Ventilator-Associated Pneumonia (VAP)

بیمارستان ولی عصر (عج) اراک

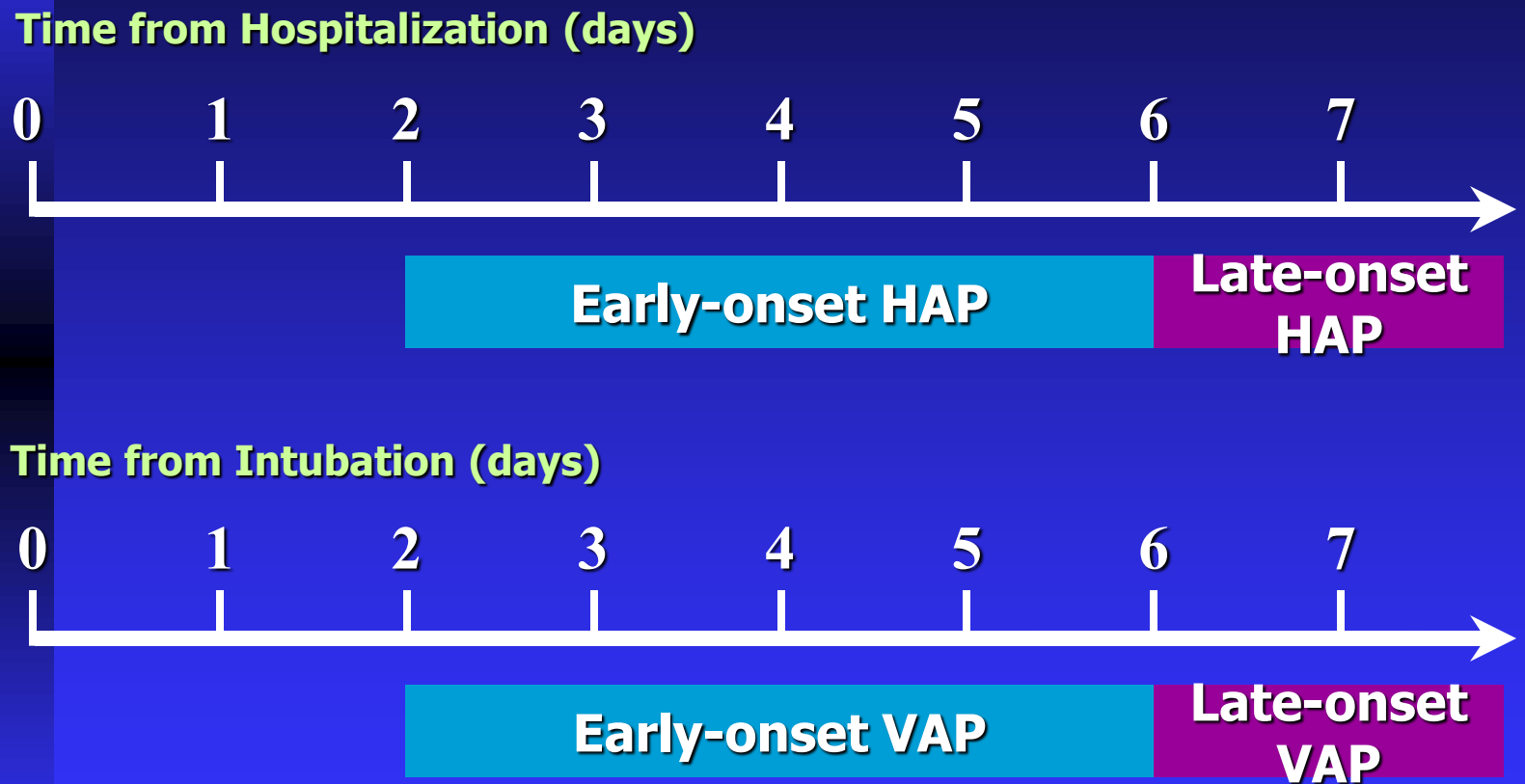
۱۴ مرداد ۹۹

Definitions

- HAP: Pneumonia that occurs 48 hours or more after admission and did not appear to be incubating at the time of admition.
  - Early and Late onset
- VAP: A type of HAP acquired at 48 hours after intubation.
  - Early and Late onset
- HCAP: Non hospital patient with healthcare contact
  - IV therapy, wound care, chemotherapy within 30 days
  - Nursing home or long term care facility **(Nursing Home Pneumonia)**
  - Hospitalization >2 days or more in past 90 days
  - Attendance at hospital within 30 days
  - Family member with a MDR pathogen

Classification of HAP & VAP:

Risk Stratification



Diagnosis

- Progressive infiltrate on lung imaging and clinical characteristics such as:
  - Fever
  - Purulent sputum
  - Leukocytosis
  - Decline in oxygenation
- Radiographic findings plus two of the clinical findings.
  - 69% sensitivity and 75% specificity for pneumonia (autopsy as reference)

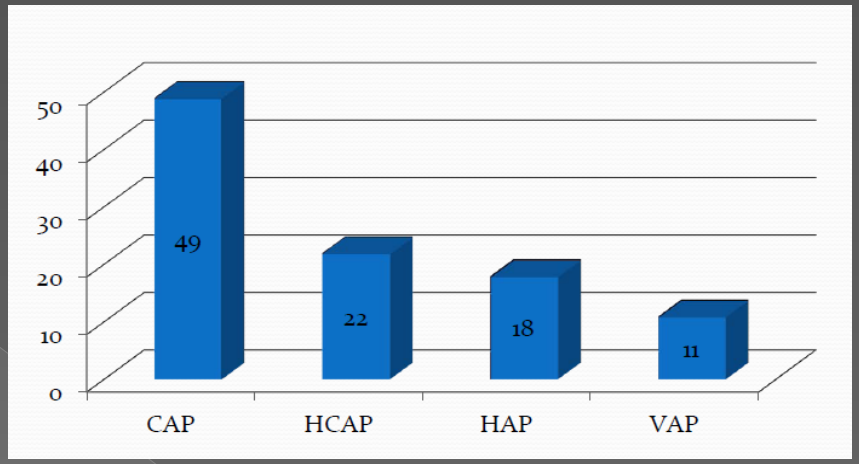
Imperfect diagnostic tests

- Blood cultures, limited role, sensitivity is only 8% to 20%
- Sputum neither sensitive, nor specific
- Tracheo-bronchial aspirates- high sensitivity
  - does not differentiate between pathogen and colonizer
  - Quantitative cultures increase specificity of the diagnosis of HAP.
- BAL, PSB's do not differ from less invasive tests in terms of sensitivity, specificity or, more importantly, morbidity and mortality.
  - Negative lower respiratory tract cultures can be used to stop antibiotic therapy in a patient who has had cultures obtained in the absence of an antibiotic change in the past 72 hours.
- Role of rapid diagnostic test (PCR) (Multiplex PCR)

Epidemiology

- HAP is the second most common nosocomial infection in the US
- HAP increased hospital stay by an average of 7-9 days per patient
- Estimated occurrence of 5-10 cases per 1,000 hospital admissions
- HAP accounts for up to 25% of all ICU infections and more than 50% of antibiotics prescribed

Study of 4543 pts. with Culture Positive Pneumonia: Incidence (%)

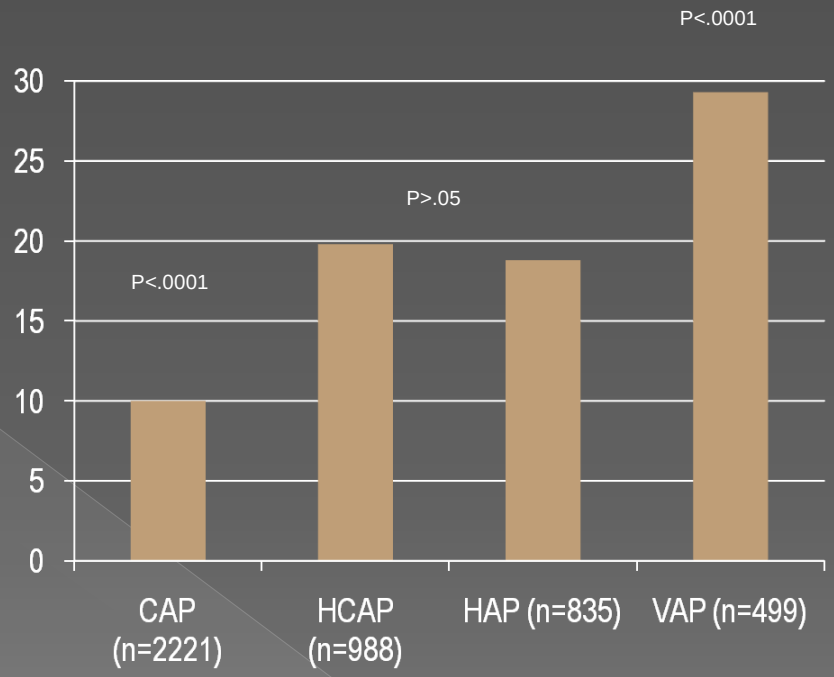


Variable	CAP	HCAP	HAP	VAP
LOS, d	7.5	8.8	15.2	23.0
Total charges, $	25,218	27,647	65,292	150,841

Kolle MH, et al. Epidemiology and outcomes of healthcare associated pneumonia: results from a large US database of culture positive pneumonia. Chest 2005;128:3854 62

Outcome

- HAP-associated mortality remains the leading cause of death among hospital-acquired infections
- Crude mortality of HAP is 30-70%
- Attributable mortality is 20-50%
- Worse outcomes in patients with bacteremia, medical rather than surgical illness, ineffective and late antibiotic therapy.



Etiology

- Aerobic gram-negative bacteria:
  - P. aeruginosa, Escherichia coli, Klebsiella pneumoniae, and Acinetobacter species
- Gram-positive cocci
  - S. pneumonia.
  - H. influenzae
  - Staphylococcus aureus (50% in ICU due to MRSA)
    - More common in patients with diabetes mellitus, head trauma and those hospitalized in the ICU.
  - Oropharyngeal commensals (viridans group streptococci, coag-negative Staph, Neisseria species and Corynebacterium) may be relevant in mostly immunocompromised patients.

Results, Time of Infection

- HAP:
  - Early onset (0-4 days): S. pneumoniae, H. influenzae
  - Late onset (5+ days): oxacillin resistant S. aureus, P. aeruginosa
- VAP:
  - Early onset (0-4 days): oxacillin susceptible S. aureus, S. pneumoniae, Hemophilus sp.
  - Late onset (5+ days): Acinetobacter sp. and S. maltophilia

Etiology

- Fungal pathogens: most common is Candida and Aspergillus
- Most commonly in organ transplant or immunocompromised, neutropenic patients.
- Aspergillus- contaminated air ducts or local construction.
- Candida- common airway colonizer and rarely requires treatment.

Etiology

- Viral Pathogens: low incidence in immunocompetent hosts.
- Influenza A is the most common viral cause of HAP and HCAP in adults.
- Risk for secondary bacterial infection "super-infection"
  - Streptococcus, H. influenza, Group A Streptococcus, S. aureus

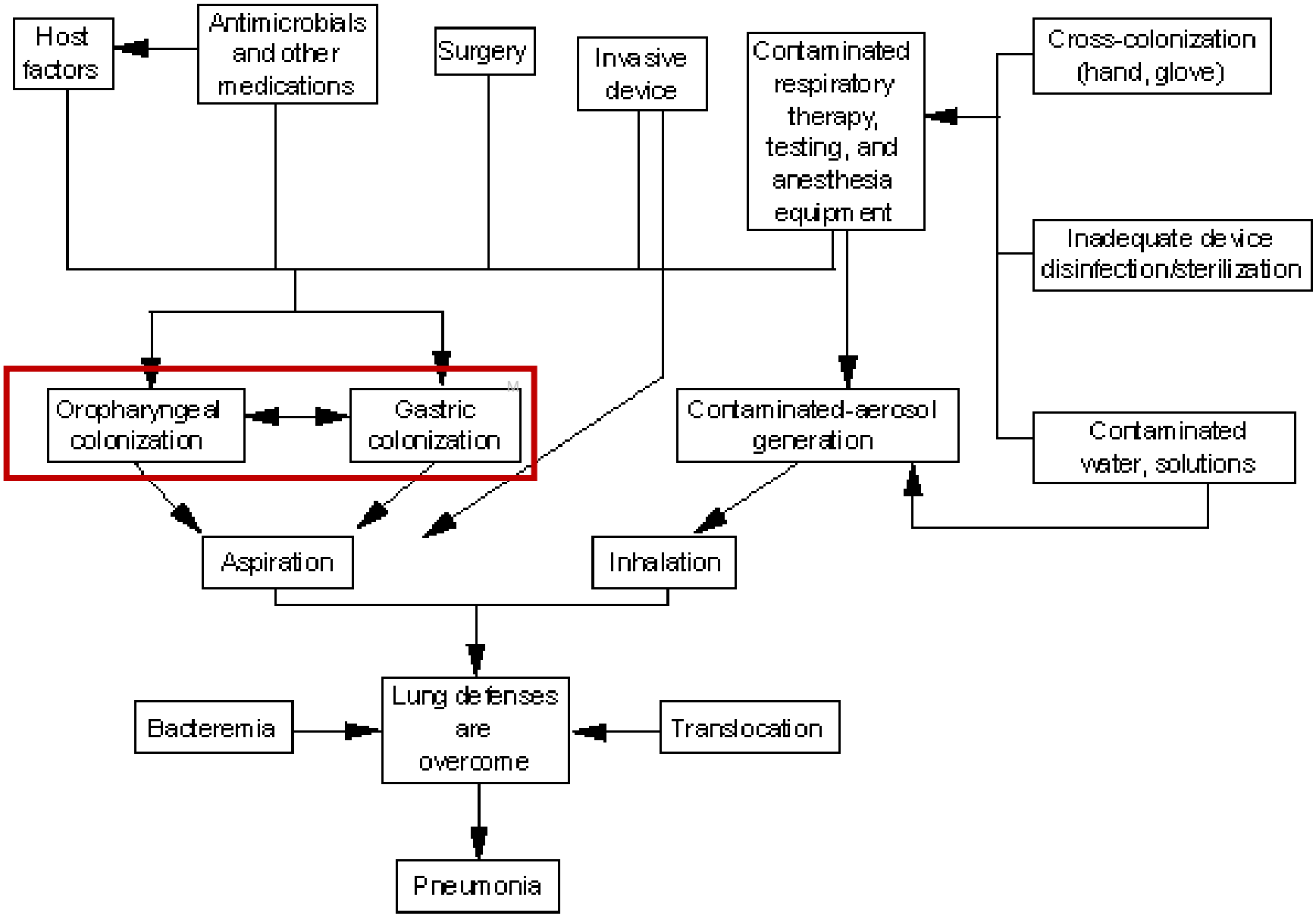
MDR risk factors

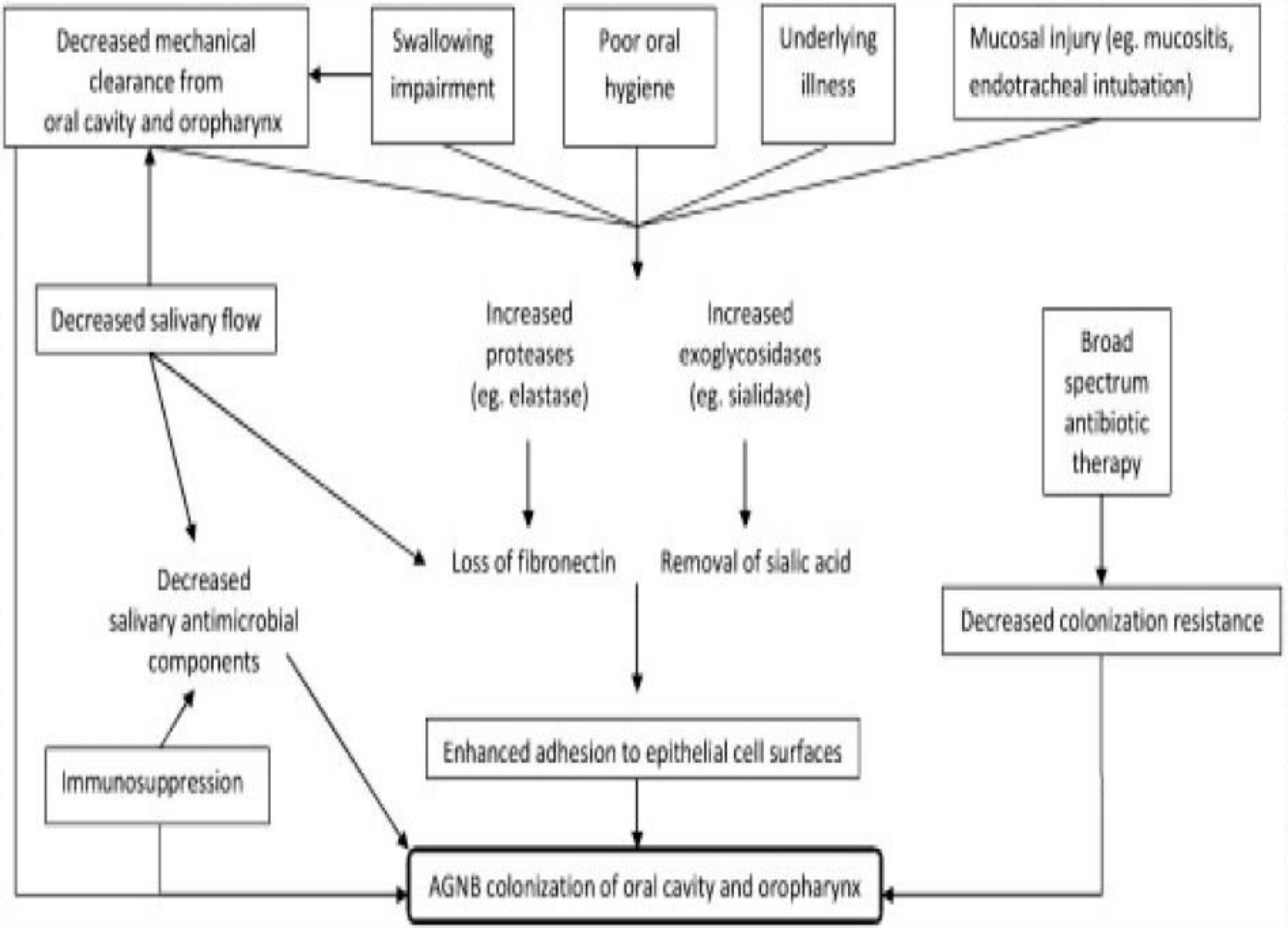
- Host risk factors for infection with MDR pathogens include:
  - Treatment with antibiotics within the preceding 90 days.
  - Current hospitalization of >4 days
  - High frequency of antibiotic resistance in the community or hospital unit
  - Immunosuppressive disease and/or therapy
  - Hospitalization for >/= 2 days within the last 90 days
  - Severe illness
  - Antibiotic therapy in the past 6 months
  - Poor functional status

Pathogenesis

- Number and virulence of organisms entering the lower respiratory tract and response of the host.
- microaspiration of organisms which have colonized the upper respiratory/gastrointestinal tract
- Hospitalized patients tend to become colonized with organisms in the hospital environment within 48 hours.
- Common mechanisms include: mechanical ventilation, routine nursing care, lack of hand washing of all hospital personnel.
- Disease state also plays a role: alteration in gastric pH due to illness, certain medications, malnutrition and supplemental feedings.

FIGURE 1. Pathogenesis of nosocomial bacterial pneumonia





Lam OLT, et al. Effectiveness of oral hygiene interventions against oral and oropharyngeal reservoirs of aerobic and facultatively anaaerobic graminegative bacilli. AJIC 2012;40:175-82.

Which Patients Are At Risk?

- Liver disease prior to and during transplantation
- End-stage renal disease undergoing hemodialysis
- Cardiovascular disease undergoing surgery
- Abdominal cancer, head and neck cancer
- Leukemia
- COPD
- Cerebral palsy
- Asthma, stroke, chronic bronchitis, pharyngitis, HIV infection, diabetes, alcoholism, Parkinson's Disease
- Hospitalized, Institutionalized elderly individuals

VAP

WHY IT IS IMPORTANT?

*VAP..... 25% of all nosocomial infections in ICU.
*VAP..... 10 -25% of all mechanical ventilated patients.
*VAP ..... 20-50% morbidity and mortality.
*VAP..... is a preventable disease.

Definition:

*Clinically defined pneumonia.

*It is associated with ventilation(by endotracheal or tracheostomy).

*Pneumonia occurs 48hrs or more after being placed on ventilator.

*Pneumonia occurs to 48hrs after extubation.

Clinically Defined Pneumonia Diagnosis:

Two or more serial x-ray with at least one of the following:

* New or progressive and persistent infiltrate.
* Consolidation .
* Cavitation.

At least one of the following:

* Fever (>38 with no other recognized cause).
* Leucopenia (<4,000 WBC/mm3) or
* Leukocytosis(>12,000WBC/mm3).
* For adults> 70y altered mental status with no other recognized cause.

Clinically Defined Pneumonia Diagnosis (cont.)

And at least two of the following:

* New onset of purulent ,or change in character of sputum or increased respiratory secretion.
* New onset of cough , dyspnea ,tachypnea.
* Rales or bronchial breath sounds.
* Worsening gas exchange ,increased oxygen requirements, or increased ventilator demand.

Risk Factors of VAP:

* Length stay in ICU.
* Presence of multiple central venous catheter.
* Prophylactic antimicrobial therapy.
* Depressed consciousness, Glascow coma scale score of less than 9/15.
* Massive gastric aspiration.
* Enteral nutrition.
* Reintubation after weaning.
* Transfer from another hospital ward .
* Tracheostomy .
* Steroid therapy.

The Most Frequent Isolated Microorganism :

* Staphylococcus aureus (MSSA or MRSA).
* Streptococcus pneumonia.
* Hemophilus influenza.
* Pseudomonus aeruginosa.
* Acinetobacter.
* Enterobacter.

Diagnosis of VAP:

VAP has been diagnosed by clinical criteria. These are non specific:

* **Fever**..... drug reaction, extrapulmonary infection, blood transfusion .

* **Pulmonary infiltrates**..... Pulmonary haemorrhage, chemical aspiration, pleural effusion, congestive heart failure, tumor .

* **Fever and pulmonary infiltrates**..... fibroproliferation of late acute respiratory distress syndrome, atelectasis, pulmonary embolism.

Specific Standard Criteria for Diagnosis of VAP

Culture of tracheal aspirates are not very useful in establishing the VAP, although such cultures are highly sensitive, their specificity is low even when they are cultured quantitatively.

Specific Standard Criteria for Diagnosis of VAP (cont.)

* Histopathologic examination of lung tissue.....lung biopsy.

* positive pleural fluid culture.

* lung autopsy.

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Bronchoscopic Diagnostic Technique:

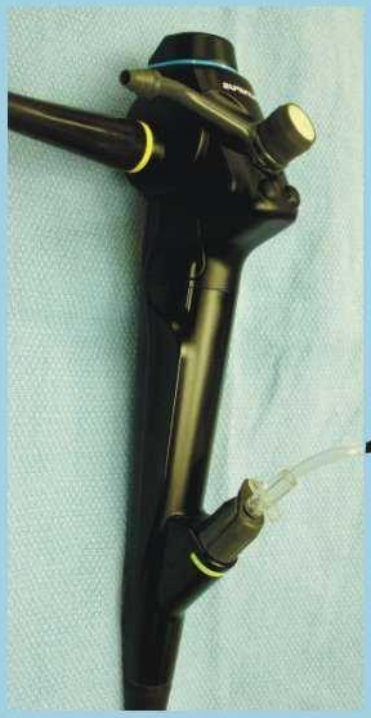
Two Bronchoscopic techniques are used:

1-Protected specimen brush(PSB)

2-Bronchoalveolar lavage examination (BAL).

Both techniques are effective in diagnosis of VAP as the standard specific criteria

AN EXAMPLE SETUP FOR OBTAINING BRONCHOALVEOLAR



The bronchoscope is wedged at the desired location for the BAL. Tubing is connected at the instrument channel which is ...

... attached to a syringe containing the saline through a three-way stopcock. The saline is instilled into the broncho-alveolar space from here. The third port of the stopcock is ...

... attached to the trap that will collect the BAL effluent. The effluent is collected when the stopcock is turned off to the syringe which causes suction through the trap ...

... from the suction unit. The typical pressure used during BAL is -80 cm-H_2O. Lower pressures may be used if complete collapse of the bronchus occurs preventing collection of the lavage sample.

Direct Non-Bronchoscopic (Blind)Technique:

This involve passage of a catheter or a telescopic catheter through the endotracheal tube with advancement to a wedge position in the lung

Antibiotics

* The ATS (American thoracic society) has focus on pseudomonas aeruginosa as an important factor in the ttt algorism of VAP.

* Patient with suspicious Pseudomonus aeruginosa.....combination therapy with a beta lactam antibiotic (penicillin or cephalosporin) plus pseudomonal quinolone or beta lactam with a aminoglycoside .

Antibiotics (cont.)

* Patient without suspicious of Pseudomonus aeruginosa.....second or third generation cephalosporin plus macrolide or quinolone .

* Empiric initial therapy is started immediately upon presentation with VAP till cultures and gram stains of collected sputum is performed then therapy is tailored to these results.

Bundles Methodology

*Bundles are group of intervention related to a disease that when instutes together give better outcomes than when done individually.

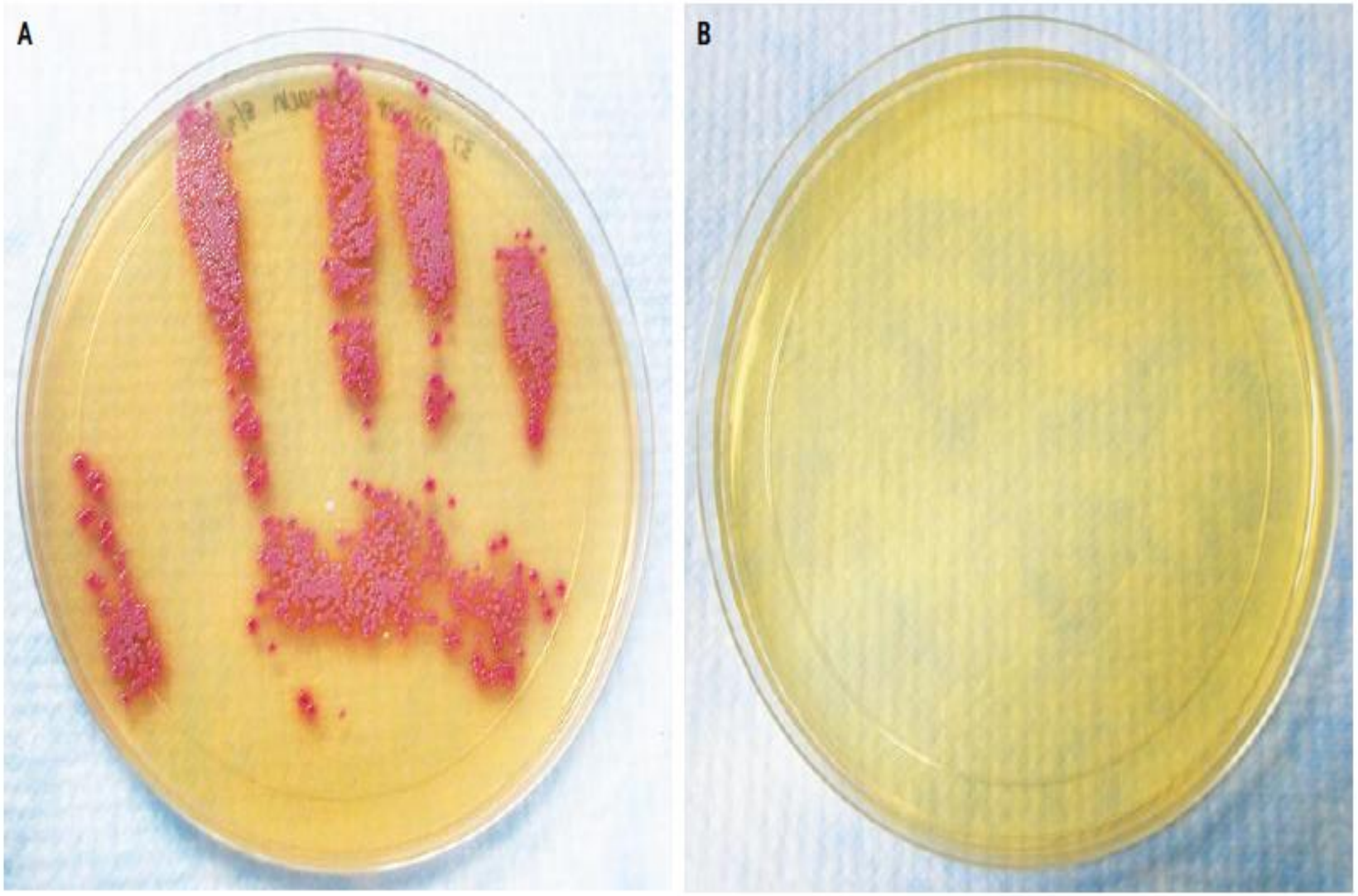
*Provide a mechanism to enhance teamwork and enhance outcome.

*The guideline become as road map to enhance outcome.

VAP Bundle

- Handwashing
- Elevation of the bed between 30-45 degree at all time (unless contraindicated).
- Deep venous thrombosis (DVT) prophylaxis (unless contraindicated).
- Peptic ulcer disease (PUD) prophylaxis.
- Sedation interruption.
- Mechanical ventilation weaning protocol.
- Oral care.

The Hands Give It Away



New CDC guideline recommends frequent use of alcohol-based handrubs

- New guideline developed by the Centers for Disease Control and Prevention (CDC) and infection control organizations recommends that healthcare workers use an alcohol-based handrub (a gel, rinse or foam) to routinely clean their hands between patient contacts, as long as hands are not dirty.

Elevation of The Head of Bed (HOB):

* Please remember to elevate the HOB>30 degree , and raise knees for all ventilated patients unless contraindicated .

*Elevation of HOB has been correlated with reduction in the rate of the ventilator associated pneumonia.

The pathogenesis of VAP:

1) Bacterial colonization of the stomach and oropharynx
2) Subsequent pulmonary aspiration of contaminated secretion

- The mechanically ventilated patients are prone to gastric bacterial colonization due to the widespread use of histamine(h2) blockers and proton pump inhibitors .....to prevent gastric ulcer. nasogastric and nasoenteric feeding tube which decrease competance of the lower oesphogeal sphincter....aspiration.

* Therefor elevation of the HOB has been correlated with reduction in the rate of VAP as this reduce the incidence of aspiration.

DVT Prophylaxis:

* As elevation of head of bed may contribute to venous stasis and DVT.

* The risk of venous thromboembolism is reduced if prophylaxis is consistently applied.

* A clinical practice guideline recommends DVT prophylaxis for patients admitted to the ICU.

PUD (Peptic Ulcer Disease) Prophylactic:

* Stress ulceration are the most common cause of gastrointestinal bleeding in intensive care unit patients .

* This predisposed to aspiration and VAP .

* Thus applying PUD prophylaxis is a necessary intervention.

Sedation Interruption:

Sedation in ICU has the benefit of reducing psychological problems to the patients .

However heavy sedation is harmful and predispose to VAP by :

1-Inhibiting coughing.

2-Inhibiting mobilization.

3-Decreasing immune function.

4-Promoting aspiration.

5-Prolongs time on ventilator.

Optimal Sedation:

1-Awake and cooperative patient.

2-Cough , swallowing reflexes intact.

3-Add analgesia to the protocol .

4- Titration to a sedation score to avoid oversedating the patient .

5-Intermittent rather than continuous sedation.

6-Sedation vacation (sedation interruption).

Sedation Vacation:

Application:

*Hold sedation until patient is alert or can follow commands at least once a day.

*After sedation interruption restart sedation at a fraction of the prior dose (1/2 or 3/4).

Mechanical Ventilation Weaning Protocol:

*Non-physician driven weaning protocol (by nurses or respiratory therapists).

*Daily assessment of readiness to wean from ventilator:

-keep Vt and pressure low.

-preextubation assessment and worksheet .

-ETT cuff inflation via minimal leak technique to 20-25cmH2O(minimal occlusive pressure).

*This reduce mechanical ventilation days and ventilation associated pneumonia .

Oral Care:

Designed for patients who are intubated or tracheostomiazed

* Mouth care protocol.
* Brush twice .
* Swab every two hours.
* Chlorhexidine rinse.
* Apply mouth moisturizer.
* Replace suction line, tubing every 24hours

Other Consideration:

* Proper care of respiratory care equipment.

* Proper care of all ICU equipment (monitor, lines, syringes, pumps, ect....).

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Caring for the Critically Ill Patient

Silver-Coated Endotracheal Tubes and Incidence of Ventilator-Associated Pneumonia

The NASCENT Randomized Trial

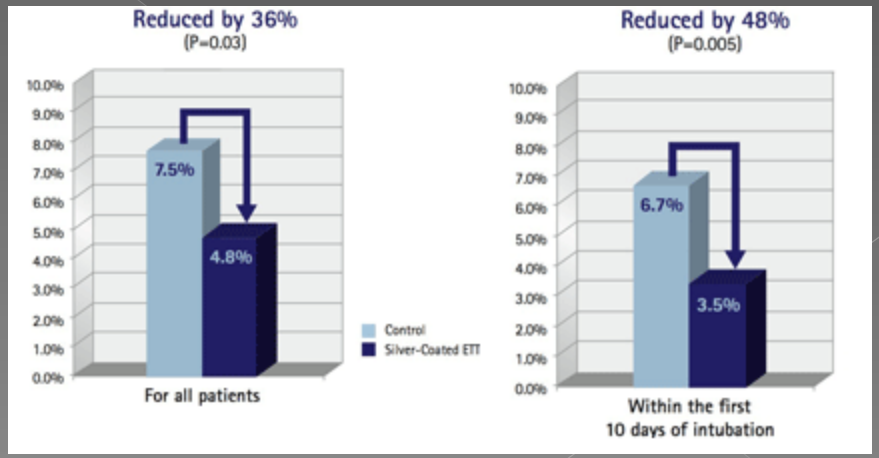
Marin H. Kollef, MD; Bekele Afessa, MD; Antonio Anzueto, MD; Christopher Veremakis, MD; Kim M. Kerr, MD; Benjamin D. Margolis, MD; Donald E. Craven, MD; Pamela R. Roberts, MD; Alejandro C. Arroliga, MD; Rolf D. Hubmayr, MD; Marcos I. Restrepo, MD; William R. Auger, MD; Regina Schinner, Dipl-Stat; for the NASCENT Investigation Group

JAMA. 2008;300(7):805-813.

Silver-Coated Endotracheal Tubes and Incidence of Ventilator-Associated Pneumonia

The NASCENT Randomized Trial

- CONCLUSION: Patients receiving a silver-coated endotracheal tube had a statistically significant reduction in the incidence of VAP and delayed time to VAP occurrence compared with those receiving a similar, uncoated tube ,



Saline instillation before tracheal suctioning decreases the incidence of ventilator-associated pneumonia*

Pedro Caruso, MD, PhD; Silvia Denari, PhD; Soraia A. L. Ruiz, RT; Sergio E. Demarzo, MD, PhD; Daniel Deheinzelin, MD, PhD

- The relative risk reduction of VAP in the saline instillation group was ▼54% (95% confidence interval [CI] 18%–74%) and the *number needed to treat was 8 (95% CI 5–27).*

Non Invasive Ventilation (NIV):

* To reduce need and duration of intubation and mechanical ventilation.

* Many studies show a decrease in pneumonia and mortality in NIV group patients compared to invasive mechanical ventilation
* Patients population in whom NIV has been effective are:-

  COPD, pulmonary edema, hypoxemic respiratory failure.

Type of NIV:

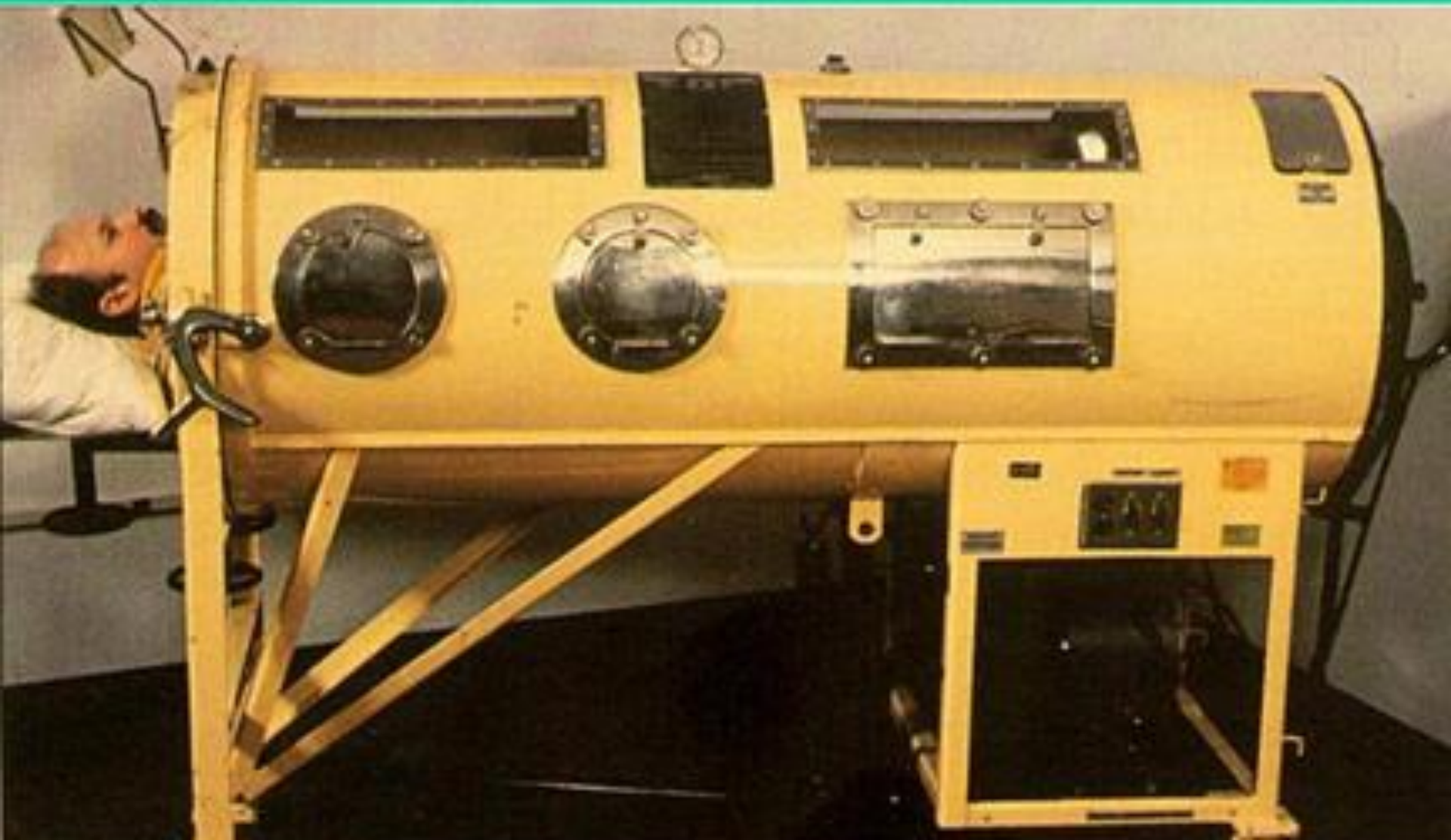
1-Negative pressure ventilation

2-Positive pressure venmtilation (BIPAP or CPAP).

Negative non invasive ventilation:

Ventilation by lowering the pressure surounding the chest wall during inspiration and reversing the pressure to atmospheric level during expiration. The device augment the tidal volume by generating negative extrathorasic pressure.

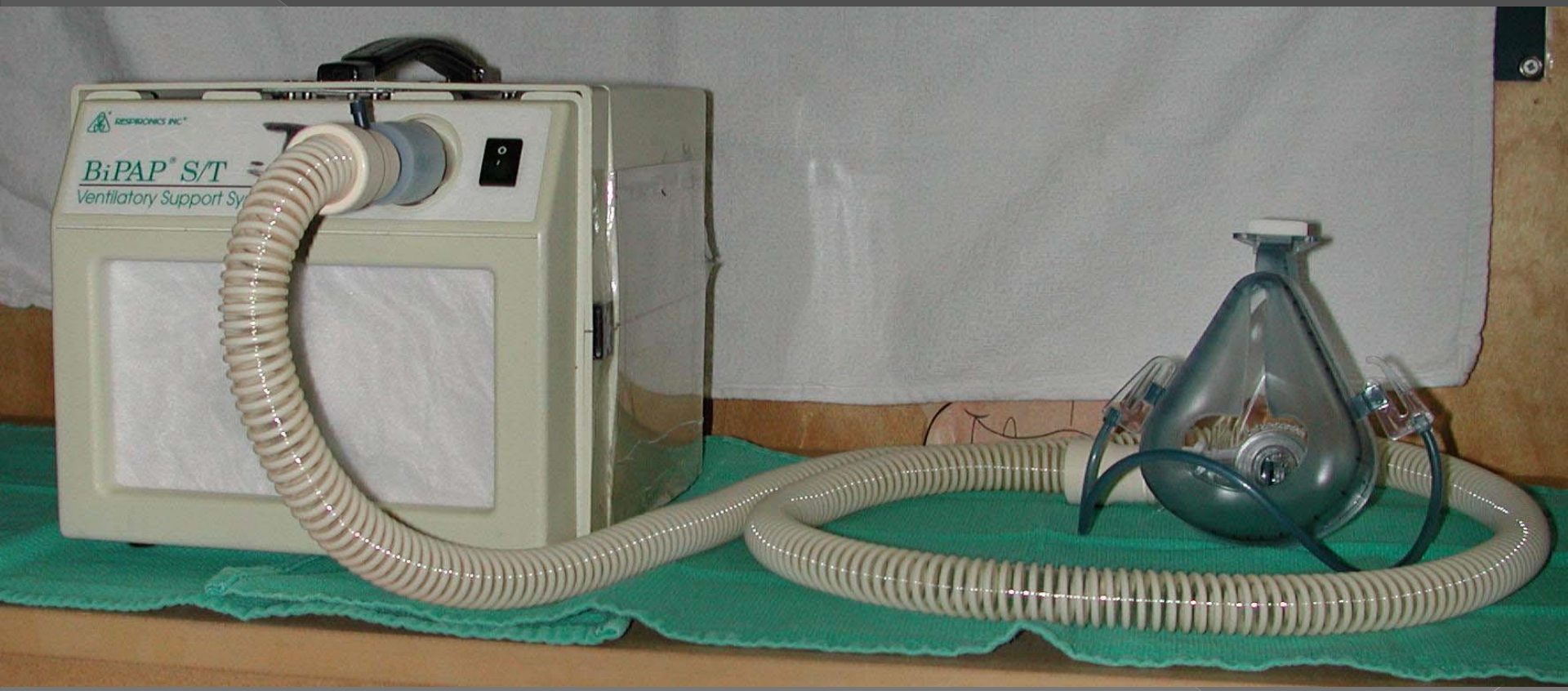
Iron Lung



Positive non invasive ventilation:

Technique supplying positive pressure ventilation support to the airways through masks attached to a patients nose or mouth.

CPAP.....raise the functional residual capacity or open collapsing obstructed airways.
BIPAP.....also reduce the inspiratory muscle load.


RESPIRONICS INC
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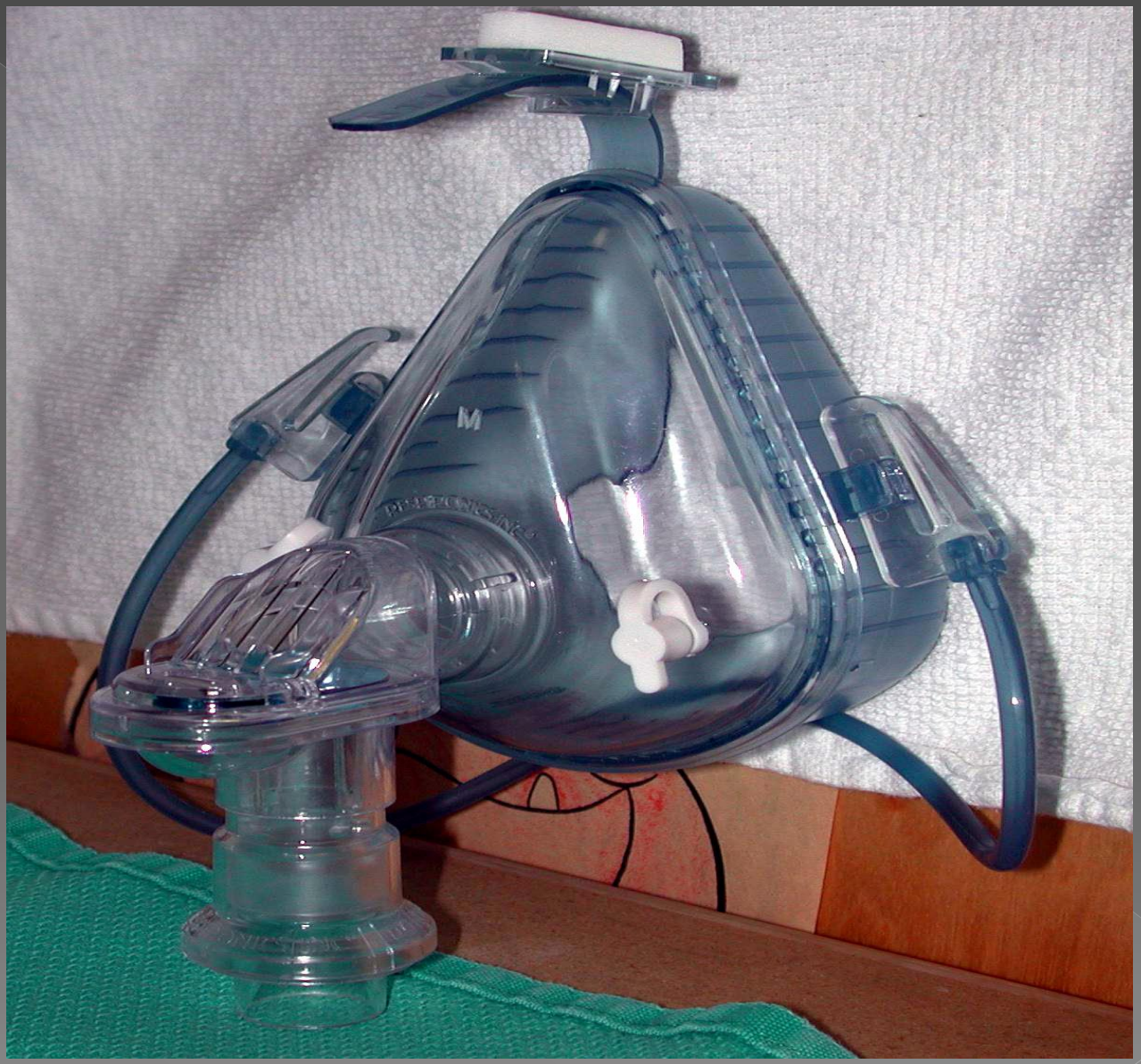
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Patients in whom NIV is effective are :

1-Acute respiratory failure

- ~acute exacerbation of COPD.
- ~acute respiratory distress syndrom ARDS
- ~pneumonia.

2- Acute heart failure.....decrease preload and afterload .....beneficial on cardiac output and blood pressure in addition to improved ventilation.

3-Weaning from mechanical ventilation.

Contra- indication to NIV:

~respiratory arrest

~inability to use mask because of trauma or surgery.

~excessive secretion

~hemodynamic instability

~impaired mental status

Summary

* VAP is an important cause of death in ICU.
* It is a presentable disease.
* VAP bundle may prevent the disease and enhance the outcome .
* In the past the specific diagnosis of VAP was difficult and need invasive procedures. (Lung biopsy).

Summary

* Bronchoscopy …….specific and sensitive diagnosis.

* Antibiotics……. Should be started immediately then tailored according to culture and gram stains.

PLEASE NOTE

You have to teach the nurses again and again , rather than simply putting rules and protocols.

Thank You