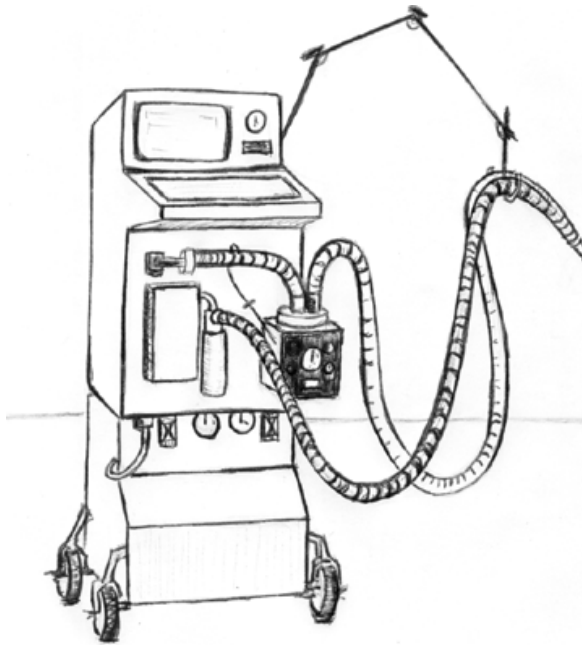
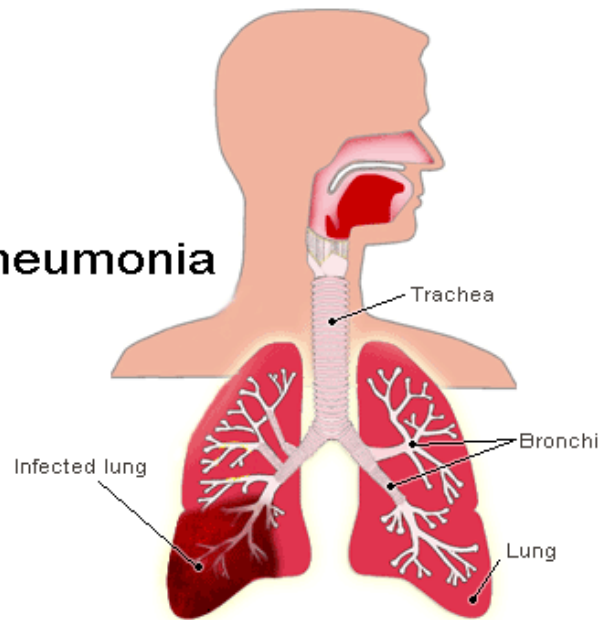


Ventilator Associated Pneumonia (VAP) Pathway



Pneumonia



Hours:

Monday – Friday: 6:00 to 16:00

Weekends: 06:00 to 14:30



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Background

Critically ill patients are at high risk of developing infections. The overall infection rate for this patient population can be as high as 50% to 60% in those remaining in the ICU greater than 5 days.¹ Hospital Acquired Pneumonia (HAP) is the second most common nosocomial infection seen in the United States with an incidence ranging from 5 to 10 cases per 1,000 hospital admissions. It is accompanied with significant morbidity and mortality with an added 7 to 9 days per patient stay and an estimated \$40,000 in additional hospital costs. Mortality attributed to HAP ranges from 33% to 50%.²

Ventilator Associated Pneumonia (VAP) is a form of HAP occurring in patients intubated for greater than 48 hours. It occurs in 9% to 27% of all intubated ICU patients, and seems to occur more frequently earlier after intubation (3% per day incidence days 1 to 5 compared to 1% per day after 10 days). This accounts for significant morbidity and mortality, especially in patients infected with multi-drug resistant (MDR) pathogens such as *Pseudomonas aeruginosa* or *Acinetobacter* species.

VAP can occur from gram positive pathogens such as *S. aureus* (MSSA or MRSA) or gram negative pathogens such as *P. aeruginosa*, *Klebsiella* species, *Enterobacter* species, *Serratia* species, or *Acinetobacter* species. Viral, atypical organisms, or fungal organisms can occur rarely and are most commonly seen in immunocompromised hosts.

VAP requires entry of the infectious agent into the lower respiratory tract followed by colonization and can produce infections if the host mechanical (mucus secretion and ciliated epithelium removal) and immune responses (antibodies and activation of PMN, macrophages, and lymphocytes) are besieged.

Making the diagnosis of VAP can be difficult. Factors such as worsening chest X-ray and respiratory status on the ventilator have to be evaluated as well as the production of copious amounts of sputum, leukocytosis, and fever. Empiric treatment should begin at suspect just after obtaining appropriate cultures for sampling. Empiric antimicrobial agents should cover the most likely pathogens and be adjusted based on culture and sensitivity results. A complete review of the diagnosis and treatment of VAP at Union Memorial Hospital will be detailed in this manual.

¹ Dodek P, et al. Evidence-based clinical practice guideline for the prevention of ventilator-associated pneumonia. *Ann Intern Med* 2004; 141(4): 305-13.

² American Thoracic Society and Infectious Disease Society of America Guideline Committee. Guidelines for the management of adults with hospital-acquired, ventilator-associated, and healthcare associated pneumonia. *Am J Respir Crit Care Med* 2005; 171: 388-416.

What are the Risk Factors for VAP?

There are several risk factors for the development of VAP.

- Remaining supine was compared to keeping patients sitting at a 45 degree angle and demonstrated a 3 fold decrease incidence in HAP.
- Administration of enteral nutrition can cause an increase in gastric content aspiration which has been found to increase the risk of HAP.
- Intensive insulin therapy³ (keeping critical care patient glucoses between 80 mg/dL and 110 mg/dL) has demonstrated:
 - 1) decreases in mechanical ventilation (11.9% intubated > 14 days vs. 7.5%),
 - 2) decreases in antibiotic days (17.1% treated with antibiotics > 10 days vs. 11.2%)
 - 3) 34% decrease in in-hospital mortality.

The development of Multidrug Resistant (MDR) Organisms can increase mortality in VAP patients. Patients at risk for the development of VAP with MRD organisms are²:

- Patients intubated > 5 days
- Patients hospitalized for ≥ 2 days and/or receiving antimicrobial agents within the previous 90 days
- Nursing home residence
- Chronic dialysis
- Home wound care
- Home IV therapy (including antibiotics)
- Family members infected with MDR pathogen
- High frequency of MRD pathogens in the community or in the unit caring for the patient
- Immunosuppressive disease and/or therapy

³ Van den Burghe G, et al Intensive insulin therapy in critically ill patients. N Engl J Med 2001; 345(19): 1359-67.

The Union Memorial Hospital VAP Guideline Implementation Team

At Union Memorial Hospital, a VAP Guidelines Implementation Team has been established to:

- Adapt evidenced-based patient care recommendations to the specific needs of our institution.
- Assist with pre-implementation education of those health care professionals who will be called upon to carry out the guidelines.
- Develop bedside tools such as treatment guidelines, training manuals, flowcharts, and order sets to facilitate implementation of the guidelines.
- Monitor compliance with the protocol, provide ongoing education, and perform outcome analysis after implementation.

As of January 1, 2005, the members of the VAP Guidelines Implementation Team are:

- Phil Buescher, M.D. – Team Leader, Pulmonary and Critical Care Medicine
- Wayne Campbell, M.D. – Infectious Disease Medicine
- Lisa Grubb, RN – Infection Control Director
- Barbara Garrity, R.N. – Nurse Manager, Critical Care Unit
- Chris Lynch, R.N., CRNP – Nurse Practitioner, Surgical Critical Care
- Jamie Reuter, Pharm.D., BCPS – Pharmacy

Please feel free to contact any member of the team if questions or comments regarding the VAP protocol arise.

Prevention of VAP

Many quality groups are looking for ways to improve patient care. The Institute for Healthcare Improvement (IHI) instituted the 100,000 lives campaign recommended 6 core interventions that if implemented across the United States could save 100,000 lives between January 2005 and July 2006. These interventions include:

- [Rapid Response Teams](#)
- [Preventing Adverse Drug Events](#)
- [AMI Care](#)
- [Preventing Surgical Site Infections](#)
- [Preventing Central Line Infections](#)
- [Preventing Ventilator-Associated Pneumonia](#)

The core measures in the IHI Ventilator Associated Pneumonia Bundle include:

- 1. Elevation of the head of the bed to between 30 and 45 degrees**
- 2. Daily “sedation vacation”**
- 3. Daily assessment of readiness to extubate**
- 4. Peptic ulcer disease (PUD) prophylaxis**
- 5. Deep venous thrombosis (DVT) prophylaxis (unless contraindicated)**

These five simple components are each based on primary literature that has shown either a direct or indirect morbidity or mortality impact in the mechanically ventilated intensive care unit patient. Every mechanically ventilated patient should be enrolled in the VAP bundle. Some of the supporting literature is summarized below.

1. Elevated head of bed

Drakulovic, et al showed 18% fewer confirmed cases of VAP in patients who had the head of bed elevated to 45 degrees compared to those left supine (p=0.018).⁴

2. Daily awakening/sedation vacation

Kress et al. demonstrate that daily awakening (the daily interruption of sedation until patients are awake) decreased the duration of ventilation was decreased from 7.3 days to 4.9 days (p=0.004).⁵

⁴ Drakulovic MB, Torres A, Bauer TT, et al. Supine body position as a risk factor for nosocomial pneumonia in mechanically ventilated patients: a randomized trial. *Lancet*. 1999;354(9193):1851-1858.

⁵ Kress JP, Pohlman AS, O'Connor MF, et al. Daily interruption of sedative infusions in critically ill patients undergoing mechanical ventilation. *N Engl J Med*. 2000;342(20):1471-1477.

Diagnosis of VAP

There is a fair amount of controversy surrounding the diagnosis of ventilator-associated pneumonia. The diagnosis is often made post hoc after the results of microbiological cultures are returned. The diagnosis can be classified into three categories⁶:

Possible:

- Abnormal chest radiograph for uncertain cause
- Low or moderate suspicion for pneumonia
- Microbiological or serologic criteria of definite or probable pneumonia

Probable:

- Abnormal chest radiograph
- High clinical suspicion of pneumonia (CPIS > 6)
- Without microbiological or serological confirmation (quantitative culture result less than threshold for treatment)

Microbiologically Confirmed:

- Abnormal chest radiograph
- High Clinical suspicion of pneumonia (CPIS > 6)
- Definite cause established by the recovery of a probable etiologic agent from:
 - An uncontaminated specimen
 - The isolation of a pathogen unlikely to colonize the upper respiratory tract (Mycobacterium tuberculosis, Legionella species, influenza virus, Pneumocystis carini)
 - Recovery of a likely pathogen in high concentrations using quantitative cultures from a lower respiratory tract sample (endotracheal aspirate, BAL, or protected specimen brush)
 - Or positive serology

The American Thoracic Society (ATS) and Infectious Diseases Society of America (IDSA) published a position paper titled “Guidelines for the Management of Adults with Hospital-acquired, Ventilator-associated, and Healthcare-associated Pneumonia in 2005. According to the guidelines to make the diagnosis all patients should have²:

- 4) A comprehensive medical history taken to determine risk factors for VAP
- 5) Presence of new or progressive radiographic infiltrates on Chest x-ray (AP and lateral)
- 6) 2 of three clinical features:
 - i. Fever > 38⁰C
 - ii. Leukocytosis or leukopenia
 - iii. Purulent secretions
- 7) A set of blood cultures taken

⁶ Calandra T, et al. The international sepsis forum consensus conference on definitions of infection in the intensive care unit. Crit Care Med 2005;33(7): 1538-48.

Specimen Sampling for the Diagnosis of VAP

All patients with suspected VAP should have lower respiratory tract samples taken. Bronchoscopic sampling is preferred (BAL or protected-specimen brush samples) over sputum sampling, and helps to prevent the over-treatment of antibiotics. The diagnostic applicability of protected specimen brush (PSB) and bronchoscopy have been compared⁷.

	PSB	BAL
Sensitivity	63-100%	42%-93%
Specificity	66-96%	45%-100%

According to ATS/IDSA when bronchoscopic samples are taken they should be sent for quantitative cultures/analysis. These invasive methods have been compared to more traditional methods of diagnosis for VAP in a multicenter randomized trial of 413 critically ill patients and were found to have a beneficial effect on 14-day mortality (16% compared to 25%, $p=0.02$), no difference in 28-day mortality, and significantly more antibiotic-free days at day 28 (11 ± 9 vs. 7 ± 7 days; $p<0.001$).⁸

Based on this data the ATS/IDSA recommend:

- Bronchoscopic sampling to be sent for quantitative culture when VAP is suspected.
- Empiric ICU specific broad spectrum antibiotics should be started soon **after** the sample is obtained.
- Patients with suspected VAP and a modified Clinical Pulmonary Infection Score (CPIS)⁹ < 6 measured 3 days after the initiation of empiric antibiotics can be considered for early discontinuation of antibiotics.¹⁰

⁷ American Thoracic Society and Infectious Disease Society of America Guideline Committee. Guidelines for the management of adults with hospital-acquired, ventilator-associated, and healthcare associated pneumonia. *Am J Respir Crit Care Med* 2005; 171: 388-416.

⁸ Fagon JY, et al. Invasive and noninvasive strategies for management of suspected ventilator-associated pneumonia: a randomized trial. *Ann Intern Med* 2000; 132(8): 621-30.

⁹ Singh N, et al. Short-course empiric antibiotic therapy for patients with pulmonary infiltrates in the intensive care unit. *Am J Respir Crit Care Med* 2000; 162: 505-11.

¹⁰ Fartoukh M, et al. Diagnosing pneumonia during mechanical ventilation: the clinical pulmonary infection score revisited. *Am J Respir Crit Care Med* 2003; 168: 173-9.

Patients Eligible for the VAP Protocol

1. Enrollment Criteria (Must Meet all 4)

- Mechanical Ventilation \geq 48 hours
- Presence of new or progressive infiltrates on chest x-ray
- Presence of 2 of the 3 clinical features
 - Fever $>$ 38.0C
 - Leukocytosis or leukopenia (WBC \leq 4,000 or \geq 11,000)
 - Purulent secretions
- ET-Tube \geq 7.5 mm or a tracheostomy tube \geq 6 mm in internal diameter

2. Exclusion Criteria

- a. Patients having:
- b. Esophagectomy
- c. Any type of Pulmonary surgery
- d. Elevated Intracranial Pressures
- e. Severe acidosis
- f. Hypercapnea
- g. Asthma with moderate or severe airway obstruction or bulbous emphysema
- h. Hypoxemia not corrected with $FI_{O_2} > 75\%$
- i. Significant coagulopathy and/or thrombocytopenia (platelet count $<$ 20,000)
- j. A myocardial infarction within the past 6 weeks
- k. Hemoptysis
- l. Serious cardiac arrhythmias

CPIS Score

The CPIS is a scoring system that was developed to predict VAP. It incorporates all of the following:

Clinical Pulmonary Infection Score (CPIS)¹¹		
Temperature (°C)	≤ 36	2 points
	≥ 36.5 and < 38.4	0 points
	≥ 38.5 and < 38.9	1 point
	≥ 39	2 points
Leukocytosis: (WBC in mm³)	≤ 4,000	1 point
	≥ 4,000 and ≤ 11,000	0 points
	≥ 11,000	1 point
	Band forms ≥ 50%	1 point
Tracheal Secretions	Absent	0 points
	Non-purulent Tracheal Secretions	1 point
	Purulent Tracheal Secretions	2 points
Oxygenation: (PaO₂:FiO₂ in mm Hg)	> 240	0 points
	< 240	2 points
Chest X-Ray	No infiltrate	0 points
	Diffuse (or patchy) infiltrate	1 point
	Localized infiltrate	2 points
72 hours Post-implementation of Protocol		
Progression of Pulmonary Infiltrate	No progression	0 points
	Radiographic progression (CHF and ARDS excluded)	2 points
Culture of Tracheal Aspirate	Pathogenic bacteria in light or rare quantity (< 10 ⁴ cfu/mL)	0 points
	Pathogenic bacteria in moderate or heavy quantity (>10 ⁴ cfu/mL)	1 point
	Same pathogenic bacteria seen on gram stain and in culture	1 point
Total Points		

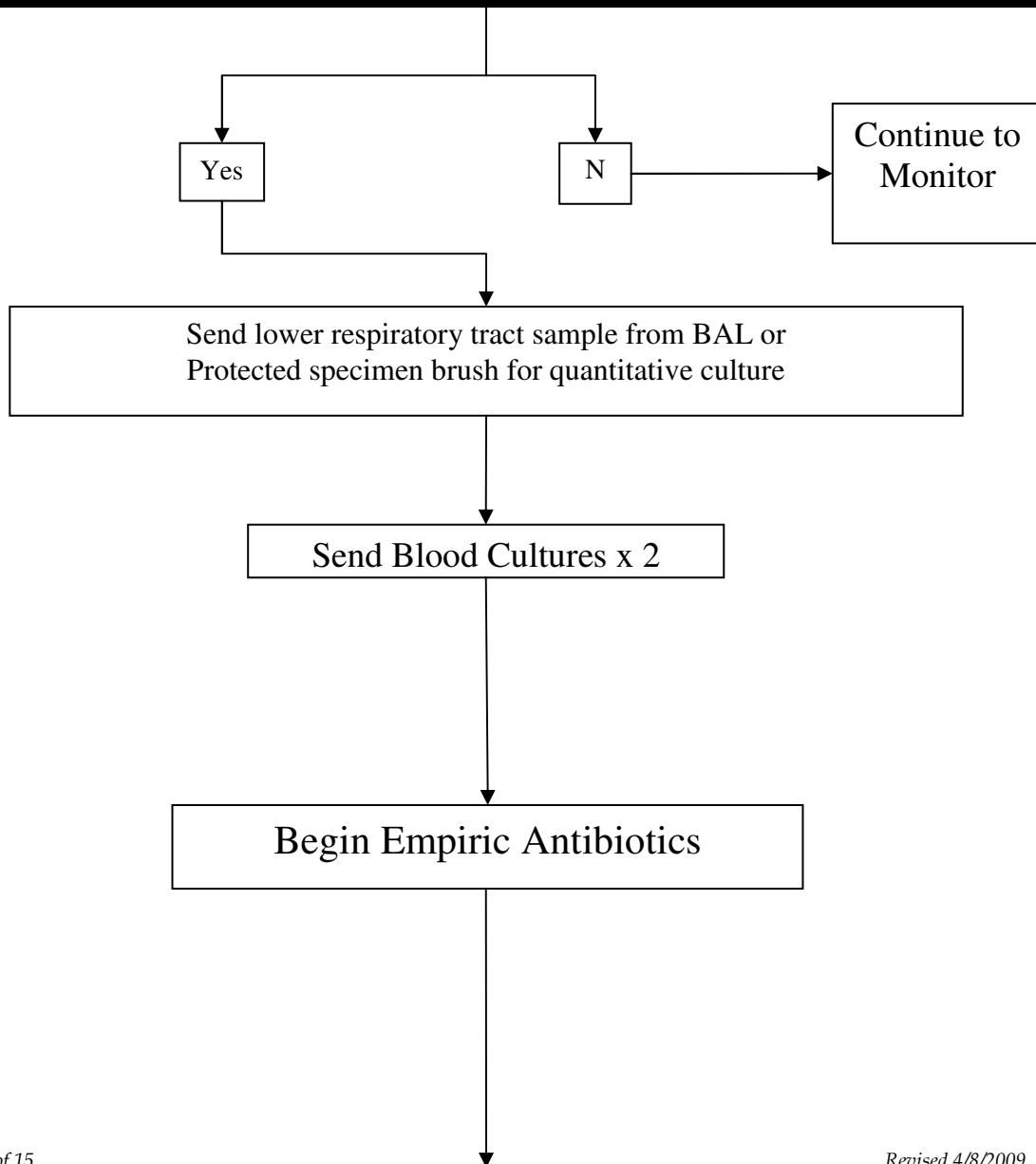
A CPIS > 6 at baseline or after 72 hours is suggestive of VAP

¹¹ Pugin J, et al. Diagnosis of VAP by bacteriologic of bronchoscopic or nonbronchoscopic “blind” BAL. Am Rev Respir Dis 1991;143:1121-9.

Treatment of VAP: Empiric Therapy

Suspect VAP

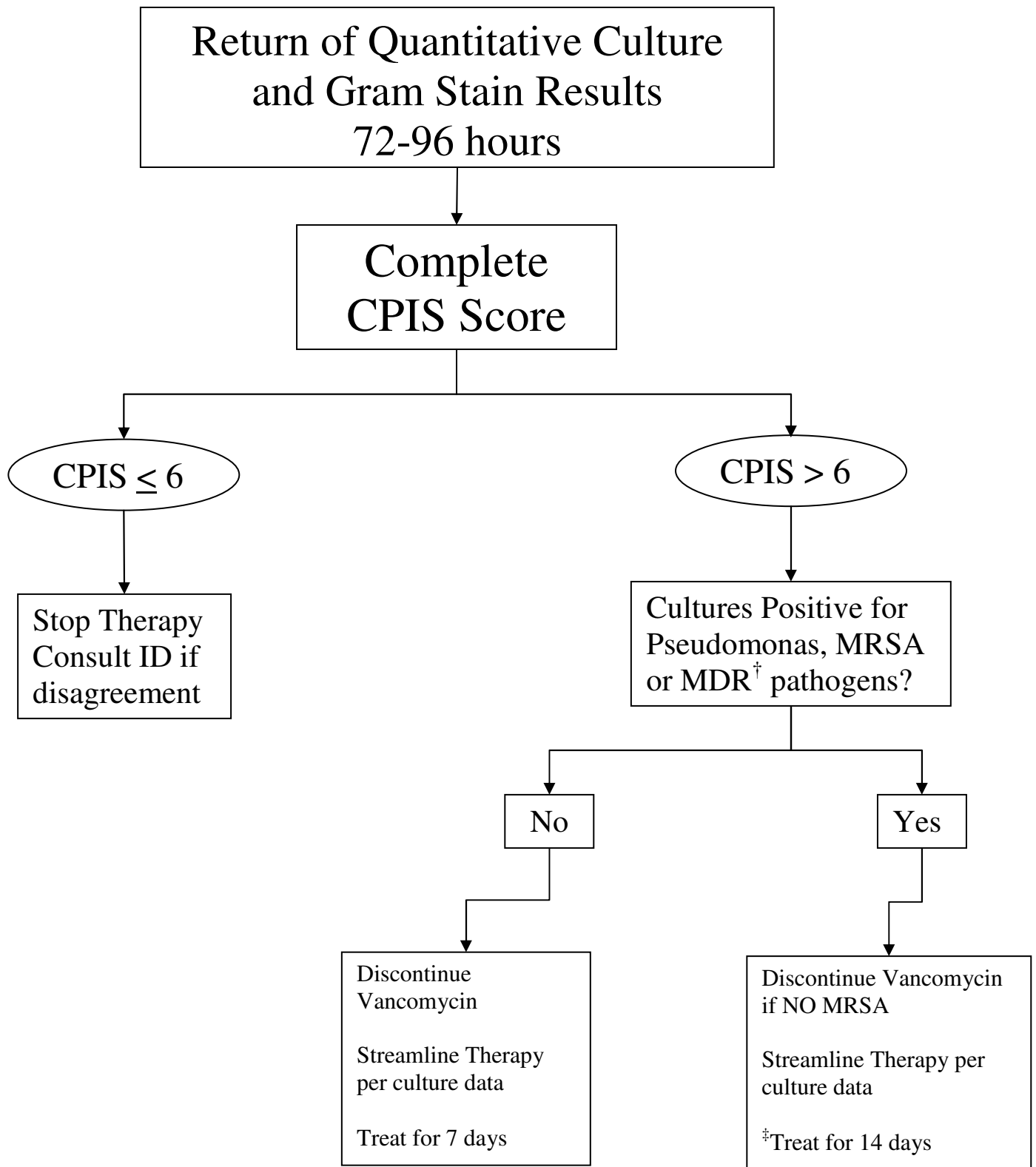
- Mechanical ventilation > 48 hours
- New or Progressive Infiltrates on Chest X-Ray
- 2 of 3 clinical findings:
 - Fever > 38⁰C
 - Leukocytosis (WBC > 11,000 /mm³) or leukopenia (WBC < 4,000/mm³)
 - Purulent Secretions



Potential Pathogens	Empiric Therapy	Empiric therapy for Penicillin Allergic Patients
Streptococcus pneumoniae Haemophilus influenzae Methicillin-sensitive Staph aureus (MSSA) Escheria coli Klebsiella pneumoniae Enterobacter species Proteus species Serratia marcescens AND Pseudomonas aeruginosa ESBL + Klebsiella pneumoniae Acinetobacter species Methicillin-resistant Staph aureus (MRSA)	Vancomycin 15mg/Kg Q12Hours (adjusted body weight) + Ceftazidime + Moxifloxacin	Vancomycin 15mg/Kg Q12Hours (adjusted body weight) + Aztreonam + Moxifloxacin

Drug therapy Based on Creatinine Clearance					
Drug	CrCl > 50 mL/min	CrCl 30-50 mL/min	CrCl 10-30 mL/min	CrCl < 10 mL/min	ESRD on HD
Vancomycin† ‡‡	IV Q12 Hrs		IV Q24 Hrs	1 gram based on Serum levels < 15mg/dL	
Ceftazidime	2 grams IV Q8 Hrs	2 grams IV Q12 Hrs	2 grams IV Q24 Hrs	1 gram IV Q24 Hrs	500 mg IV daily after HD on dialysis days
Aztreonam	2 grams IV Q8 hours		1 gram IV Q8 hours	500 mg IV Q8 Hours	500mg IV Q12 Hours
Moxifloxacin	400mg IV daily				
†Target Vancomycin trough 15-20mg/dL. Draw trough just prior to the third dose ‡‡ Vancomycin Dose is determined by adjusted body weight					

Vancomycin Dose Based on Patient Weight					
Pt Weight(kg)	40 Kg	50 Kg	65 Kg	80 Kg	> 100 Kg
Dose (mg)	500mg	750mg	1000mg	1250mg	1500mg



†Pathogens are considered MDR if they are susceptible to \leq drug classes of antibiotics.

‡Consider a shorter course of therapy for patients who's clinical course improves significantly after initiation of antibiotic therapy.

VAP Physician Orderset

Prevention of VAP Nursing Education