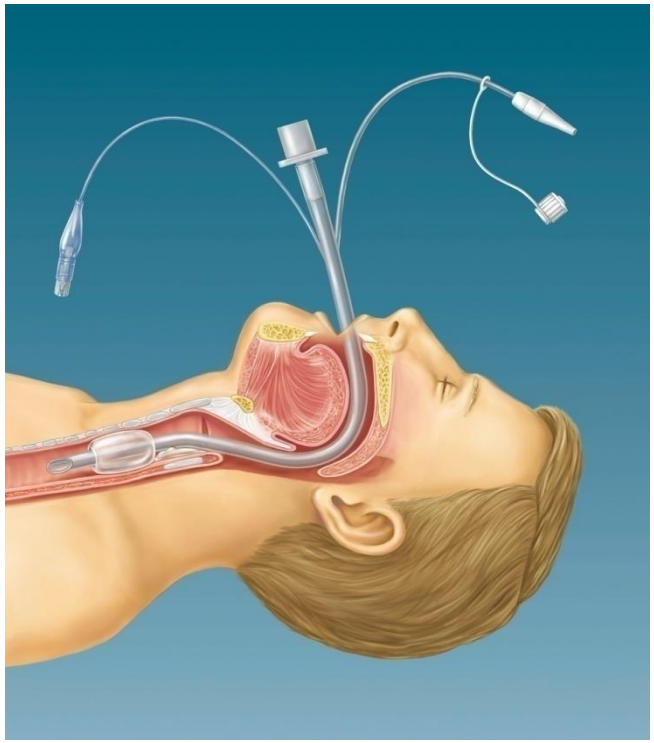
VENTILATOR-ASSOCIATED RESPIRATORY INFECTIONS (VARI)

BY
PROF. ADEL KHATTAB , MD , FCCP
PROFESSOR OF PULMONARY MEDICINE
AIN SHAMS UNIVERSITY

What is VARI?

- Intubated patients are at risk of bacterial colonization and ventilator-associated respiratory infections (VARI).



VARI includes:

Ventilator-Associated Tracheobronchitis (**VAT**)

Ventilator-Associated Pneumonia (**VAP**).

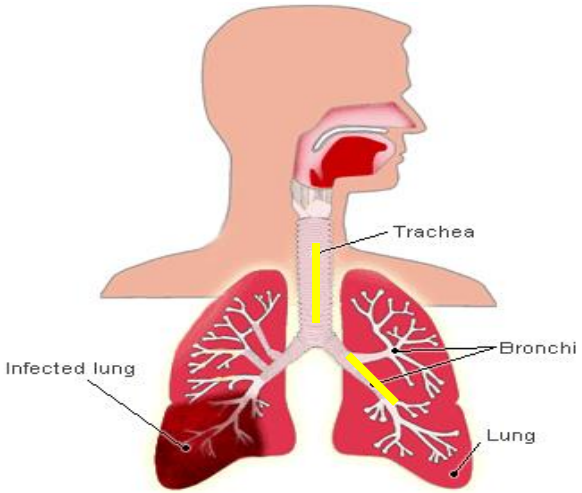
What is VARI?

What is VAP?

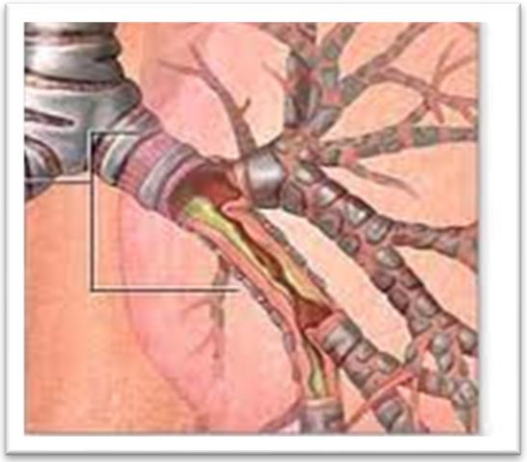
What is VAT?

A nosocomial Lower respiratory tract infection (LRTI) that arises > 48 hours after endotracheal intubation & mechanical ventilation

LRTI is Pneumonia

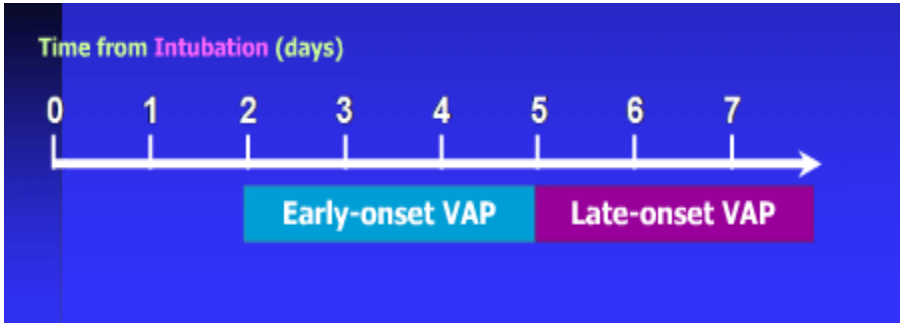


LRTI is tracheobronchitis



Dose time of onset differs?

VAP



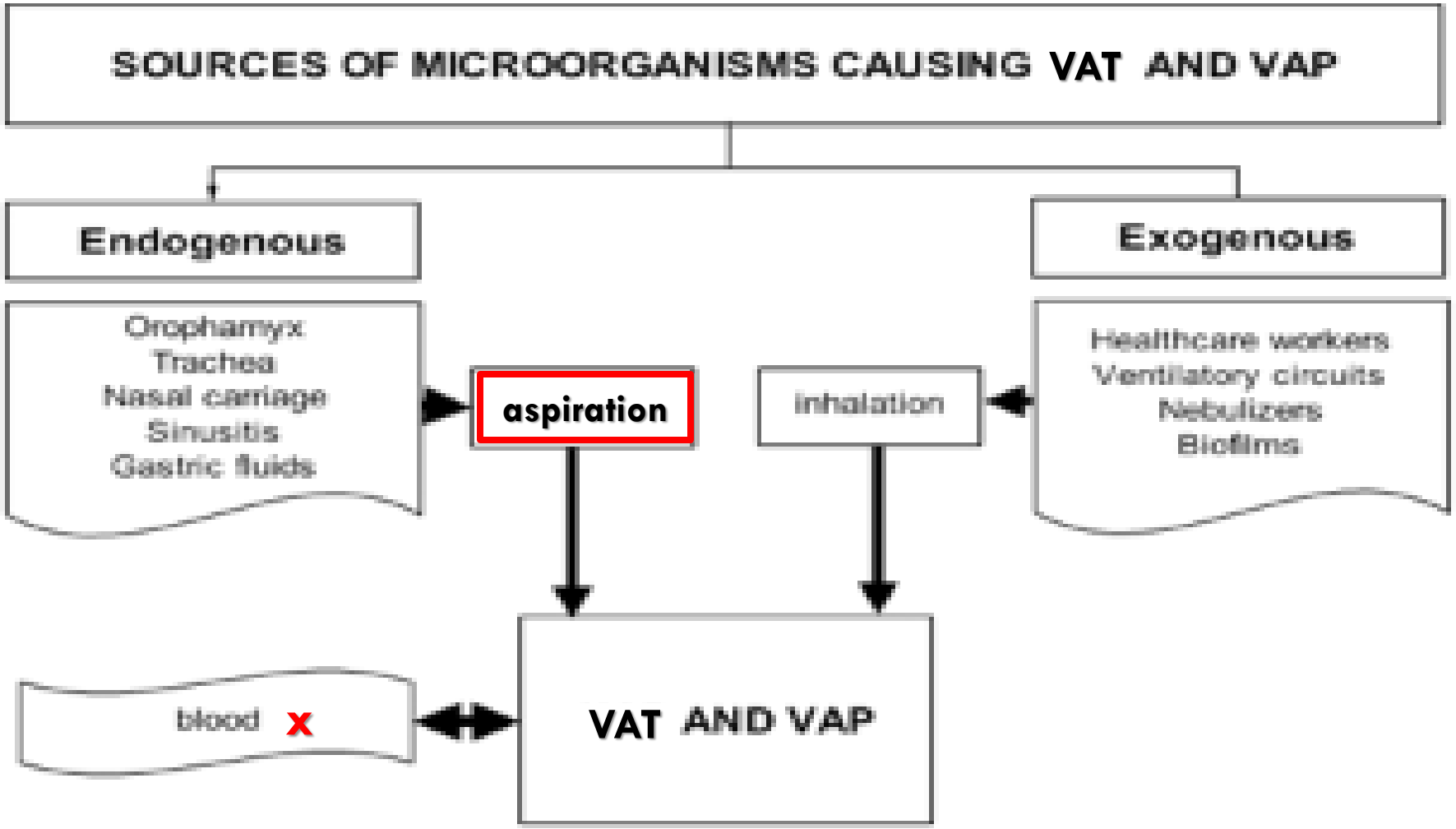
***Late onset VAP*:**

- **Associated with MDR organisms**
- **Higher mortality rates**

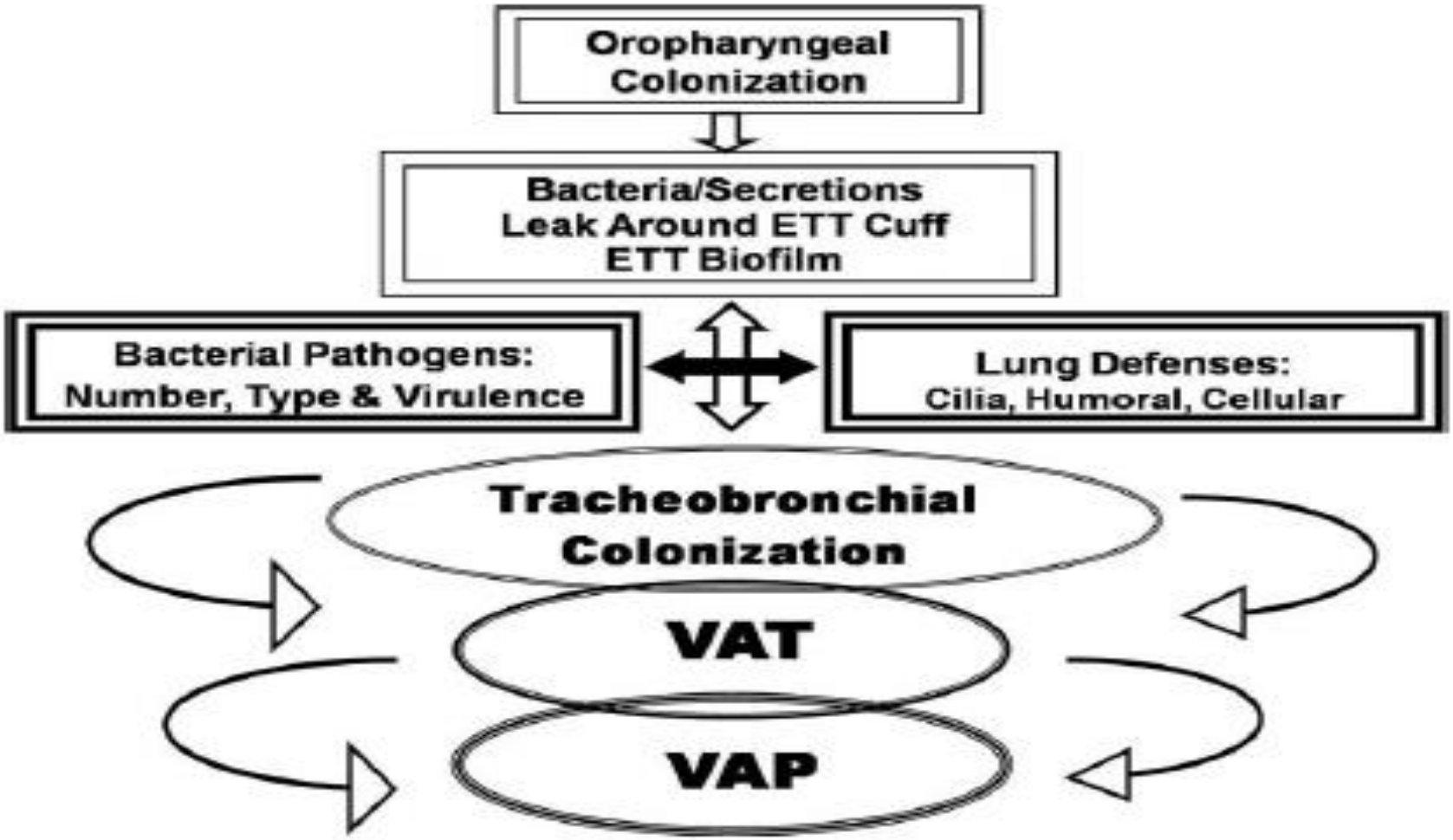
VAT

?

How do they occur?



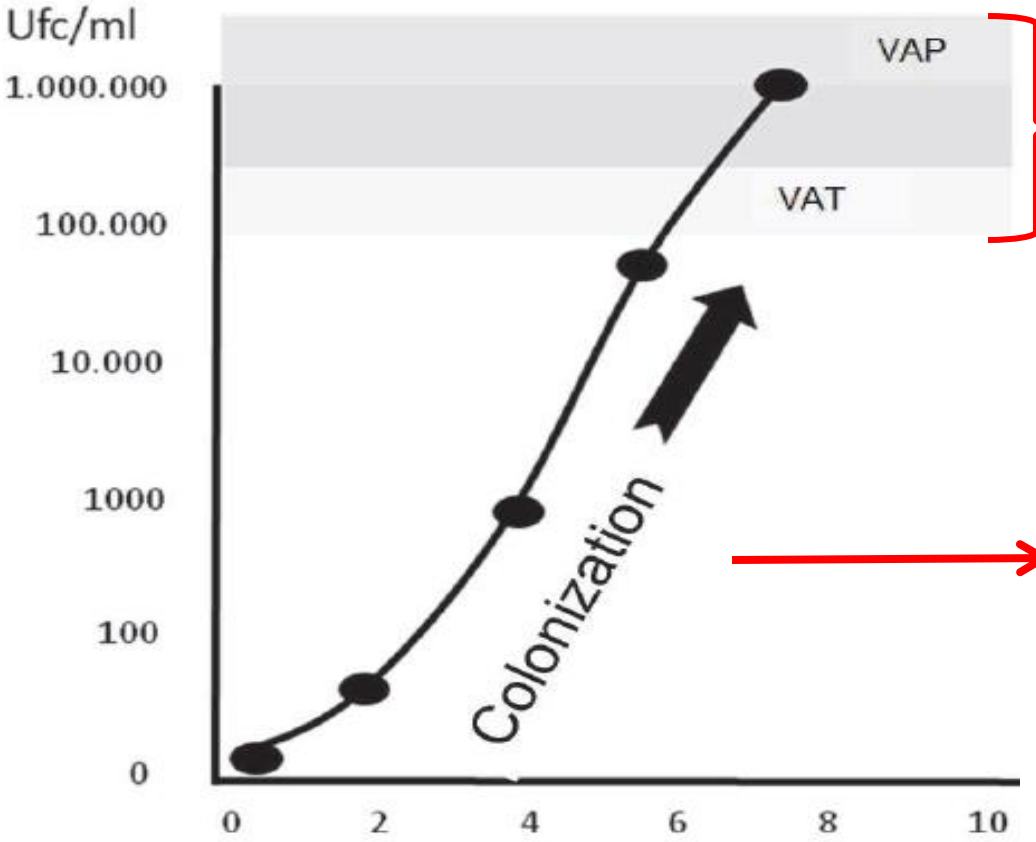
How do they occur?



Chest 2009;135;521-528

How do they occur?

Changes of tracheal colonization on mechanical ventilation



Clinical Picture of Respiratory infections

No Clinical Picture of Respiratory infections

Colonization LRT→ VAT (bronchi) → VAP (pulmonary parenchymal)

- **VAT and VAP may present simultaneously and sometimes difficult to separate clinically**

http://www.intechopen.com/books/bronchitis/ventilator-associatedtracheobronchitis

Who is at Greatest Risk?

VAP

- Reintubation
- Supine position
- Impaired cough/depressed LOC
- Oropharyngeal colonization
- Presence of NG/OG tubes and enteral feeding
- Cross contamination by staff

VAT

- Age >60 yrs
- COPD
- Prior antimicrobial treatment
- Surgery

Why Do We Care?

- VAP occurs in 10 - 65% of all ventilated patients
  Crit Care Clin (2002)
- VAP increases:
  - Medical costs
  - Ventilator days
  - ICU and hospital lengths of stay by 4 to 9 days
- Estimated direct cost of excess hospital stay due to VAP is $40,000 per patient.
- Mortality ranges from 20 to 41%, depending on infecting organism, antimicrobial therapy, and underlying disease(s).

Heyland et al, Am J Respir Crit Care Med 1999;159:1249 ; Craven, Chest 2000;117:186-187S
Rello et al, Chest 2002;122:2115; Safdar et al, Critical Care Medicine 2005;33:2184-93

Why Do We Care?

Table 1. Incidence of ventilator-associated tracheobronchitis (VAT)

First author [ref.]	Year of publication	Incidence of VAT	Population
Nseir [2]	2002	201 (9)	Medical and surgical ICU
Hortal [26]	2009	7 (10)	Heart surgery population
Ninan [27]	2010	21 (16)	Pulmonary step down unit
Dallas [22]	2011	28 (1.4)	Medical and surgical ICU

VAT significantly increases:

- **Duration of mechanical ventilation and ICU stay.**

No significant difference was found in ICU-mortality between patients with VAT and those without VAT.

Eur Respir Mon 2011. 53, 151–159.

What is the Causative Organisms?

Table 2. Microorganisms isolated in 330 episodes of ventilator-associated tracheobronchitis

Gram-negative microorganisms	295 (73)
Pseudomonas aeruginosa	104 (25)
Acinetobacter baumannii	72 (17)
Klebsiella oxytoca	21 (5)
Escherichia coli	17 (4)
Enterobacter spp.	16 (3)
Serratia spp.	15 (3)
Proteus mirabilis	13 (3)
Stenotrophomonas maltophilia	13 (6)
Citrobacter freundii	9 (2)
Morganella morgani	6 (1)
Haemophilus influenzae	8 (1)
Providencia stuartii	1 (0.2)
Gram-positive microorganisms	106 (26)
Methicillin-resistant *Staphylococcus aureus*	59 (14)
Methicillin-sensitive *Staphylococcus aureus*	27 (6)
Other *Staphylococcus*	1 (0.2)
Streptococcus pneumoniae	14 (3)
Other *Streptococci*	2 (0.4)
Enterococcus faecalis	1 (0.2)
Corynebacterium	2 (0.4)

The **MDR pathogens** most frequently isolated from patients with VAT and VAP

What is the Causative Organisms?

Early VAP

Probable Microorganisms
Streptococcus pneumoniae
Haemophilus influenzae
Staphylococcus aureus sensitive to methicillin
Gram-negative enteric bacilli
Escherichia coli
Klebsiella pneumoniae
Enterobacter spp.
Proteus spp.
Serratia marcescens

Late VAP

Probable Microorganisms
Pathogens listed in Table 4 and MDR pathogens
Pseudomonas aeruginosa
Klebsiella pneumoniae ($ESBL^+$)#
Acinetobacter species#
Methicillin-resistant Staphylococcus aureus (MRSA)
Legionella pneumophila#

The **MDR pathogens** most frequently isolated from patients with VAT and VAP

Table3: Risk Factors for Multidrug-Resistant Pathogens Causing HAP, HCAP and VAP

- Antimicrobial therapy in preceding 90 d.
- Current hospitalization of 5 d or more.
- High frequency of antibiotic resistance in the community or in the specific hospital unit.
- Presence of risk factors for HCAP:
  - Hospitalization for 2 d or more in the preceding 90 d
  - Residence in a nursing home or extended care facility
  - Home infusion therapy (including antibiotics)
  - Chronic dialysis within 30 d
  - Home wound care
  - Family member with multidrug-resistant pathogen
- Immunosuppressive disease and/or therapy.

Modified from the ATS Guidelines, 2005

How Do We Diagnose?

- Clinical criteria
- Radiological criteria
- Microbiological criteria

Suspected VAP or VAT

Microbiologically confirmed VAP or VAT Final diagnosis

How Do We Diagnose?

	VAP	VAT
Clinical signs & symptoms	New onset of purulent endotracheal secretions or change in sputum + At least **one** of Temperature (> 38°C) or leukocyte count >12,000/mL or leukopenia <4,000/mL or worsening oxygen requirements (↑ FiO2 or PaO2:FiO2)	
Radiology: CXR or CT scan	☐ New or progressive infiltrate on portable CXR	☐ No new infiltrate, or Non diagnostic CXR or CT (e.g. atelectasis, ARDS or CHF)

How Do We Diagnose?

VAP	VAT

Microbiology criteria

❑ **ETA or Mini-BAL:**

- ***Gram-stain*** with PMNLs with/without bacteria
- ***Semiquantitative culture*** (moderate-to-heavy growth) or ***Quantitative culture*** 10^{5-6} ***cfu/mL***

❑ **Bronchoscopic BAL**

Quantitative culture 10^4 **cfu/mL**

❑ **Bronchoscopic PSB**

Quantitative culture 10^3 **cfu/mL**

Bronchoscopic samples not required

How Do We Diagnose?

- **Clinical Pulmonary Infection Score (CPIS):** **Predictor scale for diagnosis of VAP and monitor response to therapy**

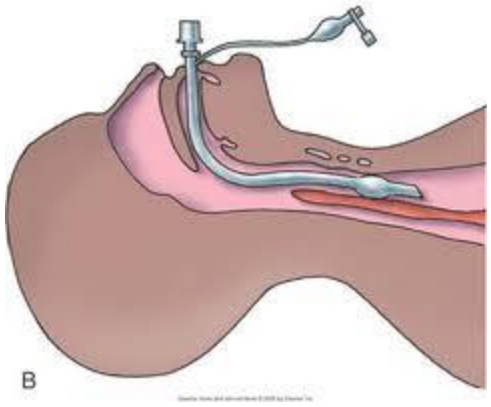
Table 1:THE MODIFIED CLINICAL PULMONARY INFECTION SCORE(CPIS) *

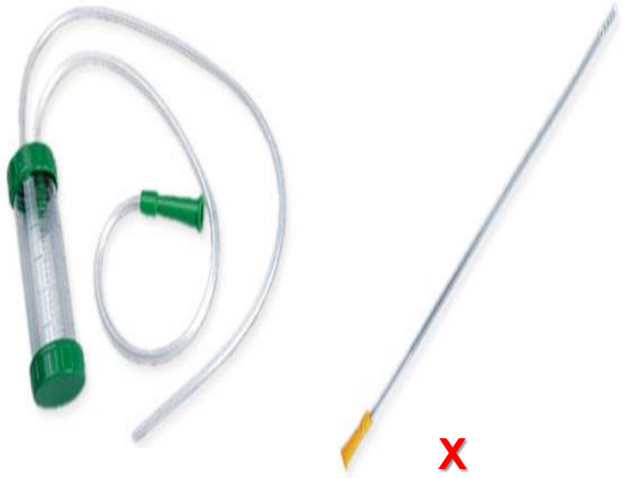
Criteria	0	1	2
Tracheal secretions	None	purulent	Abundant and purulent
Infiltrates on chest radiography	No	Diffuse	Localized
Temperature, °C	≥36.5 and ≤38.4	≥38.5 or ≤38.9	≥39 or ≤36
Leukocytes	≥4000 and≤11 000	<4000 or >11 000	<4000 or >11 000 + bands >50% or >500
PaO2/FiO2	>240 or ARDS		≤240 without ARDS
Microbiology	Negative		Positive

CPIS is made up of 6 items with a score ranging from 0 to 12. A score of more than six is considered suggestive of pneumonia.

CPIS >6 sensitivity of 93% & a specificity of 100%.

How Do We Diagnose?





Endotracheal tube aspirate (ETA):

Samples were obtained by sterile means. A length of approximately 24 cm of the catheter was passed through the endotracheal tube and secretions collected in a 25-ml mucus collector (Mucous extractor, Model No 4004, Ultra for Medical project, Abnoub, Assiut, Egypt) without instilling saline.

How Do We Diagnose?

New Mini-BAL:

AMERICAN COLLEGE OF CHEST PHYSICIANS

3300 Dundee Road, Northbrook, Illinois 60062-2348
rrabito@chestnet.org. www.chestnet.org
Voice: (847)498-8339.Fax:(847)498-5460

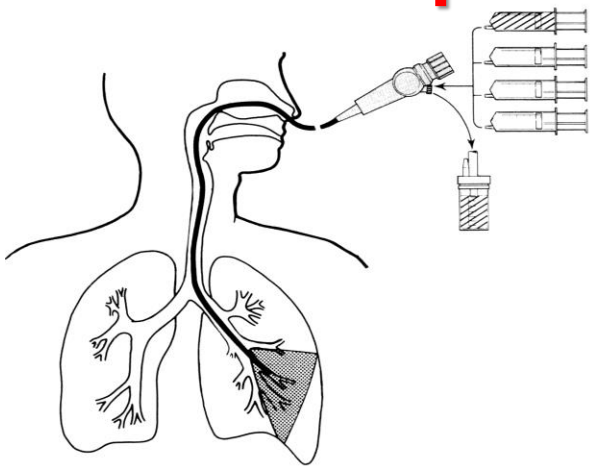
CHEST 2009 Abstract (Poster) Acceptance and Participation Invitation

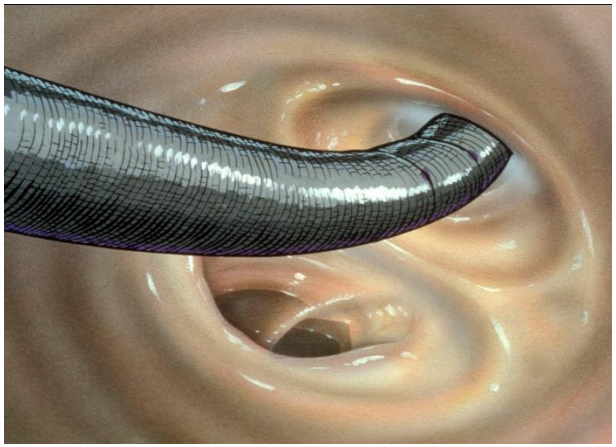
Congratulations! On behalf of the American College of Chest Physicians (ACCP) and the **Scientific Presentations and Awards Committee**, I am pleased to inform you that your abstract, (The Study of the Efficiency of a New and Cheap and Safe Method in Acquiring a Mini-Bronchoalveolar Lavage Sample for Diagnosis of Ventilator-Associated Pneumonia: An Initial Egyptian Trial) , has been accepted for:

- **Nelaton catheter** Size FG-18
  - wedged' into the distal airway
- **Sterile K-Y gel**
- **Infant ryle catheter** Size FG-10
  - advanced 2 to 3 cm beyond the tip of the nelaton, extruding the K-Y gel plug
- **Bronchoscopic Swivel Adapter.**
- **Three syringes** (20 ml each) with up to 60 mL of non-bacteriostatic normal saline and a specimen container.(a minimum of 2.0 ml)

How Do We Diagnose?

Bronchoscopic BAL



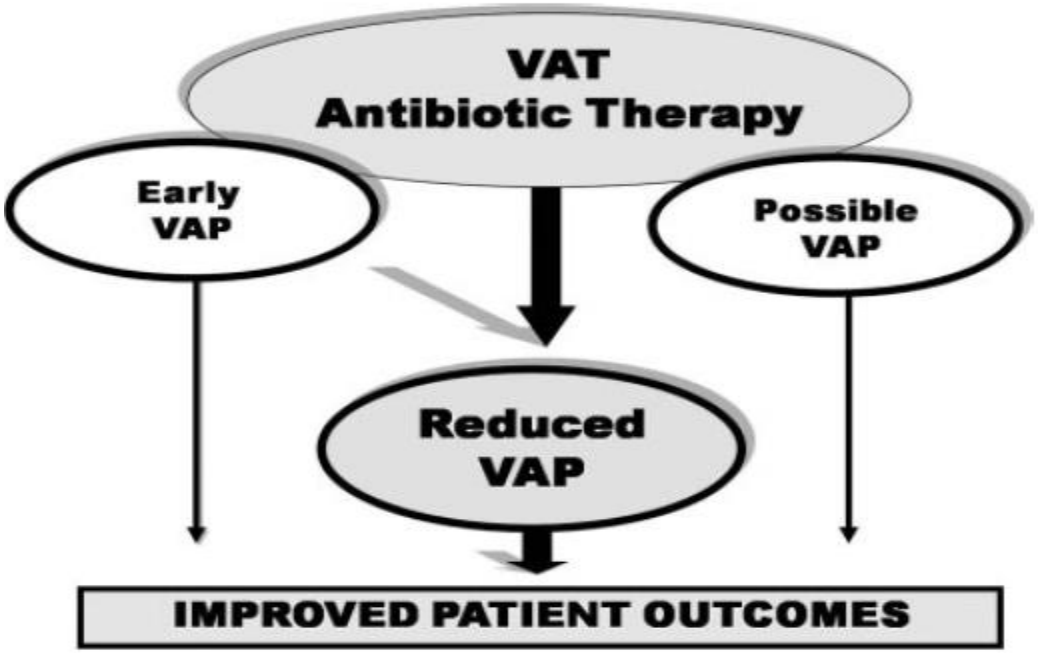


Bronchoscopic PSB

What are the treatment options available?

- VAT= Observe, No Antibiotics
- VAP= Rx Empiric Antibiotics
- VAT= Rx Empiric Antibiotics
- Don`t know, don`t care!

Why do we treat VAT?



- ***Early VAP*** (to early for chest radiograph changes)
- ***Possible VAP*** (pts with preexisting diffuse infiltrates that prevent confirmation of new infiltrate needed to diagnose VAP)

What is the impact of Antibiotic treatment on VAT outcome?

Table 3. Impact of antimicrobial treatment on outcome in patients with ventilator-associated tracheobronchitis

	Aerosolised antibiotics [4[#]]			Intravenous antibiotics [34[¶]]		
	Yes	No	p-value	Yes	No	p-value
Subjects n	19	24		22	36	
Days free of MV	10 (26)	0 (27)	0.069	12 (8–24)	2 (0–6)	<0.001
Subsequent VAP	35.7	78.6	0.007	13	47	0.011
ICU mortality	21.1	16.7	0.990	18	47	0.047
MDR-bacteria emergence	0	16.6	0.005	36	40	0.784

Eur Respir Mon 2011. 53, 151–159.

How do we manage?

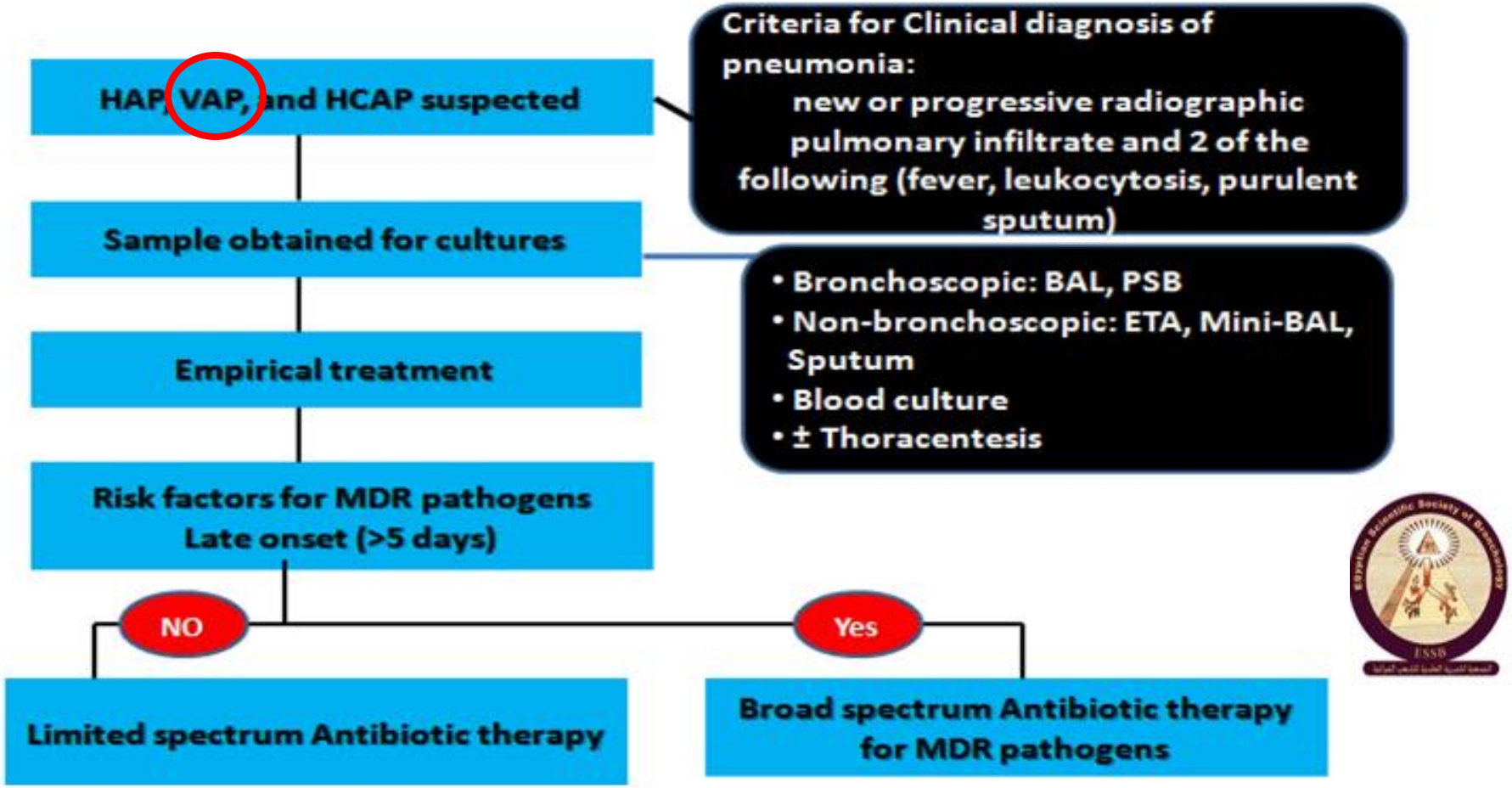


Figure 1: Algorithm for initiating empiric antibiotic therapy for HAP, VAP and HCAP

Table 4: Initial Empiric Intravenous Antibiotic therapy for HAP or VAP in patients with no risk factors for MDR pathogens, Early-onset and Any Stage of Severity

Probable Microorganisms	Recommended Antibiotic*
Streptococcus pneumoniae	3rd generation Cephalosporin
Haemophilus influenzae	*Or*
Staphylococcus aureus sensitive to methicillin	Levofloxacin
Gram-negative enteric bacilli	*Or*
Escherichia coli	Ertapenem
Klebsiella pneumoniae	
Enterobacter spp.	
Proteus spp.	
Serratia marcescens	

* *See* Table 6 for proper initial doses of antibiotics.

Table 5: Initial Empiric Intravenous Antibiotic Therapy for HAP, HCAP or VAP in patients with Late-onset or risk factors for MDR pathogens and Any Stage of Severity

Probable Microorganisms	Recommended Antibiotic*
Pathogens listed in Table 4 and MDR pathogens Pseudomonas aeruginosa Klebsiella pneumoniae (ESBL+)# Acinetobacter species# Methicillin-resistant Staphylococcus aureus (MRSA) Legionella pneumophila#	Antipseudomonal cephalosporin (Ceftazidime or Cefepime) *or* Carbapenem (Imipenem, Meropenem) *or* β-Lactam/ β-lactamase inhibitor (Piperacillin-tazobactam) ***Plus*** Antipseudomonal fluoroquinolone# (Ciprofloxacin, Levofloxacin) *or* Aminoglycoside (Amikacin, Gentamicin) ***Plus*** Teicoplanin or Vancomycin or Linezolid ‡

* See Table 6 for proper initial doses of antibiotics.

If an ESBL+ strain, such as K. pneumoniae, or an Acinetobacter species is suspected, a carbapenem is a reliable choice. If L. pneumophila is suspected, the combination antibiotic regimen should include a macrolide (e.g., azithromycin) or a fluoroquinolone (e.g., ciprofloxacin or Levofloxacin) should be used rather than an aminoglycoside.

‡ If MRSA risk factors are present or there is a high incidence locally.

What are VAT advantages, limitations & questions?

Advantages of VAT

- Standardized microbiologic criteria
- Serial Q-ETA identifies tracheal pathogens and their antibiotic
- Diagnosis does not rely on radiographic changes
- Improved patient outcomes and reduced health care costs
- An additional strategy for VAP prevention

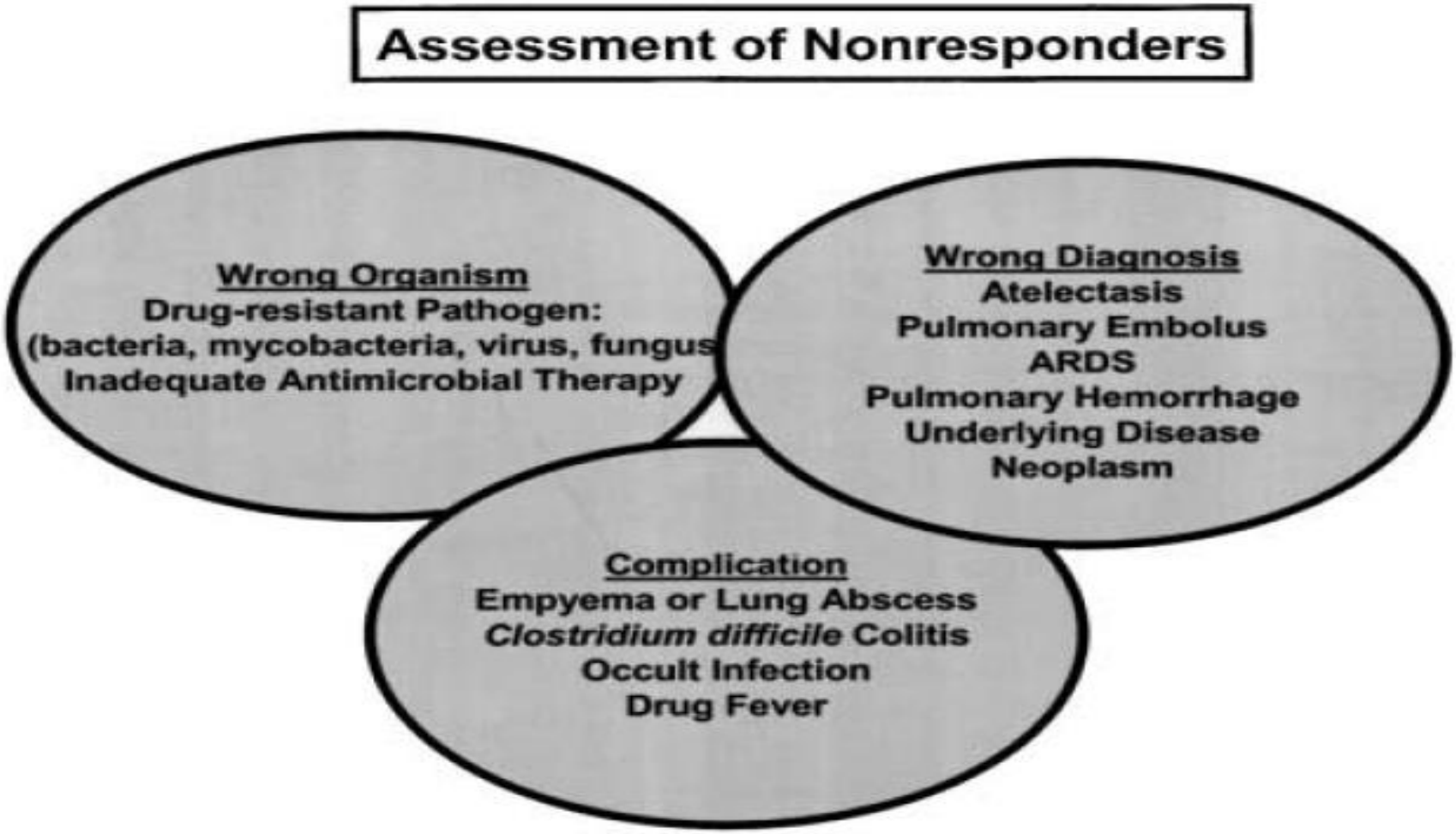
VAT limitations & questions

- Specific diagnostic threshold for Q-ETA needed (10^5 *cfu/mL* vs 10^{-6} *cfu/mL*)
- Thresholds for different pathogens & for immunocompromised patients
- Frequency of surveillance Q-ETA not well established; increased volume of work for microbiology laboratories
- Current data on VAT impact on VAP prevention needed.
- Confirmation and validation needed in larger databases.


© Original Artist
Reproduction rights obtainable from
www.CartoonStock.com
M.R.S.A.
SAL-MONELLA
E. COLI
SORRY WARD FULL
CHAFF.

Thank you

Assessment of Nonresponders



Adult Ventilator Bundle

VAP prevention measures

1. Hand washing
2. Patient positioning
3. Oral care
4. Management of oropharyngeal and tracheal secretions
5. Daily "Sedation Vacation" and daily assessment of readiness to extubate.
6. Treat VAT?

General measures to improve care

1. Peptic ulcer disease prophylaxis
2. Deep vein thrombosis (DVT) prophylaxis