

## Criteria for Defining Nosocomial Pneumonia

### General Comments Applicable to All Pneumonia Specific Site Criteria:

1. Physician's diagnosis of pneumonia alone is **not** an acceptable criterion for nosocomial 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 designated when reporting pneumonia data.
4. When assessing a patient for presence of pneumonia, it is important to distinguish between changes in clinical status due to other conditions such as myocardial infarction, pulmonary embolism, respiratory distress syndrome, atelectasis, malignancy, chronic obstructive pulmonary disease, hyaline membrane disease, bronchopulmonary dysplasia, etc. 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 nosocomial pneumonia in the elderly, infants, and immunocompromised patients since such conditions may mask typical signs or symptoms associated with pneumonia. Alternate specific criteria for the elderly, infants and immunocompromised patients, have been included in this definition of nosocomial pneumonia.
5. Nosocomial pneumonia can be characterized by its onset: early or late. Early onset pneumonia occurs during the first four days of hospitalization and is often caused by *Moraxella catarrhalis*, *H. influenzae*, and *S. pneumoniae*. Causative agents of late onset pneumonia are frequently gram negative bacilli or *S. aureus*, including methicillin-resistant *S. aureus*. Viruses (e.g. Influenza A and B or Respiratory Syncytial Virus) can cause early and late onset nosocomial pneumonia, whereas yeasts, fungi, legionellae, and *Pneumocystis carinii* are usually pathogens of late onset pneumonia.
6. Pneumonia due to gross aspiration (for example, in the setting of intubation in the emergency room or operating room) is considered nosocomial if it meets any specific criteria and was not clearly present or incubating at the time of admission to the hospital.
7. Multiple episodes of nosocomial pneumonia may occur in critically ill patients with lengthy hospital stays. When determining whether to report multiple episodes of nosocomial 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 episode 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 (potassium hydroxide) 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 infrequently causes nosocomial 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 PNU1 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 empyema without pneumonia as LUNG.
- Report acute bronchitis, tracheitis, tracheobronchitis, or bronchiolitis without pneumonia as BRON.

**Major Site: Pneumonia (PNEU)**

**Site Specific Algorithms for Clinically Defined Pneumonia**

Radiology	Signs/Symptoms/Laboratory	Code
<p>Two or more serial chest radiographs with at least <b>one</b> of the following<sup>1,2</sup>:</p> <ul style="list-style-type: none"> <li>• New or progressive <u>and</u> persistent infiltrate</li> <li>• Consolidation</li> <li>• Cavitation</li> <li>• Pneumatoceles, in infants <math>\leq 1</math> year old</li> </ul> <p>NOTE: In patients <b>without</b> underlying pulmonary or cardiac disease (e.g., respiratory distress syndrome, bronchopulmonary dysplasia, pulmonary edema, or chronic obstructive pulmonary disease), <u>one definitive</u> chest radiograph is acceptable<sup>1</sup>.</p>	<p>FOR ANY PATIENT, at least <b>one</b> of the following:</p> <ul style="list-style-type: none"> <li>• Fever (<math>&gt;38^{\circ}\text{C}</math> or <math>&gt;100.4^{\circ}\text{F}</math>) with no other recognized cause</li> <li>• Leukopenia (<math>&lt;4000</math> WBC/mm<sup>3</sup>) <u>or</u> leukocytosis (<math>\geq 12,000</math> WBC/mm<sup>3</sup>)</li> <li>• For adults <math>\geq 70</math> years old, altered mental status with no other recognized cause</li> </ul> <p><u>and</u></p> <p>At least <b>two</b> of the following:</p> <ul style="list-style-type: none"> <li>• New onset of purulent sputum<sup>3</sup>, or change in character of sputum<sup>4</sup>, or increased respiratory secretions, or increased suctioning requirements</li> <li>• New onset or worsening cough, or dyspnea, or tachypnea<sup>5</sup></li> <li>• Rales<sup>6</sup> or bronchial breath sounds</li> <li>• Worsening gas exchange (e.g., O<sub>2</sub> desaturations [e.g., PaO<sub>2</sub>/FiO<sub>2</sub> <math>\leq 240</math>]<sup>7</sup>, increased oxygen requirements, or increased ventilation demand)</li> </ul> <hr/> <p>ALTERNATE CRITERIA FOR INFANT <math>\leq 1</math> YEAR OLD:</p> <p>Worsening gas exchange (e.g., O<sub>2</sub> desaturations, increased oxygen requirements, or increased ventilator demand)</p> <p><u>and</u></p> <p>at least <b>three</b> of the following:</p> <ul style="list-style-type: none"> <li>• Temperature instability with no other recognized cause</li> <li>• Leukopenia (<math>&lt;4000</math> WBC/mm<sup>3</sup>) <u>or</u> leukocytosis (<math>\geq 15,000</math> WBC/mm<sup>3</sup>) and left shift (<math>\geq 10\%</math> band forms)</li> <li>• New onset of purulent sputum<sup>3</sup>, or change in character of sputum<sup>4</sup>, or increased respiratory secretions, or increased suctioning requirements</li> <li>• Apnea, tachypnea<sup>5</sup>, nasal flaring with retraction of chest wall, or grunting</li> <li>• Wheezing, rales<sup>6</sup>, or rhonchi</li> <li>• Cough</li> <li>• Bradycardia (<math>&lt;100</math> beats/min) or tachycardia (<math>&gt;170</math> beats/min)</li> </ul> <hr/> <p>ALTERNATE CRITERIA FOR CHILD <math>&gt;1</math> OR <math>\leq 12</math> YEARS OLD, at least <b>three</b> of the following:</p> <ul style="list-style-type: none"> <li>• Fever (<math>&gt;38.4^{\circ}\text{C}</math> or <math>&gt;101.1^{\circ}\text{F}</math>) or hypothermia (<math>&lt;37^{\circ}\text{C}</math> or <math>&lt;97.7^{\circ}\text{F}</math>) with no other recognized cause</li> <li>• Leukopenia (<math>&lt;4000</math> WBC/mm<sup>3</sup>) <u>or</u> leukocytosis (<math>\geq 15,000</math> WBC/mm<sup>3</sup>)</li> <li>• New onset of purulent sputum<sup>3</sup>, or change in character of sputum<sup>4</sup>, or increased respiratory secretions, or increased suctioning requirements</li> <li>• New onset or worsening cough, or dyspnea, apnea, or tachypnea<sup>5</sup></li> <li>• Rales<sup>6</sup> or bronchial breath sounds</li> <li>• Worsening gas exchange (e.g., O<sub>2</sub> desaturations [e.g., pulse oximetry <math>&lt;94\%</math>], increased oxygen requirements, or increased ventilation demand)</li> </ul>	<p><b>PNU1</b></p>

**Major Site:** Pneumonia (PNEU)

**Specific Site Algorithms for Pneumonia with Common Bacterial or Filamentous Fungal Pathogens and Specific Laboratory Findings**

Radiology	Signs/Symptoms	Laboratory	Code
<p>Two or more serial chest radiographs with at least <b>one</b> of the following<sup>1,2</sup>:</p> <ul style="list-style-type: none"> <li>• New or progressive <u>and</u> persistent infiltrate</li> <li>• Consolidation</li> <li>• Cavitation</li> <li>• Pneumatoceles, in infants <math>\leq</math> 1 year old</li> </ul> <p>NOTE: In patients <b>without</b> underlying pulmonary or cardiac disease (e.g., respiratory distress syndrome, bronchopulmonary dysplasia, pulmonary edema, or chronic obstructive pulmonary disease), <u>one</u> <u>definitive</u> chest radiograph is acceptable<sup>1</sup>.</p>	<p>At least <b>one</b> of the following:</p> <ul style="list-style-type: none"> <li>• Fever (<math>&gt;38^{\circ}\text{C}</math> or <math>&gt;100.4^{\circ}\text{F}</math>) with no other recognized cause</li> <li>• Leukopenia (<math>&lt;4000\text{ WBC}/\text{mm}^3</math>) <u>or</u> leukocytosis (<math>\geq 12,000\text{ WBC}/\text{mm}^3</math>)</li> <li>• For adults <math>\geq 70</math> years old, altered mental status with no other recognized cause</li> </ul> <p><u>and</u></p> <p>At least <b>one</b> of the following:</p> <ul style="list-style-type: none"> <li>• New onset of purulent sputum<sup>3</sup>, or change in character of sputum<sup>4</sup>, or increased respiratory secretions, or increased suctioning requirements</li> <li>• New onset or worsening cough, or dyspnea, or tachypnea<sup>5</sup></li> <li>• Rales<sup>6</sup> or bronchial breath sounds</li> <li>• Worsening gas exchange (e.g. <math>\text{O}_2</math> desaturations [e.g., <math>\text{PaO}_2/\text{FiO}_2 \leq 240</math>]<sup>7</sup>, increased oxygen requirements, or increased ventilation demand)</li> </ul>	<p>At least <b>one</b> of the following:</p> <ul style="list-style-type: none"> <li>• Positive growth in blood culture<sup>8</sup> not related to another source of infection</li> <li>• Positive growth in culture of pleural fluid</li> <li>• Positive quantitative culture<sup>9</sup> from minimally contaminated LRT specimen (e.g., BAL or protected specimen brushing)</li> <li>• <math>\geq 5\%</math> BAL-obtained cells contain intracellular bacteria on direct microscopic exam (e.g., Gram stain)</li> <li>• Histopathologic exam shows at least <b>one</b> of the following evidences of pneumonia: <ul style="list-style-type: none"> <li>▪ Abscess formation or foci of consolidation with intense PMN accumulation in bronchioles and alveoli</li> <li>▪ Positive quantitative culture<sup>9</sup> of lung parenchyma</li> <li>▪ Evidence of lung parenchyma invasion by fungal hyphae or pseudohyphae</li> </ul> </li> </ul>	<p><b>PNU2</b></p>

Refer to Table 1 for threshold values of bacteria from cultured specimens.

**Major Site:** Pneumonia (PNEU)

**Specific Site Algorithms for Pneumonia with Viral, *Legionella*, *Chlamydia*, *Mycoplasma*, and Other Uncommon Pathogens and Specific Laboratory Findings**

Radiology	Signs/Symptoms	Laboratory	Code
<p>Two or more serial chest radiographs with at least <b>one</b> of the following<sup>1,2</sup>:</p> <ul style="list-style-type: none"> <li>• New or progressive <u>and</u> persistent infiltrate</li> <li>• Consolidation</li> <li>• Cavitation</li> <li>• Pneumatoceses, in infants <math>\leq</math> 1 year old</li> </ul> <p>NOTE: In patients <b>without</b> underlying pulmonary or cardiac disease (e.g., respiratory distress syndrome, bronchopulmonary dysplasia, pulmonary edema, or chronic obstructive pulmonary disease), <u>one definitive</u> chest radiograph is acceptable<sup>1</sup>.</p>	<p>At least <b>one</b> of the following:</p> <ul style="list-style-type: none"> <li>• Fever (<math>&gt;38^{\circ}\text{C}</math> or <math>&gt;100.4^{\circ}\text{F}</math>) with no other recognized cause</li> <li>• Leukopenia (<math>&lt;4000</math> WBC/<math>\text{mm}^3</math>) <u>or</u> leukocytosis (<math>\geq 12,000</math> WBC/<math>\text{mm}^3</math>)</li> <li>• For adults <math>\geq 70</math> years old, altered mental status with no other recognized cause</li> </ul> <p><u>and</u></p> <p>At least <b>one</b> of the following:</p> <ul style="list-style-type: none"> <li>• New onset of purulent sputum<sup>3</sup>, or change in character of sputum<sup>4</sup>, or increased respiratory secretions, or increased suctioning requirements</li> <li>• New onset or worsening cough, dyspnea, or tachypnea<sup>5</sup></li> <li>• Rales<sup>6</sup> or bronchial breath sounds</li> <li>• Worsening gas exchange (e.g., <math>\text{O}_2</math> desaturations [e.g., <math>\text{PaO}_2/\text{FiO}_2 \leq 240</math>]<sup>7</sup>, increased oxygen requirements, or increased ventilation demand)</li> </ul>	<p>At least <b>one</b> of the following<sup>10-12</sup>:</p> <ul style="list-style-type: none"> <li>• Positive culture of virus or <i>Chlamydia</i> from respiratory secretions</li> <li>• Positive detection of viral antigen or antibody from respiratory secretions (e.g., EIA, FAMA, shell vial assay, PCR)</li> <li>• Fourfold rise in paired sera (IgG) for pathogen (e.g., influenza viruses, <i>Chlamydia</i>)</li> <li>• Positive PCR for <i>Chlamydia</i> or <i>Mycoplasma</i></li> <li>• Positive micro-IF test for <i>Chlamydia</i></li> <li>• Positive culture or visualization by micro-IF of <i>Legionella</i> spp. from respiratory secretions or tissue</li> <li>• Detection of <i>Legionella pneumophila</i> serogroup 1 antigens in urine by RIA or EIA</li> <li>• Fourfold rise in <i>L. pneumophila</i> serogroup 1 antibody titer to <math>\geq 1:128</math> in paired acute and convalescent sera by indirect IFA</li> </ul>	<p><b>PNU2</b></p>

**Major Site:** Pneumonia (PNEU)

**Specific Site Algorithm for Pneumonia in Immunocompromised Patients**

Radiology	Signs/Symptoms	Laboratory	Code
<p>Two or more serial chest radiographs with at least <b>one</b> of the following<sup>1,2</sup>:</p> <ul style="list-style-type: none"> <li>• New or progressive <u>and</u> persistent infiltrate</li> <li>• Consolidation</li> <li>• Cavitation</li> <li>• Pneumatoceles, in infants <math>\leq</math> 1 year old</li> </ul> <p>NOTE: In patients <b>without</b> underlying pulmonary or cardiac disease (e.g., respiratory distress syndrome, bronchopulmonary dysplasia, pulmonary edema, or chronic obstructive pulmonary disease), <u>one definitive</u> chest radiograph is acceptable<sup>1</sup>.</p>	<p>Patient who is immunocompromised<sup>13</sup> has at least <b>one</b> of the following:</p> <ul style="list-style-type: none"> <li>• Fever (<math>&gt;38^{\circ}\text{C}</math> or <math>&gt;100.4^{\circ}\text{F}</math>) with no other recognized cause</li> <li>• For adults <math>\geq 70</math> years old, altered mental status with no other recognized cause</li> <li>• New onset of purulent sputum<sup>3</sup>, or change in character of sputum<sup>4</sup>, or increased respiratory secretions, or increased suctioning requirements</li> <li>• New onset or worsening cough, or dyspnea, or tachypnea<sup>5</sup></li> <li>• Rales<sup>6</sup> or bronchial breath sounds</li> <li>• Worsening gas exchange (e.g., <math>\text{O}_2</math> desaturations [e.g., <math>\text{PaO}_2/\text{FiO}_2 \leq 240</math>]<sup>7</sup>, increased oxygen requirements, or increased ventilation demand)</li> <li>• Hemoptysis</li> <li>• Pleuritic chest pain</li> </ul>	<p>At least <b>one</b> of the following:</p> <ul style="list-style-type: none"> <li>• Matching positive blood and sputum cultures with <i>Candida</i> spp.<sup>14,15</sup></li> <li>• Evidence of fungi or <i>Pneumocystis carinii</i> from minimally contaminated LRT specimen (e.g., BAL or protected specimen brushing) from <b>one</b> of the following: <ul style="list-style-type: none"> <li>- Direct microscopic exam</li> <li>- Positive culture of fungi</li> </ul> </li> </ul> <p>Any of the following from:</p> <p><b>LABORATORY CRITERIA DEFINED UNDER PNU2</b></p>	<p><b>PNU3</b></p>

## Comments:

1. Occasionally, in nonventilated 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 (for example, interstitial lung disease or congestive heart failure), the diagnosis of pneumonia may be particularly difficult. Other non-infectious conditions (for example, pulmonary edema from decompensated congestive heart failure) may simulate the presentation of pneumonia. In these more difficult cases, serial chest radiographs must be examined to help separate infectious from 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 a result, rapid radiographic 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”, “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  $\geq 25$  neutrophils and  $\leq 10$  squamous epithelial cells per low power field (x100). If your laboratory reports these data qualitatively (e.g., “many WBCs” or “few squames”), be sure their descriptors match this definition of purulent sputum. This laboratory confirmation is required since 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 adults, tachypnea is defined as respiration rate  $>25$  breaths per minute. Tachypnea is defined as  $>75$  breaths per minute in premature infants born at  $<37$  weeks gestation and until the 40<sup>th</sup> week;  $>60$  breaths per minute in patients  $<2$  months old;  $>50$  breaths per minute in patients 2-12 months old; and  $>30$  breaths per minute in children  $>1$  year old.
6. Rales may be described as “crackles”.
7. This measure of arterial oxygenation is defined as the ratio of the arterial tension ( $\text{PaO}_2$ ) to the inspiratory fraction of oxygen ( $\text{FiO}_2$ ).
8. Care must be taken to determine the etiology of pneumonia in a patient 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 1 for threshold values of bacteria from cultured specimens. An endotracheal aspirate is **not** a minimally contaminated specimen. Therefore, an 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 in a hospital, clinician's presumptive diagnosis of these pathogens in subsequent cases with similar clinical signs and symptoms is an acceptable criterion for presence of nosocomial infection.
11. Scant or watery sputum is commonly seen in adults 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  $<500/\text{mm}^3$ ), 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 immunosuppressives daily for  $>2$  weeks (e.g.  $>40\text{mg}$  of prednisone or its equivalent [ $>160\text{mg}$  hydrocortisone,  $>32\text{mg}$  methylprednisolone,  $>6\text{mg}$  dexamethasone,  $>200\text{mg}$  cortisone] ).
14. Blood and sputum specimens must be collected within 48 hours of each other.
15. Semiquantitative or nonquantitative 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.

Table 1. Threshold values for cultured specimens used in the diagnosis of pneumonia

<u>Specimen collection/technique</u>	<u>Values</u>	<u>Comment</u>
Lung parenchyma	$\geq 10^4$ cfu/g tissue	1
Bronchoscopically (B) obtained specimens		
Bronchoalveolar 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	
Nonbronchoscopically (NB) obtained (“blind”) specimens		
NB-BAL	$> 10^4$ cfu/ml	
NB-PSB	$\geq 10^3$ cfu/ml	

cfu = colony forming units  
g = gram  
ml = milliliter

Comment:

1 = open-lung biopsy specimens and immediate post-mortem specimens obtained by transthoracic or transbronchial biopsy