrum-antibiotics
  - development of multi-resistant organisms
  - fungal overgrowth
  - increased costs!
- Toxicity/side effects

# Escalation → De-escalation Approach to VAP

- Prospective before and after study
- University-affiliated urban teaching hospital
- 102 patients with VAP
- Before: Standard care
- After: guideline
  - Imipenem, Cipro and Vanco
  - Recommended 7 day course
- Results before & after guideline:
  - Adequate empiric therapy (94 vs 48%,  $p < 0.001$ )
  - Shorter duration of therapy (8.6 vs 14.8 days)
  - No difference in mortality, LOS
  - Antibiotic costs not reported
  - ? Long-term effect on resistance patterns

# Modifiable Risk Factors

## *General prophylaxis (Standard of Care)*

- ✓ Effective infection control measures
  - Staff education
  - Compliance with hand disinfection
  - Isolation to reduce cross-infection with multi resistant organisms
  
- ✓ Surveillance of ICU infections
  - Identify and quantify endemic and new MROs
  - Guide appropriate antimicrobial therapy

# Modifiable Risk factors

## *Intubation and mechanical ventilation*

- ✓ Avoid intubation and reintubation
  - Use noninvasive ventilation whenever possible
- ✓ Use orotracheal/orogastric tubes to prevent nosocomial sinusitis (direct causality not proven)
- ✓ Inflate ETTs to maintain safe cuff pressure

# Modifiable Risk factors

## *Intubation and mechanical ventilation*

- ✓ Avoid neuromuscular blockade
- ✓ Prevent ventilator circuits condensate from entering ETT or in-line medication nebulizers .... Use closed ETT suctioning and eliminate saline instillation.

# Modifiable Risk factors

## *Intubation and mechanical ventilation*

- ✓ Use protocols to improve the use of sedation and to accelerate weaning
  - ✓ Avoid constant heavy sedation
    - ✓ Minimal yet effective sedation
    - ✓ Sedation scoring every 4 hours
    - ✓ Goal directed therapy
      - Sedation vacation
  - Use extubation readiness test
  
- ✓ Assure adequate nurse:patient ratios

# Modifiable Risk factors

## *Aspiration, body position, and enteral feeding*

- ✓ Position HOB up 30–45° to prevent aspiration, especially when receiving enteral feeding
  - Continuous rotational therapy and prone positioning
- ✓ Use enteral nutrition to decrease risk of bacterial translocation
- ✓ Use post-pyloric feeding in high risk patients
  - depressed gag reflex
  - delayed gastric emptying
  - gastro-esophageal reflux
  - severe bronchospasm)

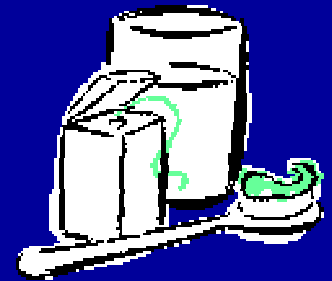
# Modifiable Risk factors

## *Modulation of colonization: oral antiseptics & antibiotics*

- Consider prophylactic systemic antibiotics for 24 hours post emergent intubation (closed head injury)
- Modulate oropharyngeal colonization with oral chlorhexidine (need more data)
  - ✓ Mouthcare practice guideline with supplies that are changed daily

# Prevention Practices

- Oral care with documentation every 2 hours
  - covered Yankauer
  - Y-connector to establish a dedicated oral care line
  - toothbrush
  - mouthwash
  - mouth moisturizer
- A new suction canister and kit obtained q 24 hrs



# Prevention Practices

- Suction oropharyngeal & subglottic area:
  - **before** suctioning the ETT
  - **before** repositioning the ETT
  - **before** deflating the cuff
  - **before** repositioning your patient to prevent aspiration of pooled secretions.

# Prevention Practices

- **Perform Hand Hygiene**



- Upon reporting for work
- Before & after gloving
- Before and after each patient contact or contact with the patient environment (eg bed, monitor, equipment etc)
- After handling contaminated objects
- Before handling medications
- Before eating
- After using the restroom
- When leaving the facility

## In conclusion...

Consensus on appropriate diagnostic, therapeutic and preventive strategies has yet to be reached.

Effective antimicrobial therapy and adequate supportive measures remain the mainstay of treatment for VAP.

