State of Kuwait
Ministry of Health
Infection Control Directorate

Guidelines for Prevention of Healt Care Associated LRTI

Aug. 2006

I- Introduction

Respiratory tract infections are extremely common health-care associated infections. Lower respiratory tract infection incorporates a spectrum of disease from acute bronchitis to pneumonia. Several factors (age, underlying disease, environment) influence mortality, morbidity and also microbial aetiology especially with the most frequently identified antibiotic resistance of respiratory pathogens.

Of the lower respiratory tract infections, pneumonia remains the most common infection seen among hospitalized patients. It is defined as a lower respiratory tract infection occurring $\geq$ 48 hrs of admission to a hospital or nursing home in a patient who was not incubating the infection on admission. It is the second most common health-care associated infection worldwide after urinary tract infection accounting for 13-18% of all health-care associated infections. Health-care associated pneumonia tends to be more serious because defense mechanisms against infection are often impaired , and the kind of infecting organisms are more dangerous than those generally encountered in the community. It is commonly caused by pathogens that need aggressive diagnostic approach with prompt recognition and urgent treatment to reduce morbidity and mortality; often the strains causing health-care associated pneumonia are multiple. It is complicate up to 1% of all hospitalizations.

Critically ill patients who require mechanical ventilation are especially vulnerable to develop ventilator associated pneumonia (VAP). Because of its tremendous risk in the last two decades, most of the research on hospital associated pneumonia has been focused on VAP. As treatment, prognosis and outcome of VAP may differ significantly from other forms of hospital acquired pneumonia, it will be discussed extensively.

Our guidelines will include:-

- **I.** Lower respiratory tract infection (LRTI) without evidence of pneumonia.
- **II.** Health care associated pneumonia (HCAP).
  - **A.** Pneumonia other than ventilator associated pneumonia.
  - **B.** Ventilator associated pneumonia (VAP).
  - **C.** Special types of pneumonia, e.g., Legionnaiers disease, Candida pneumonia, Aspergillosis.

I. Lower Respiratory Tract Infection:-

CDC criteria for diagnosis of health-care associated lower respiratory tract infection (LRTI)

(A) Bronchitis, tracheobronchitis, bronchiolitis, tracheitis, without evidence of pneumonia

DEFINITION: Tracheobronchial infections must meet at least one of the following criteria:

Criterion 1: Patient has no clinical or radiographic evidence of pneumonia

AND

Patient has at least two of the following signs or symptoms with no other recognized cause: Fever (> 38^0C) , cough, new or increased sputum production , rhonchi, wheezing

AND

at least one of the following:

a. Positive culture obtained by deep tracheal aspirate or bronchoscopy.

b. Positive antigen test on respiratory secretions.

Criterion 2: Patient ≤ 1 year of age has no clinical or radiographic evidence of pneumonia

AND

Patient has at least two of the following signs or symptoms with no other recognized cause: fever (> 38^0C), cough, new or increased sputum production, rhonchi, wheezing, respiratory distress, apnea, or bradycardia

AND

at least one of the following:

a. Organisms cultured from material obtained by deep tracheal aspirate or bronchoscopy.

b. Positive antigen test on respiratory secretions.

c. Diagnostic single antibody titer (IgM) or fourfold increase in paired sera (IgG) for pathogen.

Reporting instructions:

- Do not report chronic bronchitis in a patient with chronic lung disease as an infection unless there is evidence of an acute secondary infection, manifested by change in organism.

(B) Other infection of the lower respiratory tract. (Lung abscess-Empyema)

Definition: Other infections of the lower respiratory tract must meet at least one of the following criteria:-

Criterion 1: Patient has organisms seen on smear or cultured from lung tissue or fluid.

Criterion 2: Patient has a lung abscess or empyema seen during a surgical operation or histopathologic examination.

Criterion 3: Patient has an abscess cavity seen on radiographic examination of lung.

Reporting instructions:

- Report concurrent lower respiratory tract infection and pneumonia with the same organism(s) as pneumonia.
- Report lung abscess or empyema without pneumonia as LRTI

II. Health Care Associated Pneumonia (HCAP)

(A) Pneumonia other than ventilator associated pneumonia.

Risk factors

- Age (elderly or neonate)
- Severe illness, e.g, septic shock
- Major injuries
- Surgical operation (chest, coronary bypass surgery, abdomen)
- Existing cardiopulmonary disease
- Cerebrovascular accidents
- Coma
- Sedation
- Enteral feeding
- Antibiotic therapy, H-2 blockers
- Immunosuppressive and cytotoxic drugs
- Heavy smoking

Aetiologic Agents of Health-care associated Pneumonia (HCAP)

The reported distribution of etiologic agents that cause health-care associated pneumonia differs between hospitals because of different patient populations and diagnostic methods.

In general, however, bacteria have been the most frequently isolated pathogens. Health-care associated bacterial pneumonias are frequently polymicrobial and gram –ve bacilli are usually the predominant organisms.

However, Staphylococcus aureus (especially methicillin-resistant S. aureus) and other gram-positive cocci, including Streptococcus pneumoniae have emerged recently as important isolates.

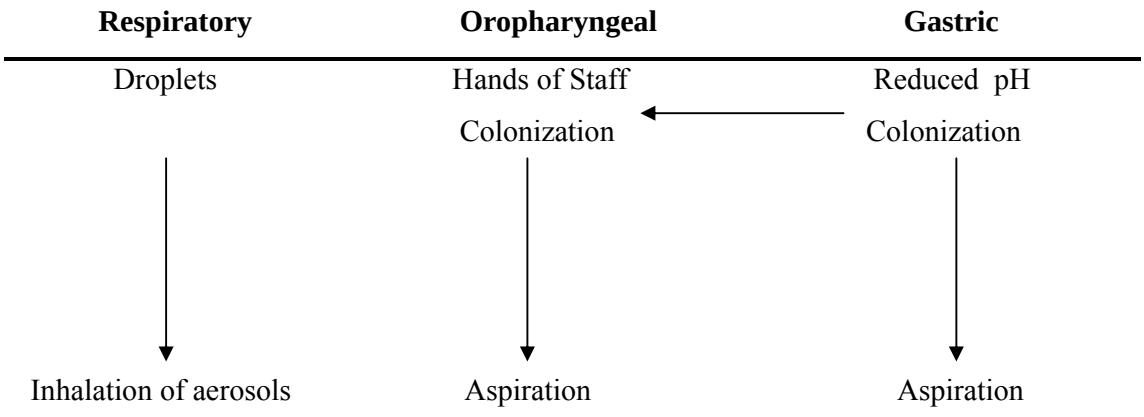
Streptococcus pneumoniae and *Haemophilus influenzae* can cause post-operative pneumonia, particularly in patients with existing pulmonary disease.

In hospitals participating in the National Nosocomial Infection Surveillance (NNIS), Pseudomonas aeruginosa, Enterobacter spp., Klebsiella pneumoniae, Escherichia coli, Serratia marcescens, and Proteus spp, comprised 50% of the isolates from cultures of respiratory tract specimens obtained from patients for whom health-care associated pneumonia was diagnosed by using clinical criteria; S. aureus accounted for 16%, and H. influenzae for 6%.

Legionella infection may be acquired from the hospital air conditioning system or from water supplies, particularly in immunocompromised patients.

Other organisms, including respiratory syncytial and other respiratory viruses, *Candida albicans*, and rarely, *Aspergillus fumigatus*.

1. Modes of Transmission of Health care Associated Pneumonia (HCAP)



2. Pathogenesis:-

Bacteria may invade the lower respiratory tract by micro or bolus aspiration of orophanyngeal organisms, inhalation of aerosols containing bacteria, or less frequently, by hematogenous spread from a distant body site. Bacterial translocation from the gastrointestinal tract had been hypothesized as a mechanism for infection. However, its occurrence in patients with HCAP has not been show.

3. Diagnosis of health-care associated pneumonia (HCAP):-

It is diagnosed by updated CDC criteria.

Criteria for defining health-care associated pneumonia (HCAP)

General comments applicable to all pneumonia specific site criteria:

1. Physician's diagnosis of pneumonia alone is not an acceptable criterion for health-care associated pneumonia.
2. Although specific criteria are included for infants and children, pediatric patients may meet any of the other pneumonia specific site criteria.
3. Ventilator associated pneumonia (i.e., pneumonia in persons who had a device to assist or control respiration continuously through a tracheostomy or by endotracheal intubation within the 48-hour period before the onset of infection) should be so designed when reporting pneumonia data.
4. When assessing a patient for presence of pneumonia, it is important to distinguish between changes in clinical status resulting from other conditions such as myocardial infarction, pulmonary embolism, respiratory distress syndrome, at electasis, malignancy, chronic obstructive pulmonary disease, hyaline membrane disease, bronchopulmonary dysplasia, and so forth. Also, care must be taken when assessing intubated patients to distinguish between tracheal colonization, upper respiratory tract infections (e.g., tracheobronchitis), and early onset pneumonia. Finally, it should be recognized that it may be difficult to determine health-care associated pneumonia in the elderly, infants, and immunocompromised patients because such conditions may mask typical signs or symptoms associated with pneumonia. Alternative specific criteria for the elderly, infants and immunocompromised patients have been included in this definition of health-care associated pneumonia.
5. Health-care associated pneumonia can be characterized by its onset: early or late. Early onset pneumonia occurs during the first 4 days of hospitalization and is often caused Moraxella catarrhalis, H. influenza, and S. pneumonia. Causative agents of late onset pneumonia are frequently gram-negative bacilli or Staphylococcus aureus, including methicillin-resistant S.aureus. Viruses (e.g., influenza A and B or respiratory syncytial virus) can cause early and late onset health-care associated pneumonia, whereas yeasts, fungi, legionellae, and Pneumocystits carinii are usually pathogens of late onset pneumonia.

6. Pneumonia resulting from gross aspiration (e.g., in the setting of intubation in the emergency room or operating room) is considered health-care associated if it meets any specific criteria and was not clearly present or intubation at the time of admission to the hospital.
7. Multiple episodes of health-care associated pneumonia may occur in critically ill patients with lengthy hospital stays. When determining whether to report multiple episodes of health-care associated pneumonia in a single patient, look for evidence of resolution of the initial infection. The addition of or change in pathogen alone is not indicative of a new episodes of pneumonia. The combination of new signs and symptoms and radiographic evidence or other diagnostic testing is required.
8. Positive gram stain for bacteria and positive KOH mount for elastin fibers and / or fungal hyphae from appropriately collected sputum specimens are important clues that point toward the etiology of the infection. However, sputum samples are frequently contaminated with airway colonizers and therefore, must be interpreted cautiously. In particular, Candida is commonly seen on stain but frequently causes health-care associated pneumonia.

Abbreviations

BAL- bronchoalveolar lavage
EIA- enzyme immunoassay
FAMA- fluorescent-antibody staining of membrane antigen
IFA- immunofluorescent antibody
LRT- lower respiratory tract
PCR- polymerase chain reaction
PMN- polymorphonuclear leukocyte
RIA- radioimmunoassay

Reporting Instructions

- There is a hierarchy of specific site categories within the major site pneumonia. Even if a patient meets criteria for more than one specific site, report only one:
  - If a patient meets criteria for both PNU 1 and PNU2, report PNU2.
  - If a patient meets criteria for both PNU2 and PNU3, report PNU3.
  - If a patient meets criteria for both PNU1 and PNU3, report PNU3.
- Report concurrent lower respiratory tract infection (e.g., abscess or empyema) and pneumonia with the same organism(s) as pneumonia.
- Report lung abscess or empynea without pneumonia as lung.
- Report acute bronchitis, tacheitis, tracheobronchitis, or bronchiolitis without pneumonia as BRON.

Pneumonia Algorithms

Major site: Pneumonia (PNEU)
Site –specific Algorithms for Clinically Defined Pneumonia (PNU1)

Radiology	Signs/ symptoms/ laboratory	Code
		PNU1
Two or more serial chest radiographs with at least one of the following [1,2] • New or progressive • And persistent infiltrate • Consolidation • Cavitation • Pneumatoceles, in infants ≤ 1year old	FOR ANY PATIENT, at least one of the following • Fever (>38°C or >100.4°F) with no other recognized cause. • Leucopenia (<4,000 WBC /mm^3) or leukocytosis (≥ 12,000 WBC/mm^3) • For adults ≥ 70 years old, altered mental status with no other recognized cause and At least two of the following: • New onset of purulent sputum[3], or change in character of sputum[4], or increased respiratory secretions, or increased suctioning requirements. • New onset or worsening cough or dyspnea, or trachypnea[5] • Rales[6] or bronchial breath sounds. • Worsening gas exchange (e.g., O_2 desaturations [e.g., PaO_2/ FiO_2 ≤ 240][7] increased oxygen requirements, or increased ventilator demand)	
NOTE: In patients without underlying pulmonary or cardiac disease (e.g., respiratory distress syndrome, bronchopulmonary dysplasia, pulmonary edema, or chronic obstructive pulmonary disease), one definitive chest radiograph is acceptable[1].	ALTERNATE CRITERIA FOR INFANT ≤ 1YEAR OLD: • Worsening gas exchange (e.g., O_2 desaturations, increased oxygen requirements, or increased ventilator demand) and At least three of the following: • Temperature instability with no other recognized cause • Leucopenia (< 4,000 WBC / mm^3) or leukocytosis (≥ 15,000 WBC/mm^3) and left shift (≥ 10% band forms) • New onset of purulent sputum[3], or change in character of sputum[4], or increased respiratory secretions, or increased suctioning requirements. • Apnea, tachypnea[5], nasal flaring with retraction of chest wall, or grunting • Wheezing, rales[5], or rhonchi. • Cough • Bradycardia (< 100 beats/ min) or trachycardia (> 100 beats/ min) ALTERNATE CRITERIA FOR CHILD > 1 OR ≤ 12 YEARS OLD, At least three of the following: • Fever (>38°C or >101.1°F) or hypothermia (>37°C or 97.7°F) with no other recognized cause. • Leucopenia (< 4,000 WBC / mm^3) or leukocytosis (≥ 15,000 WBC/mm^3) • New onset of purulent sputum[3], or change in character of sputum[4], or increased respiratory secretions, or increased suctioning requirements. • New onset or worsening cough or dyspnea, apnea or trachypnea[5] • Rales[6] or bronchial breath sounds. • Worsening gas exchange (e.g., O_2 desaturations [e.g., pulse oximetry < 94%], increased oxygen requirements, or increased ventilator demand)	

Major site: Pneumonia (PNEU)

Specific Site Algorithms for Pneumonia with Common Bacterial or Filamentous Fungal Pathogens and Specific Laboratory Findings (PNU2)

Radiology	Signs/symptoms	Laboratory	Code
			PNU 2
Two or more serial chest radiographs with at least one of the following [1,2] • New or progressive And persistent infiltrate • Consolidation • Cavitation NOTE: In patients without underlying pulmonary or cardiac disease (e.g., respiratory distress syndrome, bronchopulmonary dysplasia, pulmonary edema, or chronic obstructive pulmonary disease), one definitive chest radiograph is acceptable[1].	At least one of the following: • Fever (>38°C or >100.4°F) with no other recognized cause. • Leucopenia (>4,000 WBC /mm^3) or leukocytosis ($\geq$ 12,000 WBC/mm^3) • For adults $\geq$ 70 years old, altered mental status with no other recognized cause and At least two of the following: • New onset of purulent sputum[3], or change in character of sputum[4] , or increased respiratory secretions, or increased suctioning requirements. • New onset or worsening cough or dyspnea, or trachypnea[5] • Rales[6] or bronchial breath sounds. • Worsening gas exchange (e.g., O_2 desaturations [e.g., PaO_2/ $FiO_2 \leq$ 240][7] increased oxygen requirements, or increased ventilator demand)	At least one of the following: • Positive growth in blood culture[8] not related to another source of infection. • Positive growth in culture of pleural fluid. • Positive quantitative culture[9] from minimally contaminated LRT specimen (e.g., BAL or protected specimen brushing). • $\geq$ 5% BAL obtained cells contain intracellular bacteria on direct microscopic exam (e.g., Gram stain) • Histopathologic exams shows at least one of the following evidence of pneumonia: 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 haphae or pseudohyphae.	

Major site: Pneumonia (PNEU)

Specific Site Algorithms for Pneumonia with Viral, Legiionella, Chlamydia, Mycoplasma, and Other Uncommon Pathogens and Specific Laboratory Findings (PNU 2)

Radiology	Signs/symptoms	Laboratory	Code
Two or more serial chest radiographs with at least one of the following [1,2] • New or progressive And persistent infiltrate • Consolidation • Cavitation NOTE: In patients without underlying pulmonary or cardiac disease (e.g., respiratory distress syndrome, bronchopulmonary dysplasia, pulmonary edema, or chronic obstructive pulmonary disease), one definitive chest radiograph is acceptable[1].	At least one of the following: • Fever (>38°C or >100.4°F) with no other recognized cause. • Leucopenia (>4,000 WBC /mm^3) or leukocytosis (≥ 12,000 WBC/mm^3) • For adults ≥ 70 years old, altered mental status with no other recognized cause and At least one of the following: • New onset of purulent sputum[3], or change in character of sputum[4], or increased respiratory secretions, or increased suctioning requirements. • New onset or worsening cough or dyspnea, or trachypnea[5] • Rales[6] or bronchial breath sounds. • Worsening gas exchange (e.g., O_2 desaturations [e.g., PaO_2/ FiO_2 ≤ 240][7] increased oxygen requirements, or increased ventilator demand)	At least one of the following:[10-12] • Positive culture of virus Chlamydia from respiratory secretions. • Positive detection of viral antigen or antibody from respiratory secretions (e.g., EIA, FAMA, shell vial assay, PCR) • Fourfold rise in paired sera (IgG) for pathogen (e.g., influenza viruses, Chlamydia) • Positive PCR for Chlamydia or Mycoplasma. • Positive micro-IF test for Chlamydia • Positive culture or visualization by micro IF of Legionella spp. from respiratory secretions or tissue. • Detection of Legionella pneumophila serogroup 1 antigens in urine by RIA or EIA. • Fourfold rise in L.pneumophila serogroup 1 antibody titer to ≥1:128 in paired acute and convalescent sera by indirect IFA.	PNU 2

Major site: Pneumonia (PNEU)

Specific Site Algorithms for Pneumonia in Immunocompromised Patients (PNU 3)

Radiology	Signs/symptoms	Laboratory	Code
			PNU 3
Two or more serial chest radiographs with at least one of the following [1,2] • New or progressive And persistent infiltrate • Consolidation • Cavitation NOTE: In patients without underlying pulmonary or cardiac disease (e.g., respiratory distress syndrome, bronchopulmonary dysplasia, pulmonary edema, or chronic obstructive pulmonary disease), one definitive chest radiograph is acceptable[1].	At least one of the following: • Fever (>38°C or >100.4°F) with no other recognized cause. • Leucopenia (>4,000 WBC /mm^3) or leukocytosis (≥ 12,000 WBC/mm^3) • For adults ≥ 70 years old, altered mental status with no other recognized cause. • New onset of purulent sputum[3], or change in character of sputum[4] , or increased respiratory secretions, or increased suctioning requirements. • New onset or worsening cough or dyspnea, or trachypnea[5] • Rales[6] or bronchial breath sounds. • Worsening gas exchange (e.g., O_2 desaturations [e.g., PaO_2/ FiO_2 ≤ 240][7] increased oxygen requirements, or increased ventilator demand) • Hemoptysis. • Pleuritic chest pain.	At least one of the following: • Matching positive blood and sputum cultures with Candida spp[14,15] • 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. Any of the following from: LABORATORY CRITERIA DEFINED UNDER PNU 2	

1. Occasionally, in non-ventilated patients, the diagnosis of nosocomial pneumonia may be quite clear on the basis of symptoms, signs and a single definitive chest radiograph. However, in patients with pulmonary or cardiac disease (e.g., interstitial lung disease or congestive heart failure), the diagnosis of pneumonia may be particularly difficult. Other noninfectious conditions (e.g., pulmonary edema form decompensate congestive heart failure) may simulate the presentation of pneumonia. In these more difficult cases, serial chest radiographs must be examined to help separate infectious form non-infectious pulmonary processes. To help confirm difficult cases, it may be useful to review radiographs on the day of diagnosis, 3 days prior to the diagnosis and on days 2 and 7 after the diagnosis. Pneumonia may have rapid onset and progression but does not resolve quickly. Radiographic changes of pneumonia persist for several weeks. As result, rapid radiograph resolution suggests that the patient does not have pneumonia but rather a non-infectious process such as atelectasis or congestive heart failure.

2. Note that there are many ways of describing the radiographic appearance of pneumonia. Examples include, but are not limited to, air-space disease, focal opacification, and patchy areas of increased density. Although perhaps not specifically delineated as pneumonia by the radiologist, in the appropriate clinical setting these alternative descriptive wordings should be seriously considered as potentially positive findings.

3. Purulent sputum is defined as secretions from the lungs, bronchi, or trachea that contain > 25 neutrophils and <10 squamous epithelial cells per low power field (x100). If your laboratory reports these data qualitatively (e.g., many WBCs or few squanes), be sure their descriptors match this definition of purulent sputum. This laboratory confirmation is required because written clinical descriptions of purulence are highly variable.

4. A single notation of either purulent sputum or change in character of the sputum is not meaningful; repeated notations over a 24-hour period would be more indicative of the onset of an infectious process. Change in character of sputum refers to the color, consistency, odor, and quantity.

5. In adult trachypnea is defined as respiration rate > 25 breaths per minute. Tachypnea is defined a >75 breaths per minute in premature infants born at <37 weeks gestation and until the 40th week; > 60 breaths per minute in patients < 2 months old; 50 breaths per minute in patients 2-12 months old; > 30 breaths per minute in children > 1 year old.

6. Rales may be described as crackles.

7. This measure of arterial oxygenation id defined as the ratio of the arterial tension (PaO_2) to the inspiratory fraction of oxygen (FiO_2).

8. Care must be taken to determine the etiology of pneumonia in patients with positive blood cultures and radiographic evidence of pneumonia, especially if the patient has invasive devices in place such as intravascular lines or an indwelling urinary catheter. In general, in an immunocompetent patient, blood cultures positive for coagulase negative staphylococci, common skin contaminants, and yeasts will not be the etiologic agent of the pneumonia.

9. Refer to Table A- 2, 1 for threshold values of bacteria from cultured specimens. An endotracheal aspirate is not a minimally contaminated specimen. Therefore, and endotracheal aspirate does not meet the laboratory criteria.

10. Once laboratory –confirmed cases of pneumonia due to respiratory syncytial virus (RSV), adenovirus, or influenza virus have been identified win a hospital, clinician's' presumptive diagnosis of these pathogens in subsequent cases with similar clinical signs and symptoms is and acceptable criterion for presence of nosocomial infection.

11. Scant or watery sputum is commonly seen in adult with pneumonia due to viruses and Mycoplasma although sometimes the sputum may be mucopurulent. In infants, pneumonia due to RSV or influenza yields copious sputum. Patients, except premature infants, with viral or mycoplasmal pneumonia may exhibit few signs or symptoms even when significant infiltrates are present on radiographic exam.

12. Few bacteria may be seen on stains of respiratory secretions from patients with pneumonia due to Legionella spp, Mycoplasma, or viruses.

13. Immunocompromised patients include those with neutropenia (absolute neutrophil count $<500/mm^3$), leukemia, lymphoma, HIV with CD4 count <200, or splenectomy; those who are in their transplant hospital stay; and those who are on cytotoxic chemotherapy, high dose steroids, or other immunosuppressive daily for > 2 weeks [e.g., > 40mg of prednisone or its equivalent (> 160mg hydrocortisone, > 32 mg methylprednisolone, > 32 mg methylprednisolone, < 6 mg dexamethasone, > 200 mg cortisone)].

14. Blood and sputum specimens must be collected within 48 hours of each other.

15. Semi-quantitative or non-quantitative cultures of sputum obtained by deep cough, induction, aspiration, or lavage are acceptable. If quantitative culture results are available, refer to algorithms that include such specific laboratory findings.

Threshold values for cultured specimens used in the diagnosis of pneumonia

Specimen collection/ Technique	Values	Comment
Lung parenchyma		
Bronchoscopically (B) obtained specimens	$\geq 10^4$CFU /g tissue	1
Vronchoalveolar lavage (B-BAL)	$\geq 10^4$CFU /mL	
Protected BAL (B-PBAL)	$\geq 10^4$CFU /mL	
Protected specimen brushing (B-PSB)	$\geq 10^3$CFU /mL	
Nonbronchically (NB) obtained (blind) specimens		
NB-BAL	$\geq 10^4$CFU /mL	
NB-PSB	$\geq 10^3$CFU /mL	

1,open-lung biopsy specimens and immediate postmortem specimens obtained by transthoracic or transbronchial biopsy; CFU, colony-forming units; g, gram; mL, milliliter.

Recommendations for prevention.

Detailed preventive strategies will be discussed in VAP section.

(B) Ventilator Associated Pneumonia (VAP)

Introduction

VAP is a common disorder and must be distinguished from other forms of hospital acquired pneumonia, because treatment progress and outcome may differ significantly. The incidence of VAP is estimated to range from 10-25% .

Negative outcomes associated with VAP include increased mortality and morbidity and prolonged hospital stay. In some studies, results showed that critically ill patients in whom VAP developed were twice as likely to die as were those who did not acquire pneumonia. The risk of pneumonia increased from 6.5% in those ventilated for 10 days, to 28% in those ventilated for 30 days.

Patients with VAP stay an average of 4.3 days longer in the ICU and have an absolute risk increase of 5.8% for mortality.

Because of its reported frequency, associated high fatality rate, and attendant cost, VAP is considered as a major infection control problem.

Definition

- Ventilator Associated pneumonia (VAP) is defined as health - care associated pneumonia in a patient on mechanical ventilatory support (by endotracheal tube or tracheostomy) for $\geq$ 48 hrs.
- Ventilator-associated pneumonia that occurs within 48 -72 hrs after tracheal intubation is usually termed early-onset pneumonia; it often results from aspiration, which complicates the intubation process. Ventilator-associated pneumonia that occurs after this period is considered late-onset pneumonia. It often results from infection with multi drug resistant organisms (MDROs)

Epidemiology

Incidence of VAP

International:

- 12 infections per 1000 patient days.
- 20 infections per 1000 ventilator days.

In Kuwait: {Report of Kuwait National health-care associated Infection Surveillance - Directorate of Infection Control for the years 1999 – 2003}

- Main ICU average - 29.4 infections per 1000 ventilator days.
- NICU average - 8.2 infections per 1000 ventilator days.
- PICU average - 1.4 infections per 1000 ventilator days.

Microbial aetiology

The Microbial aetiology of VAP according to Kuwait figures are as follows:-

- All ventilator associated pneumonias over the period of 1st January 2002 till 30th December 2004 in all Kuwaiti governmental ICU settings were collected.
- The enrolling criteria was according to definition of VAP giving that the infection occurs after at least 48 hours of intubation whether the patient was on endotracheal intubation or tracheostomy connected to mechanical ventilation.
- Inclusion criteria exclude patients of CCU or general wards on mechanical ventilation were not included in the study.
- Pneumonias developed after 2days of removal of mechanical ventilation were included in the study.

Results

- Infections were collected in different ICU setting: adult ICU (915 infections) pediatric ICU (60) and NICU (152) with total infections of 1127.
- The aetiological agents were distributed as follows:

Table-1
Microbial aetiology of VAP according to Kuwait surveillance system in the period of 2002-2004

Adult ICU

Organism	Percentage
Pseudomonas spp.	24 %
Acinetobacter spp.	14%
Klebsiella spp.	9%
MRSA	9%
Candida spp.	8%
Staphylococcus aureus	6%
Candida albicans	5%
Enterobacter spp.	5%
Stenotrophomonas maltophilia	4%
E. Coli	3%
Serratia spp.	3%
Enterococcus spp.	1%
Streptococcus pneumoniae	1%
Haemophilas influenzae	1%
Staphylococcus epidermidis	1%
Proteus spp.	1%

Pediatric ICU

Organism	Percentage
Pseudomonas spp.	31%
Klebsiella spp.	13%
Stenotrophomonas maltophilia	13%
E. Coli	12%
Acinetobacter spp.	8%
Streptococcus pneumoniae	6%
Candida spp.	2%
Candida albicans	2%
Staphylococcus aureus	2%
Serratia spp.	2%
Citrobacter spp.	2%
Enterobacter spp.	2%
Coagulse negative staphylococci (CONS)	2%

NICU

Organism	Percentage
Pseudomonas spp.	19 %
E.coli	12 %
Staphylococcus epidermidis	12 %
Coagulse negative staphylococci	10 %
Klebsiella spp.	9 %
Acinetobacter spp.	9 %
Streptococcus viridans	4 %
Serratia spp.	4 %
Staphylococcus aureus	4 %
Candida spp	3 %
Enterococcus spp.	2 %
Stenotrophomonas maltophilia	1 %
Haemophilas influenza	1 %
Candida albicans	1 %

Risk Factors:

Can be grouped into the following general categories: (Fig. 2)

(1) Host factors:

- Age > 65 yrs.
- Underlying illness including:
  - Chronic pulmonary diseases.
  - Immunosupression.
  - Depressed conciousness.

(2) Factors that enhance colonization of the oropharynx or stomach by microorganisms including:

- Administration of antimicrobials.
- Admission to ICU.
- Underlying chronic lung diseases.
- Coma.
- Administration of antacids for prevention of stress bleeding in critically ill patients.

(3) Conditions favoring aspiration reflex like:

- Endotracheal intubation
- Insertion of nasogastric tube.
- Supine position.
- Depressed level of consciousness [Glasgow Coma Scale (GCS) < 9.]
- Dysphagia from neurological or esophageal disorders.

(4) Prolonged use of mechanical ventilation.

Patients receiving continuous mechanically assisted ventilation have 6-21 times increased risk for VAP. The risk was attributed partially to carriage of oropharyngeal organisms upon passage through endotracheal tube into the trachea during intubation and depressed host defenses secondary to the patient's severe underlying illness.

(5) Lack of anatomical barriers:

- leakage around the endotracheal cuff.
- Impaired cough and mucocillary clearance.
- Injury of the epithelial layer.

(6) Cross contamination via hands of health care workers (HCW) through:

- tracheal suctioning
- manipulation of the ventilator circuit, or endotracheal tubes

(7) Contamination of devices used on the respiratory tract which may be potential reservoirs and vehicles for infectious microorganisms:

- Devices used on the respiratory tract for respiratory therapy:
  - Endotracheal tube (Emergency intubation versus elective)
  - Nebulizer
  - Bronchoscopy and Spirometer
  - Anaesthesia devices

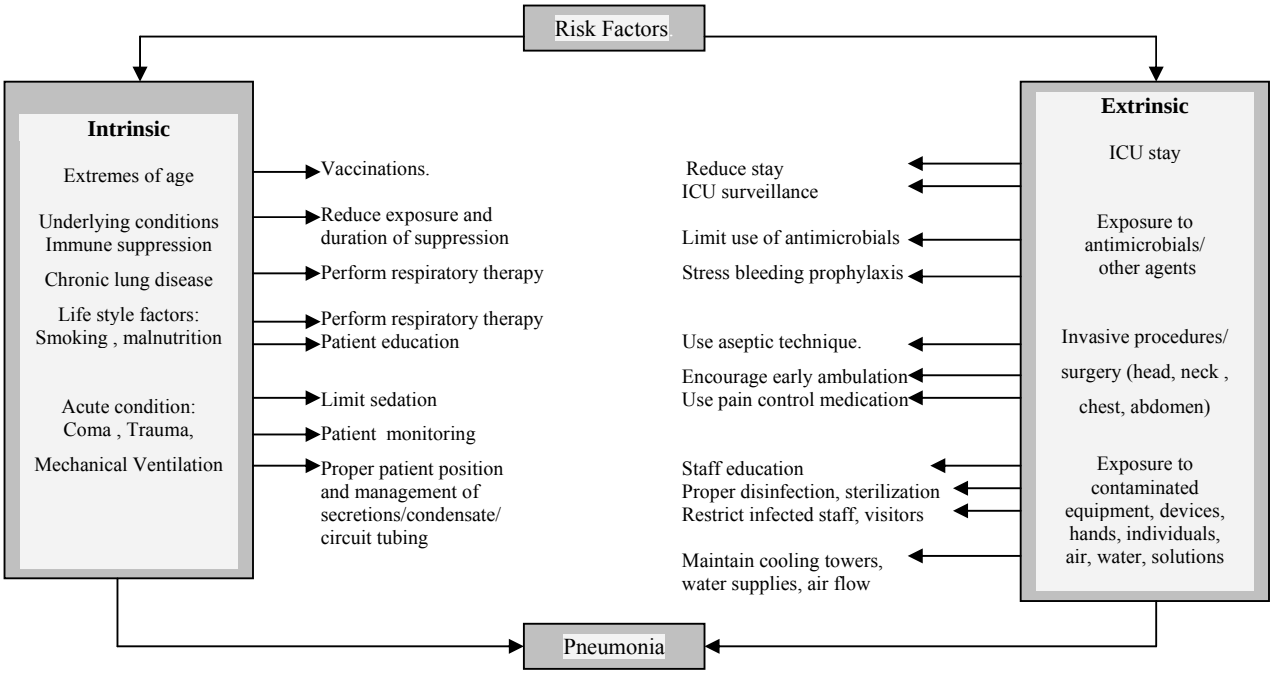


Figure 3. Intrinsic and extrinsic host factors contributing to the chain of health-care associated pneumonia and ventilator-associated pneumonia caused by bacterial pathogens. (Adapted from Craven DE et al. *Semin Respir Crit Care Med. 1997*.)

Pathogenesis of VAP

The pathogenesis of VAP is related to the number and virulence of organisms entering the lower airway and the response of the host's mechanical, humoral, and cellular defenses to the invasion (See Figure 4).

The development of pneumonia requires the pathogen to reach the alveoli and the host defenses to be overwhelmed. The endogenous sources of microorganisms are nasal carriers, sinusitis, mouth, oropharynx, gastric, or tracheal colonization, and hematogenous spread. The exogenous sources of microorganisms are biofilm of the tracheal tube, ventilator circuits, nebulizers, and humidifiers. Health care workers play major role in this setting.

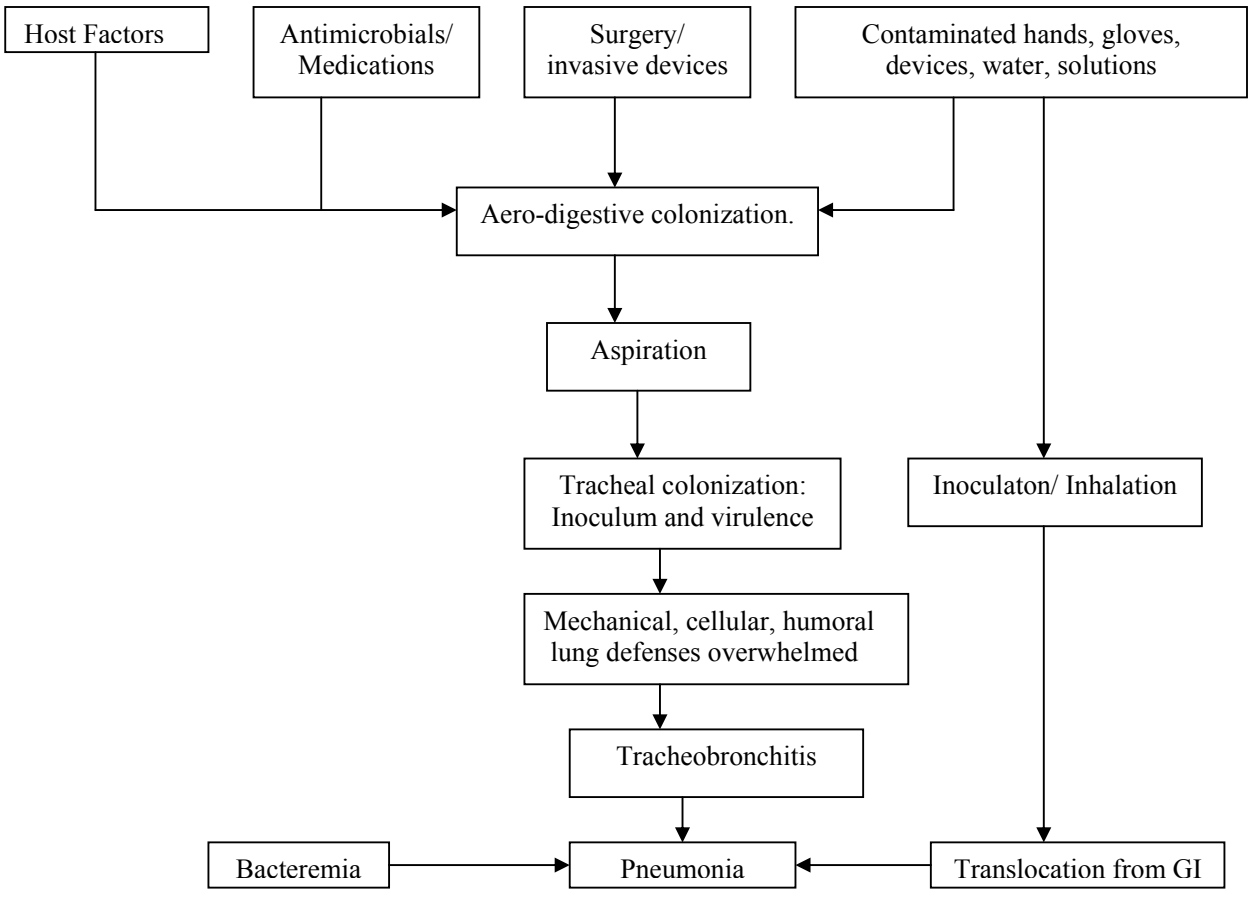


Figure 4. Risk factors for colonization of the aero-digestive tract and trachea before the development of tracheobronchitis and health-care associated / ventilator- associated pneumonia. *(Adapted from Craven DE et al. Curr Opin Crit Care. 2002)*

Different microorganism can be found depending on the onset time of pneumonia and the local pattern variation encountered between different institutions and countries. (Early versus late) See Table 2.

Table 2. Bacteria Associated With Early-and Late-Onset Ventilator – Associated Pneumonia.

Bacterial pathogen	Crude frequency (%)	Onset
Streptococcus pneumoniae: Pencillin-resistant Multidrug-resistant	10 - 20	Early
Haemophilus influenzae	5 - 15	Early
Staphylococcus aureus Methicillin-resistant Methicillin-sensitive	20 -30	Early/ Late
Gram –ve bacilli *Pseudomonas aeruginosa* *Acinetobacter species* *Klebsiella species* *Enterobacter species* *Serratia species*	30 - 60	Late
Legionella pneumophila	0 - 15	Late

Local trauma and inflammation caused by an endotracheal tube and possible leakage of contaminated secretions around the cuff and into the upper trachea increases lower airway colonization and the risk of tracheobronchitis and VAP (Figure 5)

In addition , microorganism aggregated in biofilm on the surface of the endotracheal tube may have pathogenetic relevance for colonization of the trachea and possible embolization to the lung following maneuvers such as endotracheal suctioning and bronchoscopy. Host factors, the types of bacteria colonizing the pharynx, and the recent use of antibiotics may also alter pharyngeal colonization and adherence of bacteria.

The stomach is also a potential reservoir for Multi-Drug Resistant Organisms (MDROs) bacteria that may cause retrograde colonization of the oropharynx and increase the risk of VAP, particularly in patients with increased gastric volume or alkaline pH.

The use of antacids or histamine type 2 (H_2) blockers has been associated with an increased risk of VAP compared with use of sucralfate, but patients receiving sucralfate have had a higher rate of clinically significant GI bleeding.

Furthermore, patients in a supine body position, those who have a nasogastric or orogastric tube, and those who are receiving enteral feeding are at much greater risk for VAP than are patients who are maintained in the semi-upright position.

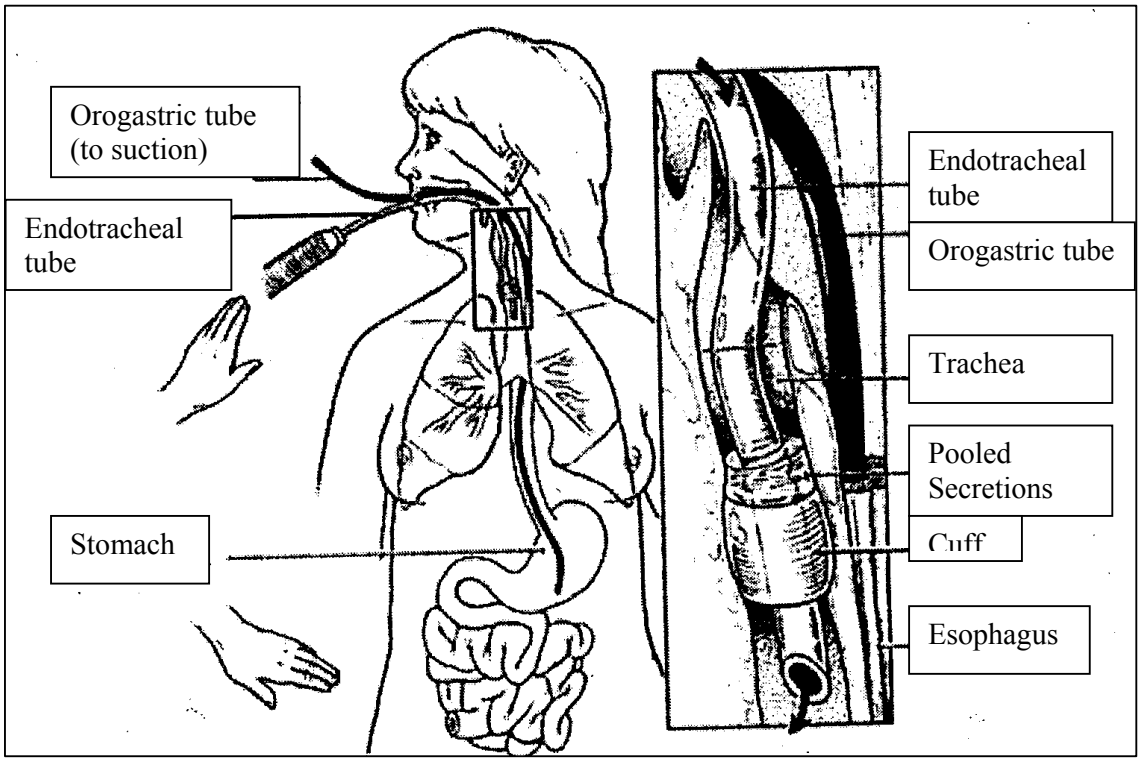


Figure 5. Schematic representation of an intubated patient with collection of subglottic secretions above the endotracheal tube cuff. Note that the placement of an orogastric tube rather than a nasogastric tube reduces the risk sinusitis and ventilator-associated pneumonia.
(Adapted from Craven DE, Steger KA. *Infect Control Hosp Epidemiol*. 1997.)

Modes of transmission of infection

1) From device to patient.
2) From one patient to another.
3) From one body site to LRT of same patient via hand or device

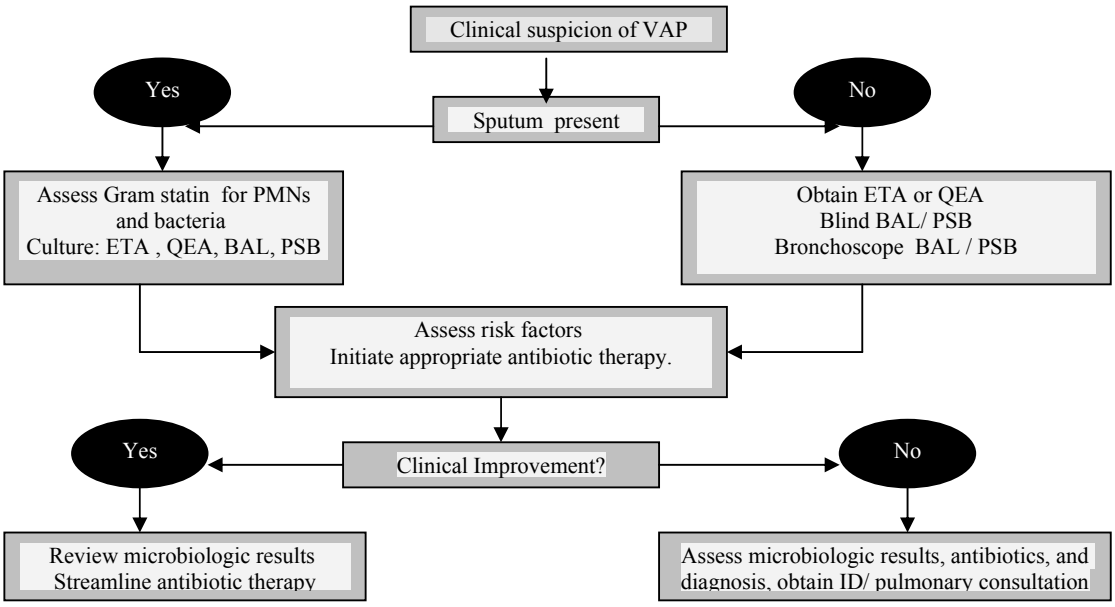
Management (Fig.6)

(A)- Diagnosis

See updated CDC definitions for HCAP on page 5.

(B). Treatment principles:-

- Early, appropriate initial antibiotic coverage for all suspected pathogens and de-escalation or streamlining of antibiotic therapy based on clinical response and microbiologic data appear to improve patient outcomes.
- The use of a specific antibiotic regimen should also be based on the local epidemiology of MDROs in the ICU.
- Although a lower respiratory tract culture should be collected from all patients before starting antibiotics, culture collection should not delay the initiation of therapy in critically ill patients.
- Empiric therapy should include agents from different antibiotic class than what the patient has received recently.
- The optimal duration of therapy for patients with VAP is unknown, but studies are in progress that may shorten the duration of treatment.
- Shorter courses of antibiotics (7-8 days) have been used in early-onset disease where there is prompt response to initial therapy, provided they have no evidence of infection with nonfermenting gram-negative bacilli.
- Longer courses of antibiotics may be needed for patients with *Legionella* infection or for patients with complications of VAP, such as empyema, lung abscess, or additional sites of infection.
- Stopping antibiotic therapy in patients who do not meet the criteria for a diagnosis of VAP is important. (E.g., negative lower respiratory tract cultures in a patient who has not changed antibiotics in the past 72 hrs).
- **Initial antibiotic regimens for early-onset or late-onset, mild to severe ventilator-associated pneumonia will be based upon local antibiotic policy.**



PMNs : Polymorphonuclear Leucocytes, ETA: Endotracheal Aspirate; QEA: Quantitative Endotracheal Aspirate; BAL: Bronchoalveolar Lavage; PSB: Protected Specimen Brush; ID: Infectious Diseases.

Figure 6. Management algorithm for ventilator-associated pneumonia (VAP)

C. Recommendations for prevention of health-care associated pneumonia (HCAP)

Categorization of Recommendations

Based on a review of the literature, several recommendations for preventing HCAP are presented. The CDC has promoted some of these suggestions; others are based on results in studies that have been published since the 1994 CDC guidelines were published. Each recommendation is categorized on the basis of existing scientific evidence, theoretical rationale, applicability, and potential economic impact. In addition, a new category accommodates recommendations that are made on the basis of existing national or state health regulations. The following categorization scheme is applied in this guideline:

Category IA. Strongly recommended for implementation and strongly supported by well-designed experimental, clinical, or epidemiological studies.

Category IB. Strongly recommended for implementation and supported by certain clinical or epidemiological studies and by strong theoretical rationale.

Category IC. Required for implementation, as mandated by federal or state regulation or standard.

Category II. Suggested for implementation and supported by suggestive clinical or epidemiological studies or by strong theoretical rationale.

No recommendation; unresolved issue. Practices for which insufficient evidence or no consensus exists about efficacy.

I. STAFF EDUCATION AND INFECTION SURVEILLANCE

A. Staff Education

Educate healthcare workers about the epidemiology of, and infection-control procedures for, preventing HCAP. Also involve the workers in the implementation of interventions to prevent HCAP by using performance-improvement tools and techniques (IA).

B. Surveillance

1. Conduct surveillance for bacterial pneumonia in ICU patients who are at high risk for HCAP (e.g., patients with mechanically assisted ventilation or selected postoperative patients) to determine trends and help to identify outbreaks and other potential infection-control problems. Include data on the causative microorganisms and their antimicrobial susceptibility patterns. Express data as rates (e.g., number of infected patients or infections per 100 ICU days or per 1,000 ventilator days) to facilitate intra hospital comparisons and trend determination. (IB).

2. In the absence of specific clinical, epidemiological, or infection-control objectives, do not **routinely** perform surveillance cultures of patients or of equipments or devices used for respiratory therapy, pulmonary-function testing, or delivery of inhalation anesthesia (II)

II. INTERRUPTION OF TRANSMISSION OF MICROORGANISMS

A. Sterilization or Disinfection, and Maintenance of Equipment and Devices

Proper cleaning and sterilization or disinfection of reusable equipment is an important component of a program to reduce infection associated with respiratory therapy and anesthesia equipment. Many devices used on the respiratory tract have been categorized as semicritical in the Spaulding classification system of appropriate sterilization or disinfection of medical devices because they come into direct or indirect contact with mucus membranes but do not ordinarily penetrate body surfaces and the associated infection risk following the use of these devices in patients is less than that associated with devices that penetrate normally sterile tissues.

1. General Measures

a) Thoroughly clean all equipment and devices to be sterilized or disinfected (IA)

b) Sterilize (by autoclaving or ethylene oxide) for semicritical equipment or devices. If it is neither possible or cost effective to sterilize these devices, they can be subjected to high level disinfection by using utensil disinfector machine at 94°C for 4 minutes, or by using liquid chemical disinfectant. Follow disinfection with appropriate rinsing, drying, and packaging, taking care not to contaminate the disinfected items in the process (IA)

c) Use sterile water for rinsing reusable semicritical respiratory equipment and devices when rinsing is needed after they have been chemically disinfected. Data are insufficient regarding safety of using tap water for rinsing (followed by drying) reusable semicritical respiratory devices after their disinfection or between their uses on the same patient. If this is not feasible, rinse the device with filtered water (i.e., water that has been through a 0.2μ filter) or tap water, and then rinse with isopropyl alcohol and dry with forced air or in a drying cabinet (IB)

d) Do not reprocess an equipment or device that is manufactured for single use only.

2. Mechanical ventilators

The internal machinery of mechanical ventilators is not considered an important source of bacterial contamination of inhaled gas. Thus, routine sterilization or disinfection of the internal machinery is considered unnecessary. (II)

3. Breathing circuits, humidifiers, and heat-and-moisture exchangers (HMEs)

- **Breathing circuits with humidifiers (See appendix 1)**

a) Do not routinely change more frequently than 48 hr, including ventilator tubing and exhalation valve, and the attached humidifier that is in use on an individual patient. Change the circuit when it is visibly soiled or mechanically malfunctioning. (IA)

b) Breathing-circuit--tubing condensate

- Periodically drain and discard any condensate that collects in the tubing of a mechanical ventilator, taking precautions not to allow condensate to drain toward the patient (IB)
- Wear gloves to perform the previous procedure and/or when handling the fluid (IB)
- Decontaminate hands with antiseptic hand wash and water (if hands are visibly soiled) or with an alcohol-based hand rub after performing the procedure or handling the fluid (IA)

c) Humidifier fluids

- Clean bubbling humidifiers and subject to high level disinfection (e.g.utensil disinfector) daily and in between patients.
- Use sterile water to fill bubbling humidifiers. (II)
- No recommendation can be made for the preferential use of a closed or continuous-feed humidification system (Unresolved issue). In Kuwait a closed system is recommended for use as humidification system.

- **Ventilator breathing circuits with HMEs**

a) Changing HME

- Change an HME that is in use on a patient when it malfunctions mechanically or becomes visibly soiled or when its water content increase causes resistance on the ventilator (II).
- Do not routinely change more frequently than every 48 hours an HME that is in use on a patient (II)

b) Do not change routinely (in the absence of gross contamination or malfunction) the breathing circuit attached to an HME while it is in use on a patient (II)

4. Oxygen humidifiers

Change the humidifier tubing (including any nasal prongs or mask) that is in use on one patient when it malfunctions or becomes visibly contaminated. (II).

5. Small-volume medication nebulizers: in-line and hand-held nebulizers

a) Between treatments on the same patient clean with liquid detergent and wipe with alcohol 70%, and dry small-volume in-line or hand-held medication nebulizers. (IB)
b) Use only sterile fluid for nebulization, and dispense the fluid into the nebulizer aseptically. (IA)
c) Whenever possible, use aerosolized medications in single-dose vials. If multidose medication vials are used, follow manufacturers' instructions for handling, storing, and dispensing the medications. (IB)

6. Mist tents

a) Between uses on different patients, replace mist tents and their nebulizers, reservoirs, and tubings with those that have been subjected to sterilization or high-level disinfection. (II)
b) No recommendation can be made about the frequency of routinely changing mist-tent nebulizers, reservoirs, and tubings while in use on one patient. (Unresolved issue).
c) Subject mist-tent nebulizers, reservoirs, and tubings that are used on the same patient to daily low-level disinfection (e.g., with 2% acetic acid) followed by air-drying (II) or according to manufacturer's instructions.

7. Other devices used in association with respiratory therapy

a) Respirometer and ventilator thermometer: between their uses on different patients, sterilize or subject to high-level disinfection portable respirometers and ventilator thermometers (IB)

b) Resuscitation bags

- Between their uses on different patients, sterilize or subject to high-level disinfection reusable hand-powered resuscitation bags (IB). (**See appendix 2)**
- **Our recommendation in Kuwait is to change the hydrophopic filter whenever visibly soiled or when used for a known infected case.**

8. Anesthesia machines and breathing systems or patient circuits

a) Do not routinely sterilize or disinfect the internal machinery of anesthesia equipment. (IB)

b) Clean and then sterilize or subject to high-level liquid chemical disinfection if available reusable components of the breathing system or patient circuit (ie. the y-piece; face mask; reservoir bag and humidifiers) and use disposable tracheal tubes, and inspiratory and expiratory breathing tubing, between uses on different patients, in accordance with the device manufacturers' instructions for their reprocessing (IB). (See appendix 3a)

c) Follow published guidelines or manufacturers' instructions about in-use maintenance, cleaning, and disinfection or sterilization of other components or attachments of the breathing system or patient circuit of anesthesia equipment (IB)

d) No recommendation can be made for placing a bacterial filter in the breathing system or patient circuit of anesthesia equipment (Unresolved issue)

9. Pulmonary-function testing equipment

a) Do not routinely sterilize or disinfect the internal machinery of pulmonary-function testing machines between uses on different patients (II)

b) Change the mouthpiece of a peak flow meter or the mouthpiece and filter of a spirometer between uses on different patients (II)

10. Room-air "humidifiers" and faucet aerators

a) Do not use large-volume room-air humidifiers that create aerosols (e.g., by venturi principle, ultrasound, or spinning disk, and thus actually are nebulizers) unless they can be sterilized or subjected to high-level disinfection at least daily and filled only with sterile water (II)

b) Faucet aerators

- No recommendation can be made about the removal of faucet aerators from areas for immunocompetent patients (Unresolved issue).
- If *Legionella* spp. are detected in the water of a transplant unit and until *Legionella* spp. are no longer detected by culture, remove faucet aerators in the unit (II)

B. Prevention of Person-to-Person Transmission of Bacteria

1. <u>Standard Precautions</u>

a) Hand hygiene

Meticulous hand washing is the first step in reducing VAP. Decontaminate hands by washing them with either antiseptic hand wash and water (if hands are visibly dirty or contaminated with proteinaous material or are soiled with blood or body fluids) or by using an alcohol-based antiseptic agent (e.g., hand rub) if hands are not visibly soiled. Decontaminate hands as described previously after contact with mucous membranes, respiratory secretions, or objects contaminated with respiratory secretions, whether or not gloves are worn and before and after contact with a patient who has an endotracheal or tracheostomy tube in place, and before and after contact with any respiratory device that is used on the patient, whether or not gloves are worn (IA)

b) Gloving

- Wear gloves when suctioning patients orally or through the endotracheal tube. Gloves are also needed when handling respiratory secretions or objects contaminated with respiratory secretions of any patient. Gloves are also recommended when closed-suction devices are used. (IB)
- Change gloves and decontaminate hands as described previously between contacts with different patients; after handling respiratory secretions or objects contaminated with secretions from one patient and before contact with another patient, object, or environmental surface; and between contacts with a contaminated body site and the respiratory tract of, or respiratory device on, the same patient (IA)

Although these recommendations seem simple, many times staff are observed leaving a patient's room with gloves on, and proceed to enter data on the patient's record, answer the phone, and perform other duties.

c) Gowning

When soiling with respiratory secretions from a patient is anticipated, wear a gown and change it after soiling occurs and before providing care to another patient (IB)

2. Care of patients with tracheostomy

a) Perform tracheostomy under aseptic conditions (II).

b) When changing a tracheostomy tube, wear a gown, use aseptic technique, and replace the tube with one that has undergone sterilization or high-level disinfection (IB)

c) No recommendation can be made for the daily application of topical antimicrobial agent(s) at the tracheostomy site (Unresolved issue).

However, in Kuwait it is not recommended to make daily topical application of antimicrobial agent(s) at the tracheostomy site.

3. Suctioning of respiratory tract secretions (See also Section IV-B-1-e)

Endotracheal Suctioning The current standard of care is to suction patients only when need is determined by auscultation of adventitious lung sounds or other assessments. The rationale for this standard is to reduce trauma to the airways. However, some patients have minimal secretions and may not have to be suctioned for several hours. Because stagnant mucus and lack of a cough reflex are risk factors for the development of VAP, suctioning and interventions to facilitate effective coughing may be needed periodically.

When suction catheters are used, it is important to rinse the secretions, to remove mucus from the suction catheter and to reduce the likelihood of bacterial growth.

a) No recommendation can be made for the preferential use of either the multiuse closed-system suction catheter or the single-use open-system suction catheter for prevention of pneumonia (Unresolved issue)

b) No recommendation can be made about wearing sterile rather than clean gloves when performing endotracheal suctioning (Unresolved issue).

c) No recommendation can be made about the frequency of routinely changing the in-line suction catheter of a closed-suction system in use on one patient (Unresolved issue)

d) If the open-system suction is employed, use a sterile, single-use catheter (II).

e) Use only sterile fluid to remove secretions from the suction catheter if the catheter is to be used for re-entry into the patient's lower respiratory tract (II).

In Kuwait it is recommended to rinse the tube connected to the vacuum bottle catheter (in-line catheter) with sterile saline after each use. Galipot used for rinsing in-line catheter should be discarded after each use. Change daily the used in-line catheter.

IV. MODIFYING RISK FACTORS FOR INFECTION

A. Increasing Host Defense Against Infection: Administration of immune modulators

1. Pneumococcal vaccination (Consider Vaccination whenever indicated)

a- Administer the pneumococcal polysaccharide vaccine to persons aged > 65 years.

b- Persons aged 5 - 64 years

▪ Who have chronic cardiovascular disease, chronic pulmonary disease (e.g., chronic obstructive pulmonary disease [COPD] or emphysema, but not asthma), diabetes mellitus, alcoholism, chronic liver disease (e.g., cirrhosis), or cerebrospinal fluid (CSF) leaks.

▪ Who have functional or anatomic asplenia.

▪ Who are living in special environments or social settings; immunocompromised persons aged ≥5 years with HIV infection, leukemia, lymphoma, Hodgkin's disease, multiple myeloma, generalized malignancy, chronic renal failure, nephrotic syndrome, or other conditions associated with immunosuppression (e.g., receipient of Homeopetic stem cell transplantation-HSCT, solid-organ transplant, or immunosuppressive chemotherapy, including long-term systemic corticosteroids) and persons in long-term care facilities (IA)

2. No recommendation can be made for the routine administration of preparations of granulocyte-colony stimulating factor (GCSF) or intravenous gamma globulin for prophylaxis against VAP (Unresolved issue)

3. No recommendation can be made for the routine enteral administration of glutamine for prevention of VAP (Unresolved issue)

B. Precaution for Prevention of Aspiration

As soon as the clinical indications for their use are resolved, remove devices such as endotracheal, tracheostomy, and/or enteral (i.e., oro- or nasogastric or jejunal) tubes from patients (IB)

Because aspiration of oropharyngeal secretions is a primary route for acquiring VAP, strategies to reduce aspiration of secretions are recom mended.

1. <u>Prevention of aspiration associated with endotracheal intubations</u>

a) Use of noninvasive ventilation (NIV) to reduce the need for and duration of endotracheal intubation:

- When feasible and not medically contraindicated, use noninvasive positive-pressure ventilation (NIV) delivered continuously by face or nose mask, instead of performing endotracheal intubations in patients who are in respiratory failure and are not needing immediate intubations (e.g., those who are in hypercapneic respiratory failure secondary to acute exacerbation of COPD or cardiogenic pulmonary edema) (II)
- When feasible and not medically contraindicated, use NIV as part of the weaning process (from mechanically assisted ventilation) to shorten the period of endotracheal intubation (II)

b) Early Extubation: Because the likelihood of pneumonia increases with prolonged ventilation period; separation from mechanical ventilation as soon as possible must be a priority. Accidental extubation and subsequent reintubation increases the risk for VAP. Therefore, strategies to prevent unplanned extubation are warranted.

c) As much as possible, avoid repeated endotracheal intubations in patients who have received mechanically assisted ventilation. (II)

d) Unless contraindicated by the patient's condition, perform orotracheal rather than nasotracheal intubations on patients. (IB)

e) If feasible, use an endotracheal tube with a dorsal lumen above the endotracheal cuff to allow drainage (by continuous or frequent intermittent suctioning) of tracheal secretions that accumulate in the patient's subglottic area. (II)

f) Endotracheal cuff: Before deflating the cuff of an endotracheal tube in preparation for tube removal, or before moving the tube, ensure that secretions are cleared from above the tube cuff (II). The incidence of VAP increases when the endotracheal cuff pressure is less than 20 cm water pressure. It is important to check cuff pressures routinely and to maintain at least 20 cm of pressure.

g) Repositioning Endotracheal Tubes: Oral endotracheal tubes are repositioned and retaped according to hospital protocol, usually once a day. The rationale for repositioning tubes is to prevent breakdown of the oral mucosa and mouth. There is no guidance in reported research regarding frequency of repositioning tubes. Because pooled secretions above the endotracheal cuff are associated with VAP, it is important that thorough oral suctioning be performed before repositioning tubes. Optimal frequency of repositioning tubes should be established.

h) Aspiration of Subglottic Secretions: Studies evaluated a special dual-lumen endotracheal tube that has a port through which subglottic secretions are continually aspirated. Results in a randomized trial of this new tube versus conventional endotracheal tubes showed a significant decrease in VAP in the patients with continuous subglottic aspiration and a delay in onset of VAP. Failure of the continuous aspiration device was cited as a risk factor for VAP. This is a fairly new treatment that appears to be beneficial, and ongoing evaluation is recommended. Alternative methods for aspiration may be tried for example, thoroughly suctioning the oropharynx of patients every 1 to 2 hours in an attempt to decrease the amount of pooled secretions around the endotracheal cuff.

2. <u>Prevention of aspiration associated with enteral feeding</u>

a) Bed elevation: In the absence of medical contraindication(s), elevation of the head of bed to an angle of 30 - 45 degrees is effective in reducing the risk of aspiration in high risk patients (e.g., a person receiving mechanically assisted ventilation and/or who has an enteral tube in place). (II)

b) Routinely verify appropriate placement of the feeding tube. (IB)

c) No recommendation can be made for the preferential use of small-bore tubes for enteral feeding. (Unresolved issue)

d) No recommendation can be made for preferentially administering enteral feedings continuously or intermittently. (Unresolved issue)

e) No recommendation can be made for preferentially placing the feeding tubes, (e.g., jejunal tubes) distal to the pylorus. (Unresolved issue)

f) Gastric Residuals Patients receiving tube feeding must be closely monitored for aspiration. Checking residual volumes is one method of assessment. High residual gastric volumes may occur when gastric emptying is impaired, increasing the likelihood of regurgitation and aspiration. No standard for checking residuals has been established. Based on review of the literature and on clinical experience, residuals should be checked every 2 hours when feedings are initiated. Once tube feedings are progressing without difficulty, residuals can be checked every 4 to 6 hours.

g) Gastric Versus Intestinal Feeding: Where to place feeding tubes in the stomach or the small intestine is another issue related to aspiration. In addition, it is believed that critically ill patients better tolerate early enteral feeding into the small intestine. However, one researcher found that aspiration was associated with both feeding methods. Although further investigation is needed, rationale for feeding into the small intestine supports its use to reduce the risk of VAP. (Unresolved issue)

h) Evaluating Swallowing: Oral feeding is initiated in patients with tracheostomies and in some patients who are nasally intubated. It is important to avoid oral feedings in patients with artificial airways until a dysphagia evaluation and a rehabilitation of swallowing are completed, since subclinical aspiration is common in this group.

3. <u>Prevention or modulation of oropharyngeal colonization</u>

The first step in preventing VAP is to reduce colonization by pathogens of the oropharynx (Basic nursing care principles are essential).

a) Oral Hygiene Although considered a standard nursing intervention, oral hygiene is often neglected when caring for intubated patients. Many times, it is performed by quickly swabbing the mouth. Oral care involves brushing the patient's teeth, use of solutions and mouthwash to cleanse the mouth, and thorough suctioning of oral secretions. Systematic oral assessment is recommended in intubated patients.

b) Nasal Hygiene Meticulous nasal care and cleansing of the nasopharynx may reduce bacterial colonization. As in oral care, nasal care is often neglected as a part of routine hygiene. Most patients have a nasogastric or nasoenteric tube in place, and the endotracheal tube may be placed nasally. The tubes remain taped for prolonged periods, and secretions accumulate and crust in the nares. Protocols for routinely cleansing the nose and suctioning nasopharyngeal secretions should be implemented and evaluated.

c) Oropharyngeal cleaning and decontamination with an antiseptic agent: develop and implement a comprehensive oral-hygiene program (that might include the use of an antiseptic agent) for patients in acute-care settings or residents in long-term care facilities that are at high risk for VAP. (II)

d) Turning and Positioning: Stagnant mucus in the lower airways is a medium for bacterial growth, should pathogens reach the lower airways. Routine turning and positioning assists in mobilization of secretions.

e) Chlorhexidine oral rinse: Use an oral chlorhexidine gluconate (0.12%) rinse during the perioperative period on adult patients who undergo cardiac surgery. (II)

f) Oral decontamination with topical antimicrobial agents: No recommendation can be made for the routine use of topical antimicrobial agents for oral decontamination to prevent VAP. (Unresolved issue)

4. <u>Prevention of gastric colonization</u>

Stress Ulcer Prophylaxis Each patient should be individually evaluated for the need for medications to prevent stress ulcers.

a) No recommendation can be made for the preferential use of sucralfate, H2-antagonists, and/or antacids for stress-bleeding prophylaxis in patients receiving mechanically assisted ventilation. (Unresolved issue)

b) No recommendation can be made for the routine selective decontamination of the digestive tract (SDD) of all critically ill, mechanically ventilated, or ICU patients. (Unresolved issue)

c) No recommendation can be made for routinely acidifying gastric feeding. (Unresolved issue)

D. Special types of pneumonia:-

Candida Pneumonia

Introduction:-

Candida species produce a wide spectrum of diseases, ranging from superficial mucocutaneous disease to invasive illnesses, such a hepatosplenic candidiasis, Candida peritonitis, and systemic candidiasis. Management of serious and life-threatening invasive candidiasis remains severely hampered by delay in diagnosis and lack of reliable diagnostic methods that allow detection of both fungemia and tissue invasion by candida species. High risk areas for candida infection include neonatal, pediatric and adult intensive care units (ICUs) both medical and surgical.

Candida pneumonia does not exist alone and occurs only rarely as part of disseminated candidiasis. The most common form is multiple abscesses due to hematogenous dissemination of candida species. The high degree of colonization and isolation of candida species from the respiratory tract makes it difficult to make a diagnosis. The patients history reveals similar risk factors for disseminated candidiasis.

Risk factors associated with Candidiasis include the following:

- Granulocytopenia
- Bone-marrow transplantation
- Solid organ transplantation (liver, kidney)
- Parental hyperalimentation
- Hematologic malignancies
- Folleys catheters.
- Solid neoplasms
- Recent chemotherapy or radiation therapy
- Corticosteroids
- Broad-spectrum antibiotics
- Burns, ulcerations
- Prolonged hospitalization
- Severe trauma
- Recent bacterial infection
- Recent surgery
- Gastrointestinal tract surgery
- Central intravascular access devices

- Premature birth
- Hemodialysis
- Granulocytopenia
- Hypocomplementemia
- Hypogammaglobulinemia
- HIV
- DM

The first step in the development of a candidal infection is colonization of the mucocutaneous surfaces. The factors outlined above are all associated with increased colonization rates. Routes of candidal invasion include disruption of a colonized surface (skin or mucosa), allowing the organisms gain access to the blood stream, and absorption via the gastrointestinal wall may occur following massive colonization with large numbers of organism that pass directly into the bloodstream.

Diagnosis of Candida pneumonia:-

As the respiratory tract frequently is colonized with candida species, the diagnosis of pneumonia due to candida species must be not made by culturing respiratory secretions. The diagnosis is made by demonstration of tissue invasion of a lung biopsy by histopathologic studies. The classic appearance demonstrates the candida species as either ovoid yeast cells, hyphae, or pseudo hyphae.

Cultures of respiratory tract (non-sterile site) although not useful in establishing a diagnosis, may demonstrate high degree of candidal colonization. This may be useful in initiating antifungal therapy in patients with fever unresponsive to broad spectrum antimicrobials. Therefore, appropriate interpretation is required. In contrast, positive blood culture and culture from other sterile site in patient at risk imply that invasive disease is present.

Always consider positive culture results from sterile sites to be significant and evidence of infection.

Health-Care--Associated Legionnaires Disease

Legionnaires disease is a multi-system illness, with pneumonia. It is caused by *Legionella* spp. with *legionella pneumophila* responsible for 90% of infections.

Epidemiology:

Since the etiologic agent of Legionnaires disease was identified, numerous nosocomial outbreaks of the disease have been reported, thus enabling researchers to study the epidemiology of epidemic legionellosis. In contrast, the epidemiology of sporadic nosocomial Legionnaires disease has not been well defined. However, when one case is identified, the presence of additional cases should be suspected.

Of 196 cases of health-care associated Legionnaires disease reported in England and Wales during 1980-1992, 69% occurred during health-care associated outbreaks (defined as two or more cases occurring at a hospital during a 6-month period).

Sources of infection:

Legionella is widely distributed in aquatic environments. The bacteria survive and grow particularly well in man-made environments, especially if water is in a temperature range of 25-42^{o}C (77-108^{o}F), sediment and scaling are present, and water flow is relatively stagnant. Growth may also be facilitated by the presence of certain free-living aquatic amoebae that are capable of supporting intracellular growth of legionellae.

In hospitals and other institutions, *legionella* are found primarily in two locations:

1) **Potable hot water systems** (defined as all building plumbing systems that distribute water for direct human contact).

2) **Water in cooling towers**.

As *legionella* is chlorine tolerant, it will survive many of the standard municipal water treatment protocols. Once present in a hospital hot water system, *legionella* is able to survive and multiply, particularly as hot water temperatures are kept relatively low to minimize the scald risk for patients. In hot water systems, concentrations of the bacterium are highest in biofilms within the system and at openings of water outlets.

Modes of transmission:

Inhalation of aerosols of water contaminated with *Legionella* sp. is believed to be the primary mechanism by which these organisms enter a patient's respiratory tract. In several hospital outbreaks, patients were considered to be infected through exposure to contaminated aerosols generated by cooling towers, showers, faucets, respiratory therapy equipment, and room-air humidifiers. In other studies, **aspiration** of contaminated potable water was proposed as the mode of transmission to certain patients. However, person-to-person transmission has not been observed.

Risk factors:

A person's risk for acquiring legionellosis after exposure to contaminated water depends on a number of factors, including the type and intensity of exposure and the person's health status . Persons who are severely immunosuppressed or who have chronic underlying illnesses, such as hematologic malignancy or end-stage renal disease, are at a **markedly increased risk** for legionellosis. Persons in the later stages of acquired immunodeficiency syndrome (AIDS) also are **probably at increased risk** for legionellosis, but data are limited because of infrequent testing of patients. Persons who have diabetes mellitus, chronic lung disease, or non hematologic malignancy; those who smoke cigarettes; and the elderly are at **moderately increased risk**. Males are affected more commonly than females.

Underlying disease and advanced age are risk factors not only for acquiring Legionnaires disease but also for dying as a result of the illness. The mortality rate reached 40% for nosocomially acquired cases, compared with 20% for community-acquired cases. This difference probably reflected the increased severity of underlying disease in hospitalized patients.

Clinical features:

The incubation period of legionnaires disease is 2-10 days. The clinical spectrum of disease is broad and ranges from asymptomatic infection to rapidly progressive pneumonia. Legionnaires disease cannot be distinguished clinically or radiographically from pneumonia caused by other agents and evidence of infection with other respiratory pathogens does not exclude the possibility of concomitant *Legionella* sp. Severe infections may lead to respiratory failure and death.

Diagnosis

The diagnosis of legionellosis may be confirmed by any one of the following:

- Culture isolation of *Legionella* from **respiratory secretions** (sputum, endotracheal aspirates, bronchial brushing and bronchoalveolar lavage fluid) or **tissues**.
- Demonstration of the organism by direct immmunofluorescent staining of the bacterium in respiratory secretions or tissues .
- For legionellosis caused by *Legionella pneumophila* serogroup 1: detection of *L. pneumophila* serogroup-1 antigens in urine by radioimmunoassay, or observation of a four-fold rise in *L. pneumophila* serogroup-1 antibody titer to greater than or equal to 1:128 in paired acute and convalescent serum specimens by use of an indirect immunofluorescent antibody (IFA) test. A single elevated antibody titer does not confirm a case of Legionnaires disease because IFA titers greater than or equal to 1:256 are found in 1%-16% of healthy adults.

Because the above tests complement each other, performing each test when Legionnaires disease is suspected increases the probability of confirming the diagnosis. However, because none of the laboratory tests is 100% sensitive, the diagnosis of legionellosis is not excluded even if one or more of the tests are negative. Of the available tests, the most specific is culture isolation of *Legionella* sp. from any respiratory tract specimen.

Definition of Nosocomial Legionnaires Disease:

Since the incubation period for Legionnaires disease is usually 2-10 days; thus, according to CDC and Hospital Infection Control Practices Advisory Committee (HICPAC) recommendations:

A definite case of nosocomial Legionnaires disease is laboratory-confirmed legionellosis that occurs in a patient who has been hospitalized continuously for greater than or equal to 10 days before the onset of illness.

A possible case of nosocomial Legionnaires disease is laboratory-confirmed infection that occurs 2-9 days after hospital admission.

Prevention and Control of Health-Care--Associated Legionnaires Disease:

I. Primary Prevention (Preventing health-care--associated Legionnaires disease when no cases have been documented)

A. Staff Education

1. Educate physicians to heighten their suspicion for cases of health-care--associated Legionnaires disease and to use appropriate methods for its diagnosis (II).

2. Educate patient-care, infection-control, and engineering personnel about measures to prevent and control health-care--associated legionellosis (II).

B. Infection and Environmental Surveillance

1. Maintain a high index of suspicion for the diagnosis of health-care associated Legionnaires disease and perform laboratory diagnostic tests (both culture of appropriate respiratory specimen and the urine antigen test) for legionellosis on suspected cases, especially in patients who are at high risk for acquiring the disease (e.g., patients who are immunosuppressed, including hemopoietic stem cell transplant (HSCT) or solid-organ transplant recipients; patients receiving systemic steroids; patients aged $\geq$65 years; or patients who have chronic underlying disease such as diabetes mellitus, congestive heart failure, and COPD) (IA).

2. Periodically review the availability and clinicians' use of laboratory diagnostic tests for Legionnaires disease in the facility, and if clinicians do not routinely use the tests on patients with diagnosed or suspected pneumonia, implement measures to enhance clinicians' use of the tests (e.g., by conducting educational programs) (II).

3. Routine culturing of water systems for *Legionella* spp.

a. No recommendation can be made about routinely culturing water systems for *Legionella* spp. in health-care facilities that do not have patient-care areas (i.e., transplant units) for persons at high risk for *Legionella* infection (Unresolved issue).

b. In facilities with hemopoietic stem-cell and/ or solid-organ transplantation programs, periodic culturing for legionellae in water samples from the transplant unit(s) can be performed as part of a comprehensive strategy to prevent Legionnaires disease in transplant recipients (II).

c. If such culturing (as in b) is undertaken:

1) No recommendation can be made about the optimal methods (i.e., frequency or number of sites) for environmental surveillance cultures in transplant units (Unresolved issue).

2) Perform corrective measures aimed at maintaining undetectable levels of *Legionella* spp. in the unit's water system (II).

3) Maintain a high index of suspicion for legionellosis in transplant patients with health-care associated pneumonia even when environmental surveillance cultures do not yield legionellae (IB).

C. Use and Care of Medical Devices, Equipment, and Environment

1. Nebulizers and other devices

a. Preferentially use sterile water for rinsing nebulization devices and other semi critical respiratory-care equipment after they have been cleaned or disinfected. If this is not feasible, rinse the device with filtered water (i.e., water that has been through a 0.2μ filter) or tap water and then rinse with isopropyl alcohol and dry with forced air or in a drying cabinet (IB).

b. Use only sterile (not distilled, nonsterile) water to fill reservoirs of devices used for nebulization (IA).

c. Do not use large-volume room-air humidifiers that create aerosols (e.g., by venture principle, ultrasound, or spinning disk and thus are really nebulizers) unless they can be sterilized or subjected to high-level disinfection at least daily and filled only with sterile water (II).

d. Faucet aerators

No recommendation can be made for the removal of faucet aerators from areas for immunocompetent patients.

If *Legionella* spp. are detected in the water of a transplant unit and until *Legionella* spp. are no longer detected by culture, remove faucet aerators in areas for severely immunocompromised patients (II).

2. Cooling towers

a. When a new building is constructed, place cooling towers in such a way that the tower drift is directed away from the facility's air-intake system, and design the cooling towers such that the volume of aerosol drift is minimized (IB).

b. For cooling towers, install drift eliminators, regularly use an effective biocide, maintain the tower according to manufacturers' recommendations, and keep adequate maintenance records (IB).

3. Water-distribution system

a. Where practical and allowed by state law, maintain potable water at the outlet at $\geq$51°C ($\geq$124°F) or <20°C (<68°F), especially in facilities housing organ-transplant recipients or other patients at high-risk. If water is maintained at $\geq$51°C ($\geq$124°F), use thermostatic mixing valves to prevent scalding (II).

b. No recommendation can be made about the treatment of water with chlorine dioxide, heavy-metal ions, ozone, or ultraviolet light. Hospitals served by municipalities with monochloramine-treated water have had success in controlling *legionella* (Unresolved issue).

4. In health-care facilities with hemopoietic stem-cell or solid-organ transplantation programs, if legionellae are detected in the potable water supply of a transplant unit, and until legionellae are no longer detected by culture:

a. Decontaminate the water supply as per section (II-B-2-b-3-a)-*i* to *v* (IB).

b. Restrict severely immunocompromised patients from taking showers (IB).

c. Use water that is not contaminated with *Legionella* spp. for HSCT patients' sponge baths (IB).

d. Provide HSCT patients with sterile water for tooth brushing or drinking or for flushing nasogastric tubes (IB).

e. Do not use water from faucets with *Legionella*-contaminated water in patients' rooms to avoid creating infectious aerosols (II).

II. Secondary Prevention (Response to identification of laboratory-confirmed health-care--associated Legionellosis)

A. In Facilities with HSCT or Solid-Organ Transplant Recipients:

When one inpatient of an HSCT or solid-organ transplant unit develops a case of laboratory-confirmed definite (i.e., after ≥10 days of continuous inpatient stay) or possible (i.e., within 2-9 days of inpatient stay) health-care associated Legionnaires disease, or when two or more patients develop laboratory-confirmed Legionnaires disease within 6 months of each other and after having visited an outpatient transplant unit during part of the 2-10 day period before illness onset:

1. Contact the local infection control office.

2. In consultation with the facility's infection-control team, conduct a combined epidemiologic and environmental investigation (as outlined from II-B-2-b-1) through (II-B-2-b-5) to determine the source(s) of *Legionella* spp.. Include but do not limit the investigation to such potential sources as showers, water faucets, cooling towers, hot-water tanks, and carpet-cleaner water tanks. On its identification, decontaminate or remove the source of *Legionella* spp (II).

3. If the health-care facility's potable water system is found to be the source of *Legionella* spp., refer to the measures outlined in Section (I-C-4-b to e), with respect to the nonuse of the facility's potable water by recipients of HSCT or solid-organ transplants and decontaminate the water supply as per Section (II-B-2-b-3)-a)-*i* to *v* (IB).

4. Do not conduct an extensive facility investigation when an isolated case of possible health-care associated Legionnaires disease occurs in a patient who has had little contact with the inpatient transplant unit during most of the incubation period of the disease (II).

B. In Facilities That Do Not House Severely Immunocompromised Patients (e.g., HSCT or Solid-Organ Transplant Recipients):

When a single case of laboratory-confirmed definite health-care associated Legionnaires disease is identified, or when two or more cases of laboratory-confirmed, possible health-care associated Legionnaires' disease occur within 6 months of each other:

1. Contact the local infection control office.

2. Conduct an epidemiologic investigation through a retrospective review of microbiologic, serologic, and postmortem data to identify previous cases, and begin an intensive prospective surveillance for additional cases of health-care associated Legionnaires disease (II).

a. If no evidence of continued nosocomial transmission exists, continue the intensive prospective surveillance for cases for ≥2 months after surveillance is begun (II).

b. If evidence of continued transmission exists:

1) Conduct an environmental investigation to determine the source(s) of *Legionella* spp. by collecting water samples from potential sources of aerosolized water in addition to saving and subtyping isolates of *Legionella* spp. obtained from patients and the environment (IB).

2) If a source is not identified, continue surveillance for new cases for ≥2 months and, depending on the scope of the outbreak, decide to either defer decontamination pending identification of the source(s) of *Legionella* spp. or proceed with decontamination of the hospital's water distribution system, with special attention to the specific hospital areas involved in the outbreak (II).

3) If a source of infection is identified by the epidemiologic and environmental investigations, promptly decontaminate the source (IB).

a) If the heated water system is implicated:

i. Decontaminate the heated water system either by superheating or by hyperchlorination. To superheat, raise the hot water temperature to 71°C–77°C (160°F–170°F) and maintain at that level while progressively flushing each outlet around the system. A minimum flush time of 5 minutes has been recommended; however, the optimal flush time is not known and longer flush times might be required. Post warning signs at each outlet being flushed to prevent scald injury to patients, staff, or visitors. If possible, perform flushing when the building has the fewest occupants (e.g., nights and weekends). For systems on which thermal shock treatment is not possible, use shock chlorination as an alternative. Add chlorine, preferably overnight, to achieve a free chlorine residual of ≥2 mg/L (≥2 ppm) throughout the system. This might require chlorination of the water heater or tank to levels of 20–50 mg/L (20–50 ppm). Maintain the water pH between 7.0 and 8.0 (IB).

ii. Depending on local and state regulations about potable water temperature in public buildings, circulate potable water at temperatures not conducive to amplification of *Legionella;* store and distribute cold water at <20°C (<68°F); and store hot water at >60°C (>140°F) and circulate it at a minimum return temperature of 51°C (124°F) (II).

iii. If the methods described in 3a-i and 3a-ii are not successful in decontaminating the hospital's water, seek expert consultation for review of decontamination procedures and assistance with further efforts (II).

iv. No recommendation can be made for the treatment of water with chlorine dioxide, heavy-metal ions, ozone, or ultraviolet light. Hospitals have reported successful decontamination using each of these methods (Unresolved issue).

v. Clean hot-water storage tanks and water heaters to remove accumulated scale and sediment (IB).

b) If cooling towers or evaporative condensers are implicated, decontaminate the cooling-tower system (IB).

4) Assess the efficacy of implemented measures in reducing or eliminating *Legionella* spp. by collecting specimens for culture at 2-week intervals for 3 months (II).

a) If *Legionella* spp. are not detected in cultures during 3 months of monitoring at 2-week intervals, collect cultures monthly for another 3 months (II).

b) If *Legionella* spp. are detected in one or more cultures, reassess the implemented control measures, modify them accordingly, and repeat decontamination procedures. Options to repeat decontamination include the intensive use of the same technique used for the initial decontamination or a combination of superheating and hyper chlorination (II).

5) Keep adequate records of all infection-control measures, including maintenance procedures, and of environmental test results for cooling towers and potable-water systems (II).

Health-care Associated Aspergillosis

I. Epidemiology:-

Aspergillus spp. are ubiquitous fungi, commonly occurring in soil, water, and decaying vegetation. aspergillus spp. have been cultured from unfiltered air, ventilation systems, contaminated dust dislodged during hospital renovation and construction, horizontal surfaces, food, ornamental plants, and recently water from hospital water system.

A fumigates and A. flavus are the most frequently isolated Aspergillus spp. in patients with proven aspergillosis.

II. Pathogenesis:-

Pulmonary aspergillosis is acquired primarily by inhalation of the fungal spores. In severely immuno-compromised patients, primary Aspergillus spp. pneumonia results from local lung tissue invasion. Subsequently, the fungus may disseminate via the blood stream to involve multiple other deep organs. A role for nasopharyngeal colonization with Aspergillus spp. as an intermediate step before invasive pulmonary disease has been proposed but remains to be elucidated. Likewise colonization of the lower respiratory tract by Aspergillus spp. especially in patients with pre-existing lung disease such as cystic fibrosis, or inactive tuberculosis was reported to predispose patients to invasive pulmonary or disseminated infection; however, more recent data have not shown the correlation.

III. Diagnosis:-

- Diagnosing pneumonia due to Aspergillus spp. is often difficult.
- Clinical signs and symptoms, such as fever, chest pain, cough, malaise, weight loss, and dyspnsea are highly variable and non-specific.
- CXR findings can vary from single or multiple nodules with or without cavitations to widespread infiltrates.

❖ Definitive diagnosis:-

Requires both histopathologic demonstration of branching , septate, nonpigmented hyphae in lung tissue and isolation of the microorganism in culture.

❖ Probable diagnosis:-

Histologic identification in the absence of a positive culture because aspergillus hyphae are identical to those of fusarium spp. Scedosporium spp. and many other non-pigmented molds.

- Examination of BAL-fluid by smear, culture may be helpful in some cases.
- By itself, culture isolation of Aspergillus spp. from respiratory tract specimens of patients may indicate colonization. However, when aspergillus spp. is grown from the sputum of a febrile neutropenic patient with a new pulmonary infiltrate, it is highly likely that the patient has pulmonary aspergillosis.
- Routine blood cultures are remarkably insensitive for detecting Aspergillus spp.
- Abnormalities detected by computerized tomography (CT) scanning often precede those detected by plain chest radiograph. In neutropenic patients, the most distinctive lesions are small nodules surrounded by a zone of low attenuation, termed the "halo sign". Overtime the nodules may cavitate, resulting in the "crescent sign", a thin air crescent near the edge of the nodule.
- Testing for antibiotics against Aspergillus spp. has seldom proved helpful in diagnosing invasive aspergillosis in neutropenic patients. However, recent results from lung transplant recipients suggest that this procedure might be a useful adjunct other methods of diagnosis.

IV. Risk groups:-

- ❖ Persons with severe, prolonged granulocytopenia e.g:-
  - Hematologic malignancy
  - Hematopoietic stem cell and solid organ transplant recipients.
  - Patients on high dose corticosteroids.
- ❖ Rarely, persons with HIV infection.

Prevention and Control of Health-care Associated Pulmonary Aspergillosis.

I. Staff education and infection surveillance.

A. Staff Education:

Educate health-care personnel according to their level of responsibility about infection control procedures to decrease the occurrence of health-care associated pulmonary aspergillosis (II).

B. Surveillance:

1. Maintain a high index of suspicion for health-care associated pulmonary aspergillosis in severely immuno-compromised patients (i.e, patients with severe, prolonged neutropenia [ANC<500/mm^3 for 1 week], most notably HSCT recipients, and including recipients of solid organ transplants or patients with hematologic malignancies who are receiving chemotherapy, when they are severely neutropenic as defined previously) and persons receiving prolonged high-dose steroids (IA).

2. Maintain surveillance for cases of health-care associated pulmonary aspergillosis by establishing systems by which the facility's infection control personnel are promptly informed when Aspergillus spp. is isolated from cultures of specimens from patient's respiratory tract and by periodically reviewing the hospital's microbiologic histopathologic, and postmortem data (II).
3. Surveillance cultures:
   a. Do not perform routine, periodic cultures of the nasopharynx of asymptomatic patients at high risk (IB)
   b. Do not perform routine, periodic cultures of equipment or devices used for respiratory therapy, pulmonary function testing, or delivery of inhalation anesthesia in the HSCT unit, nor of dust in rooms of HSCT recipients (IB).
   c. No recommendation can be made about routine microbiologic air sampling before, during or after facility construction or renovation or before or during occupancy of areas housing immnuo-compromised patients (Unresolved issue).

4. In facilities with protective environment (PEs), perform surveillance of the ventilation status of these areas either by continuous monitoring or periodic analysis of the following parameters: room air exchanges, pressure relations, and filtration efficacy to ensure that appropriate levels are maintained (IB).

II. Prevention of transmission of Aspergillus spp. spores.

A. Planning new specialized care units for high-risk patients.

1. PE for allogeneic HSCT recipients

   a. When constructing new specialized care units with PE for HSCT recipients, ensure that patient rooms have adequate capacity to minimize accumulation of fungal spores via.
      1) HEPA filter of incoming air.
      2) Directed room airflow, incoming at one side of the room and outgoing on the opposite side of the room.
      3) Positive air pressure in patient's room in relation to the corridor.
      4) Well-sealed room and
      5) High ($\geq$ 12) air changes per hour (IB, IC).

   b. Do not use laminar air flow (LAF) routinely in PE (IB).

2. Units for autologous HSCT and solid-organ transplant recipients. No recommendation can be made for constructing PE for reciepients of autologous HSCTs or solid –organ-transplants (e.g.,heart, liver, lung, kidney) (Unresolved issue).

B. <u>In existing facilities with HSCT Units, and no cases of health-care associated Aspergillosis.</u>

1. Placement of patient in PE
   a. Place an allogeneic HSCT recipient in a PE that meets the conditions outlined in section II-A-1 (IB).
   b. No recommendation can be made for routinely placing a recipient of autologous HSCT or solid-organ transplant in a PE. (Unresolved issue).
2. Maintain air-handling systems in PE and other high-risk patient-care areas.
3. Develop a water-damage response plan for immediate execution when water leaks, spills, and moisture accumulation occur to prevent fungal growth in the involved areas (IB).
4. Use proper dusting methods for patient care areas designated for severely immuno-compromised patients (e.g., HSCT recipients) (IB)
   a. Wet –dust horizontal surfaces daily using cloth that has been moistened with an EPA-registered hospital disinfectant (IB) . (EPA= Environmental protection agency)
   b. Avoid dusting methods that disperse dust (e.g., feather dusting) (IB).
   c. Keep vacuums in good repair and equip them with HEPA filter for use in areas with patients at high risk (IB).
   d. Use vacuum cleaners that are equipped with HEPA filters in patient-care areas for the severely immuno-compromised (IB).
5. Do not use carpeting in hallways and rooms occupied by severely immuno-compromised patients. (IB).
6. Avoid using upholstered furniture or furnishings in rooms occupied by severely immuno-compromised patients. (IB)
7. Minimize the length of the time that immuno-compromised patients in PEs are outside their rooms for diagnostic procedure and other activities (II).
   a. Instruct severely immuno-compromised patients to wear a high efficiency respiratory-protection device (e.g., an N-95 respirator) when they leave the PE during periods when construction, renovation, or other dust-generating activities are ongoing in and around the health-care facility (II).
   b. No recommendation can be made about the specific type of respiratory protection device (e.g., surgical mask, N-95 respirator) for use by a severely immuno-compromised patient who leaves the PE during periods when there is no construction, renovation, or other dust generating activity in progress in or around the health care facility (Unresolved issue).

8. Systematically review and coordinate infection control strategies with personnel in charge of the facilities engineering, maintenance, central supply and distribution, and catering services. (IB).
9. When planning construction, demolition, and renovation activities in and around the facility, assess whether patients at high-risk for aspergillosis are likely to be exposed to high ambient-air spore counts of aspergillus spp. from construction, demolition, and renovation sites, and if so, develop a plan to prevent such exposures (IA)
10. During construction, demolition, or renovation activities, construct impermeable barriers between patient-care and construction areas to prevent dust from entering the patient-care areas (IB).
11. Direct pedestrian traffic that come from construction areas away from patient-care areas to limit the opening and closing of doors or other barriers that might cause dust dispersion, entry of contaminated air, or tracking of dust into patient-care areas (IB).
12. Do not allow fresh or dried flowers or potted plant in patient care areas for severely immuno-compromised patients. (II)

C. <u>When a case of Aspergillosis occurs</u>

1. Assess whether the infection is health-care related or community acquired.

   a. Obtain and use the following information to help in the investigation: background rate of disease at the facility; presence of concurrent or recent cases, as determined by a review of the facility's microbiologic, histopathologic, and postmortem records; length of patient's stay in the facility before onset of aspergillosis; patients stay at, visit of, or transfer from, other healthcare facilities or other locations within the facility; and the period the patient was exposed outside the health-care facility after the onset of immuno-suppression and before onset of aspregillosis (II).
   b. Determine if any ventilation deficiency exists in PEs (IB).

2. If no evidence exists that the patient's aspergillosis is facility-acquired, continue routine maintenance procedures to prevent health-care-associated aspergillosis, as in Section II-B-I through II-B-12 (IB).
3. If evidence of possible facility acquired infection with aspergillosis spp. exists, conduct an epidemiologic investigation and an environmental assessment to determine and eliminate the source of Aspergillus spp. (IB).
4. Use an antifungal biocide (e.g., copper -8-quinolinolate) that is registered with the environmental protection agency for decontamination of structural materials (IB).

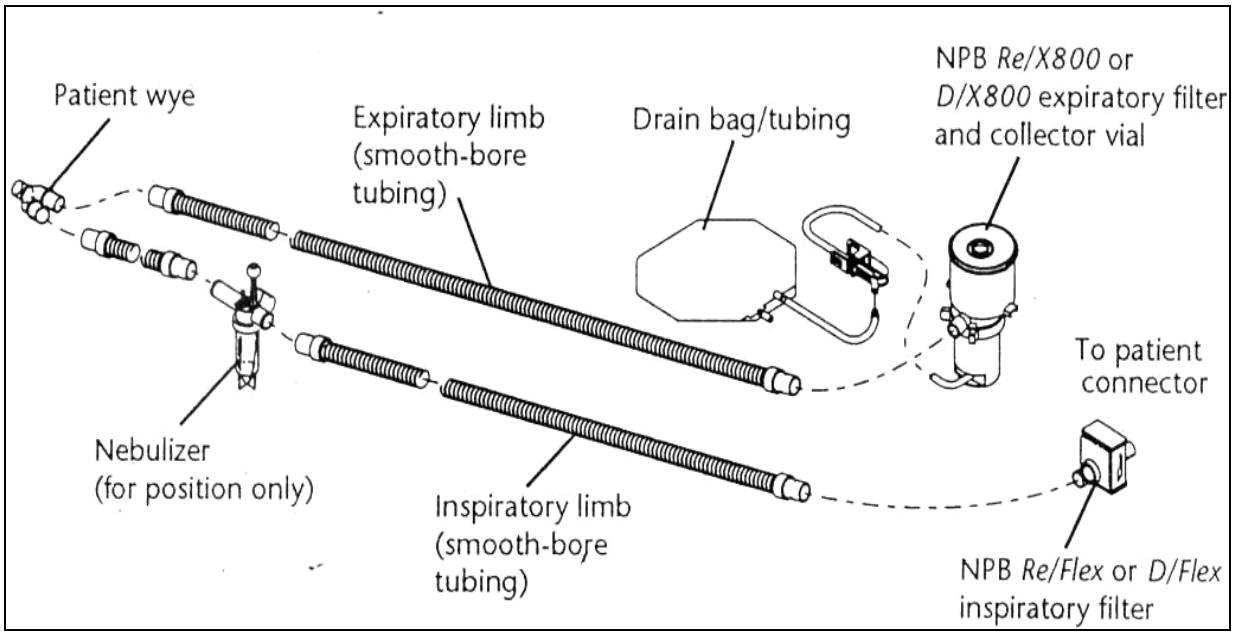
III. Chemoprophylaxis

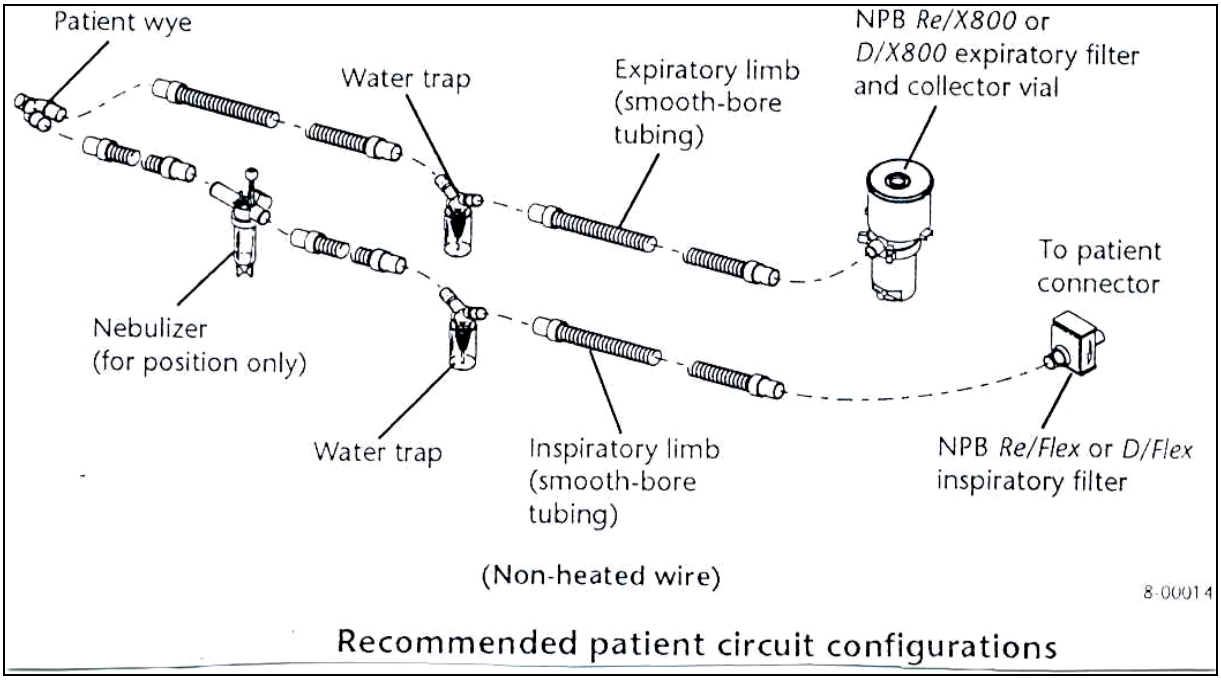
A. No recommendations can be made for the routine administration of antifungal agents such as itraconazole oral solution (5mg/ kg/ day) or capsules (500 mg twice a day), low dose parenteral amphotericin B (0.1 mg / kg/ day), lipid based formulations of amphotericin B (1 mg/ kg / day), or nebulized amphotericin B administered by inhalation as prophylaxis for pulmonary aspergillosis in patients at high risk for this infection . (Unresolved issue).

B. No recommendations can be made for any specific strategy (e.g., deferral of hematopoiectic stem-cell transplantation for a particular length of time or routine prophylaxis with absorbable or intravenous antifungal medications) to prevent recurrence of pulmonary aspergillosis in patients undergoing hematopoietic stem-cell transplantation who have a history of pulmonary aspergillosis (Unresolved issue).

Appendix – 1

Recommended patient circuit configurations





Recommended patient circuit configurations

Appendix – 2(i)

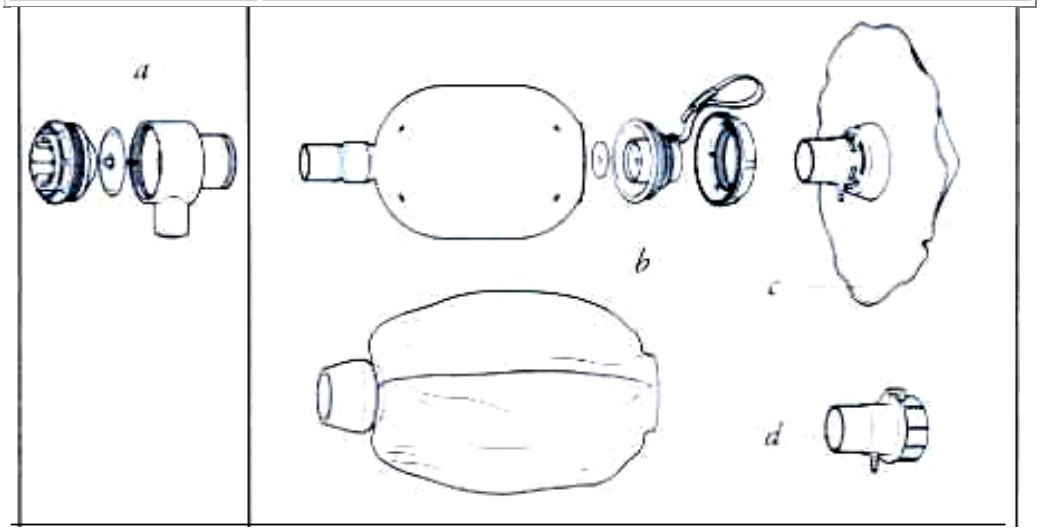
Applicable methods for cleaning, disinfecting-sterilizing ambubag

● Applicable ○ not applicable		Methods						
		Cleaning		Disinfecting-sterilizing				
		Washing		Disinfecting			Auto-claving	
(a), (b), (c) and (d) refer to the figure above **Resuscitator parts**		Manual washing	Washing Machine (WM)	W.M. heat disinfecting	Boiling	Chemical	121ºC	134ºC
Each Patient	Patient valve (a)	●	●	●	●	●	●	●
Regularly	Bag (b)	●	●	●	●	●	●	●
	Oxygen reservoir attachment (c)	●	○	○	○	●	○	○
	Gas filter adapter (d)	●	●	●	●	●	●	●
	Extension tube	●	●	●	●	●	●	●
	Oxygen supply tube	●	●	●	●	●	●	●

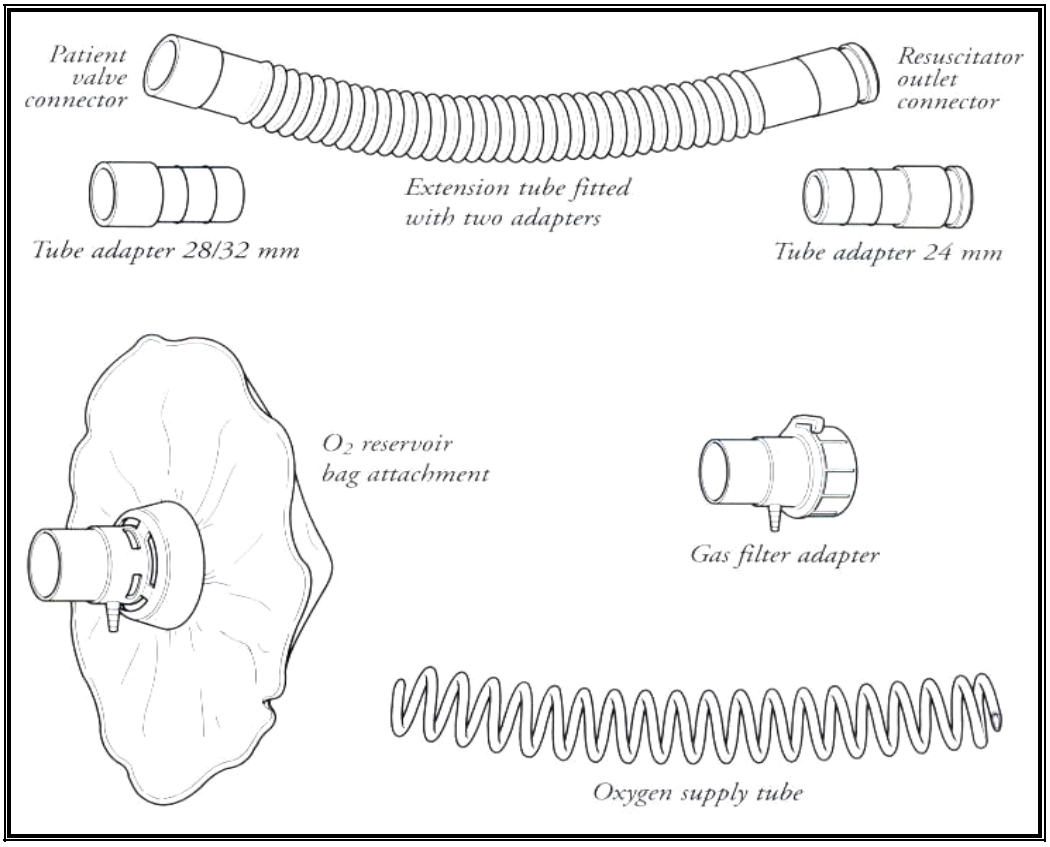
Appendix -2 (ii)

Cleaning, disinfection and sterilization of Ambubag Mark III resuscitator

Parts exposed to expiratory gases	Parts not exposed to patient expiratory gases



Note: Do not disassemble parts further than shown



Appendix – 3a

Cleaning, disinfection and sterilization of parts of for anesthesia machine in general

Anesthetic Apparatus	***Sterilization / Disinfection***
Airways	Machine wash, then sterilize with ethylene oxide. If it does not withstand high temperatures, otherwise autoclave.
Endotracheal & Endobronchial tubes	Disposable
Endotracheal tube Metal or polypropylene	Machine wash and autoclave.
Corrugated tubing and valves	Machine wash then sterilize.
Face masks	Machine wash then sterilize.
Forceps and Introducers	Metal, machine wash and autoclave.
Humidifiers	Disposable humidifiers are preferable. If not available autoclave, if possible the water reservoir should be emptied, cleaned and autoclaved, daily and between patients use. Refill with sterile water immediately prior to use.
Mouth gags, Tooth guards, & Props	Machine wash and autoclave after use.
Laryngoscope blades	Machine wash then sterilize.
Suction ends	Disposable.
Suction tubing	Machine wash and autoclave after use. Change daily if not disposable.
Suction bottles	Machine wash. If not in use, keep it dry and change daily.

Appendix – 3b

Cleaning, disinfection, and sterilization of ventilator parts and surfaces for "840 ventilator system."

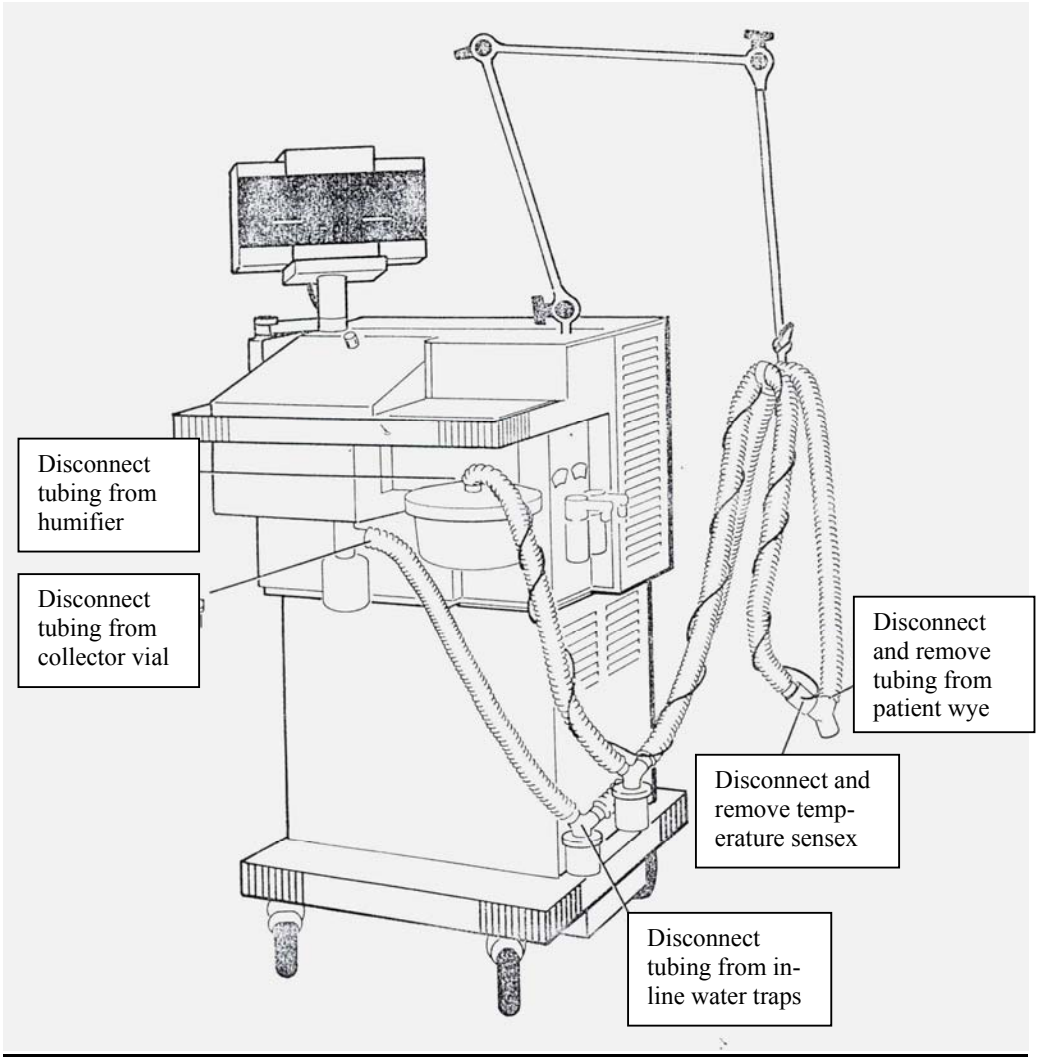
Part	Procedure	Comments
Ventilator exterior (including touch screen and flex arm) GUI (Graphic user interface)	Wipe clean with a damp cloth and mild soap solution. Then wipe with Isopropyl alcohol (70% solution) Vacuum vents at the back of the GUI (Graphic user interface) to remove dust.	- Do not allow liquid or sprays to penetrate the ventilator or cable connections. - Do not attempt to sterilize the ventilator by exposing to ethylene oxide (ETO) gas. - Do not use pressurized air to clean or dry the ventilator, including the GUI vents.
	Caution: • To avoid damaging filter materials used on the back of the GUI, do not use hydrogen peroxide to clean the GUI.	

Appendix – 3c (i)

Cleaning , disinfection and sterilization of ventilator parts and surfaces for " 7200ae ventilator system."

Part	Recommended Action	Cautions
Ventilator exterior, front panel, and con-sole cover eg. housing, basket, tray, gas supply hoses , and power cord	Wipe clean with a damp cloth and mild detergent.	Do not use liquid bactericide. Do not allow moisture to sit between keyboard panel and console cover.
All other outside surfaces, including flex arm	Wipe clean with alcohol or bactericide.	Do not allow liquid to penetrate the ventilator or keyboard display pane. Do not attempt to sterilize the ventilator by exposing to ETO gas.
Gas supply water traps	Wash in mild solution of soap and water.	Do not steam-autoclave, chemically disinfect, or expose to ETO gas.
Accessory equipment surfaces.	Wipe clean with a damp cloth and mild detergent .	Consult appropriate operator's manual for details.
• Patient circuit tubing • In-line water traps • Nebulizer • Collector vial	• Use disposable items if feasible or disassemble and cle-an in the utensil disinfector machine connecting the tub-ing circuit to a special rack for flushing then steam auto-clave or chemical disinfect or exposure to ETO gas. • Change patient circuit tubing every 4 days and between different patients.	• If submerged in liquid during cleaning and sterilizing, blow moisture from inside tubing with pressurized air before using. Inspect for nicks and cuts. • Check for cracks. • Ensure that nebulizer jet passages are cleaned with the jet cleaning rod provided with the nebulizer.
Coupling and connectors	Steam – autoclave or chemically disinfect.	If submerged in liquid during cleaning and sterilizing, blow moisture from inside tubing with pressurized air before using. Inspect for nicks and cuts.
Bacterial filters	Discard disposable or single -patient use filters. Wipe the exterior surface of the reus-able filters with damp cloth and mild detergent and change when visibly soiled or showing resistance and between patients. The num-ber of autoclavable cycles depend on manufacturer recommendations	Do not chemically disinfect or expose to ETO gas. Check resistance of filter before reusing.
Exhalation flow sensor and internal exhalation valve.	Do not clean.	Do not attempt to remove the flow sensor and valve. Do not flush them with liquids or pressurized air. To clean the exhalation flow circuit, remove and clean the exhalation bacterial filter, collector vial, and tee. No further cleaning is required.

Appendix – 3c (ii)



Disassembly of the Patient Service Circuit of 7200 ae ventilator system

Appendix – 3d

Cleaning, disinfection and sterilization of ventilator parts and surfaces for "Galilio ventilator system."

Part (Material)	How to decontaminate	Remarks
Ventilator exterior	Wipe with an appropriate bactericidal agent after each patient use. Eg. alcohol	Do not clean the ventilator interior. This can damage internal parts.
Breathing tubes (silicone rubber)	Steam autoclave, chemically disinfect, or ETO sterilize.	Roll tubes into large coils. Do not twist, kink, or cross tubes when sterilizing them. The tubing lumen should not have vapor or moisture before wrapping for autoclaving. Avoid exposing silicone rubber breathing tubes to grease, oil, silicone-based lubricants, organic solvents (benzene, ether, ketone, and chlorinated hydrocarbons), acids, concentrated alkaline cleaning products, and phenols and derivatives.
Flow Sensor	Refer to the accompanying instructions	
Inspiratory filter, reusable autoclavable	Steam autoclave	Inspect the filter media for cracks or foreign matter; replace if necessary. Replace after 20 autoclave cycle. Do not chemically disinfect or expose to ETO gas.
Expiratory valve membrane (silicone rubber)	Steam autoclave, chemically disinfect, or ETO sterilize.	Inspect the membrane for damage; replace if necessary. Replace after 30 autoclave cycles.

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