Pneumonia (Ventilator-associated [VAP] and non-ventilator-associated Pneumonia [PNEU]) Event

Introduction: In 2015 CDC conducted a point-prevalence survey in a sample of acute care hospitals in U.S. and determined that of the 427 health care–associated infections identified, pneumonia was the most common infection with 32% of those being ventilator associated.[1] Patients receiving invasive mechanical ventilation are at risk for numerous complications, including pneumonia. Ventilator-associated pneumonia (VAP) and other healthcare-associated pneumonias are important, common healthcare-associated infections, but national surveillance for VAP has long been a challenge because of the lack of objective, reliable definitions. Due to these challenges, in January 2013 the National Healthcare Safety Network (NHSN) replaced surveillance for ventilator-associated pneumonia (VAP) in adult inpatient locations with surveillance for ventilator-associated events (VAE).[2] Based on discussions with an expert working group in 2012-2013, NHSN also discontinued in-plan VAP surveillance in neonatal locations. As of January 2014, in-plan VAP surveillance is only available in pediatric inpatient locations.

Settings: Surveillance may occur in any inpatient pediatric location where denominator data can be collected, such as critical/intensive care units (pedICUs), specialty care areas (SCA), step-down units, wards, and long term care units. In-plan surveillance for ventilator-associated pneumonia (pedVAP) using the criteria found in this chapter is restricted to patients of any age in pediatric locations (excludes neonatal locations). In-plan surveillance conducted for mechanically-ventilated patients in adult locations (regardless of age) will use the Ventilator-Associated Event (VAE) protocol (see VAE chapter). The PNEU definitions are still available for those units seeking to conduct off-plan PNEU surveillance for mechanically-ventilated adult, pediatric and neonatal patients and non-ventilated adult, pediatric or neonatal patients. The PNEU definitions are also available for secondary bloodstream infection assignment when performing Central Line-Associated Bloodstream Infection (CLABSI) surveillance in ventilated or non-ventilated patients in any location. A complete listing of inpatient locations and instructions for mapping can be found in the CDC Locations and Descriptions chapter.

Note: If you are following pedVAP in your monthly reporting plan it is not required to monitor for VAPs after the patient is discharged from the facility. However, if discovered, any VAPs with event date on the day of discharge or day after discharge should be reported to NHSN (see Transfer Rule in Chapter 2). No additional ventilator days are reported.

Definitions:

Present on Admission (POA): Infections that are POA, as defined in Chapter 2, are not considered HAIs and therefore are never reported to NHSN.

Healthcare-associated infections (HAI): All NHSN site-specific infections must first meet the HAI definition as defined in Chapter 2 before a site-specific infection can be reported to NHSN.

Guidance for Determination of Eligible Imaging Test Evidence

- If only one imaging test is available it is acceptable for this to satisfy the imaging requirement for PNEU/VAP-POA determinations regardless of whether the patient has underlying pulmonary or cardiac disease.
- When multiple imaging test results are available, persistence of imaging test evidence of pneumonia is a requirement for all patients not just those with underlying cardiac or pulmonary disease.
- When identifying persistence of imaging test evidence of pneumonia, the second imaging test must occur within seven days of the first but is not required to occur within the Infection Window Period. The date of the first eligible imaging test will be utilized when determining if the PNEU/VAP criteria are met within the infection window period. All other elements of PNEU/VAP definition must be present within the infection window period.

Pneumonia (PNEU) is identified by using a combination of imaging, clinical and laboratory criteria. The following pages detail the various criteria that may be used for meeting the surveillance definition of healthcare-associated pneumonia (Tables 1-4 and Figures 1 and 2), general comments applicable to all site-specific criteria, and reporting instructions. Table 5 shows threshold values for cultured specimens used in the surveillance diagnosis of pneumonia.

Date of event: For a PNEU/VAP the date of event is the date when the first element used to meet the PNEU infection criterion occurred for the first time within the 7-day Infection Window Period.

Ventilator: Any device used to support, assist or control respiration (inclusive of the weaning period) through the application of positive pressure to the airway when delivered via an artificial airway, specifically an oral/nasal endotracheal or tracheostomy tube.

Note: Ventilation and lung expansion devices that deliver positive pressure to the airway (for example: CPAP, Bipap, bi-level, IPPB and PEEP) via non-invasive means (for example: nasal prongs, nasal mask, full face mask, total mask, etc.) are not considered ventilators unless positive pressure is delivered via an artificial airway (oral/nasal endotracheal or tracheostomy tube).

Ventilator-associated pneumonia (VAP): A pneumonia where the patient is on mechanical ventilation for >2 calendar days on the date of event, with day of ventilator placement being Day 1,*

AND

the ventilator was in place on the date of event or the day before.

*If the ventilator was in place prior to inpatient admission, the ventilator day count begins with the admission date to the first inpatient location.

General Comments Applicable to All Pneumonia Specific Site Criteria:

1. Physician's diagnosis of pneumonia alone is not an acceptable criterion for POA (present on admission) or HAI (healthcare-associated) pneumonia.
2. Although specific criteria are included for infants and children and immunocompromised patients, all patients may meet any of the other pneumonia site-specific criteria.
3. Pneumonia due to gross aspiration (for example, in the setting of intubation in the field, emergency department, or operating room) that meets the PNEU/VAP definition with a date of event during the HAI timeframe is considered healthcare-associated (HAI).
4. Multiple episodes of healthcare-associated pneumonia may occur in critically ill patients with lengthy hospital stays. When determining whether to report multiple episodes of healthcare-associated pneumonia in a single patient, follow the Repeat Infection Timeframe (RIT) guidance found in Chapter 2.
5. Excluded organisms that cannot be used to meet the PNEU/VAP definition are as follows:
    a. "Normal respiratory flora," "normal oral flora," "mixed respiratory flora," "mixed oral flora," "altered oral flora" or other similar results indicating isolation of commensal flora of the oral cavity or upper respiratory tract
    b. The following organisms unless identified from lung tissue or pleural fluid (where specimen was obtained during thoracentesis or initial placement of chest tube and NOT from an indwelling chest tube):
        i. Any *Candida* species as well as a report of "yeast" that is not otherwise specified
        ii. Any coagulase-negative *Staphylococcus* species
        iii. Any *Enterococcus* species
6. If the excluded pathogens, Candida species *or yeast not otherwise specified, coagulase-negative Staphylococcus species, and Enterococcus species are identified from blood they can only be attributed as a secondary BSI to PNEU if PNU2 or PNU3 is met with a matching organisms identified from a pleural fluid (where specimen was obtained during thoracentesis or initial placement of chest tube and NOT from an indwelling chest tube) or lung tissue and the blood specimen collection date is within the Secondary BSI Attribution Period (SBAP)

    *The exception to this is Candida species or yeast not otherwise specified identified from blood can be attributed as a secondary BSI to PNEU if PNU3 is met using the blood and a sputum, endotracheal aspirate, BAL or protected specimen brushing with matching Candida species and both specimens have a collection date in the Infection Window Period.

7. Additionally, because organisms belonging to the following genera are typically causes of community-associated infections and are rarely or are not known to be causes of healthcare-associated infections, they are also excluded, and cannot be used to meet any NHSN definition: *Blastomyces, Histoplasma, Coccidioides, Paracoccidioides, Cryptococcus* and *Pneumocystis*.

8. Abbreviations used in the PNEU laboratory criteria:

   BAL–bronchoalveolar lavage
   EIA–enzyme immunoassay
   IFA–immunofluorescent antibody
   LRT–lower respiratory tract
   PMN–polymorphonuclear leukocyte
   RIA–radioimmunoassay

Reporting Instructions:

- There is a hierarchy of specific categories within the major site pneumonia. If the patient meets criteria for more than one specific site during the infection window period or the RIT, 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.
- Pathogens and secondary bloodstream infections can only be reported for PNU2 and PNU3 specific events.
- Report concurrent LUNG and PNEU with at least one matching organism(s) as PNEU.

Table 1: Specific Site Algorithms for Clinically Defined Pneumonia (PNU1)

Imaging Test Evidence	**Signs/Symptoms**
Two or more serial chest imaging test results with at least ***one*** of the following[1,2,14]: New and persistent **or** Progressive and persistent • Infiltrate • Consolidation • Cavitation • Pneumatoceles, in infants ≤1 year old **Note:** In patients ***without*** underlying pulmonary or cardiac disease (for example: respiratory distress syndrome, bronchopulmonary dysplasia, pulmonary edema, or chronic obstructive pulmonary disease), one definitive imaging test result is acceptable.[1]	For ANY PATIENT, at least ***one*** of the following: • Fever (>38.0°C or >100.4°F) • Leukopenia (≤4000 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 tachypnea[5] • Rales[6] or bronchial breath sounds • Worsening gas exchange (for example: O_2 desaturations (for example: PaO_2/FiO_2 ≤240)[7], increased oxygen requirements, or increased ventilator demand)
	ALTERNATE CRITERIA, for infants ≤1 year old: Worsening gas exchange (for example: O_2 desaturations [for example pulse oximetry <94%], increased oxygen requirements, or increased ventilator demand) And at least ***three*** of the following: • Temperature instability • Leukopenia (≤4000 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 nasal flaring with grunting • Wheezing, rales[6], or rhonchi • Cough • Bradycardia (<100 beats/min) or tachycardia (>170 beats/min)
	ALTERNATE CRITERIA, for child >1 year old or ≤12 years old, at least ***three*** of the following: • Fever (>38. 0°C or >100. 4°F) or hypothermia (<36. 0°C or <96. 8°F) • Leukopenia (≤4000 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 tachypnea[5]. • Rales[6] or bronchial breath sounds • Worsening gas exchange (for example: O_2 desaturations [for example pulse oximetry <94%], increased oxygen requirements, or increased ventilator demand)

Table 2: Specific Site Algorithms for Pneumonia with Common Bacterial or Filamentous Fungal Pathogens and Specific Laboratory Findings (PNU2)

Imaging Test Evidence	**Signs/Symptoms**	**Laboratory**

Two or more serial chest imaging test results with at least ***one*** of the following[1,2,14]:
 	
New and persistent
or
Progressive and persistent
 	
• Infiltrate
• Consolidation
• Cavitation
• Pneumatoceles, in infants ≤1 year old
 	
Note: In patients ***without*** underlying pulmonary or cardiac disease (for example: respiratory distress syndrome, bronchopulmonary dysplasia, pulmonary edema, or chronic obstructive pulmonary disease), one definitive chest imaging test result is acceptable.[1]
	At least ***one*** of the following:
	
	• Fever (>38.0°C or >100.4°F)
	• Leukopenia (≤4000 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 tachypnea[5]
	• Rales[6] or bronchial breath sounds
	• Worsening gas exchange (for example: O_2 desaturations [for example: PaO_2/FiO_2 ≤240][7], increased oxygen requirements, or increased ventilator demand)
		At least ***one*** of the following:
		
		• Organism identified from blood[8,13]
		• Organism identified from pleural fluid[9,13]
		• Positive quantitative culture or corresponding semi-quantitative culture result[9] from minimally-contaminated LRT specimen (specifically, BAL, protected specimen brushing or endotracheal aspirate)
		• ≥5% BAL-obtained cells contain intracellular bacteria on direct microscopic exam (for example: Gram's stain)
		• Positive quantitative culture or corresponding semi-quantitative culture result[9] of lung tissue
		• Histopathologic exam shows at least ***one*** of the following evidences of pneumonia:
		  ○ Abscess formation or foci of consolidation with intense PMN accumulation in bronchioles and alveoli
		  ○ Evidence of lung parenchyma invasion by fungal hyphae or pseudohyphae

Table 3: Specific Site Algorithms for Viral, Legionella, and other Bacterial Pneumonias with Definitive Laboratory Findings (PNU2)

Imaging Test Evidence	**Signs/Symptoms**	**Laboratory**
Two or more serial chest imaging test results with at least ***one*** of the following[1,2,14]: New and persistent **or** Progressive and persistent • Infiltrate • Consolidation • Cavitation • Pneumatoceles, in infants ≤1 year old **Note:** In patients ***without*** underlying pulmonary or cardiac disease (for example: respiratory distress syndrome, bronchopulmonary dysplasia, pulmonary edema, or chronic obstructive pulmonary disease), one definitive chest imaging test result is acceptable.[1]	At least ***one*** of the following: • Fever (>38.0°C or >100.4°F) • Leukopenia (≤4000 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 tachypnea[5] • Rales[6] or bronchial breath sounds • Worsening gas exchange (for example: O_2 desaturations [for example: PaO_2/FiO_2 ≤240][7], increased oxygen requirements, or increased ventilator demand)	At least ***one*** of the following: • Virus, *Bordetella, Legionella, Chlamydia or Mycoplasma* identified from respiratory secretions or tissue by a culture or non-culture based microbiologic testing method which is performed for purposes of clinical diagnosis or treatment (for example: not Active Surveillance Culture/Testing (ASC/AST). • Fourfold rise in paired sera (IgG) for pathogen (for example: influenza viruses, *Chlamydia*) • Fourfold rise in *Legionella pneumophila* serogroup 1 antibody titer to ≥1:128 in paired acute and convalescent sera by indirect IFA. • Detection of *L. pneumophila* serogroup 1 antigens in urine by RIA or EIA

Table 4: Specific Site Algorithm for Pneumonia in Immunocompromised Patients (PNU3)

Imaging Test Evidence	**Signs/Symptoms**	**Laboratory**
Two or more serial chest imaging test results with at least ***one*** of the following[1,2,14]: New and persistent **or** Progressive and persistent • Infiltrate • Consolidation • Cavitation • Pneumatoceles, in infants ≤1 year old **Note:** In patients ***without*** underlying pulmonary or cardiac disease (for example: respiratory distress syndrome, bronchopulmonary dysplasia, pulmonary edema, or chronic obstructive pulmonary disease), one definitive chest imaging test result is acceptable.[1]	Patient who is immunocompromised (see definition in footnote [10]) has at least ***one*** of the following: • Fever (>38.0°C or >100.4°F) • 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 tachypnea[5] • Rales[6] or bronchial breath sounds • Worsening gas exchange (for example: O_2 desaturations [for example: PaO_2/FiO_2 ≤240][7], increased oxygen requirements, or increased ventilator demand) • Hemoptysis • Pleuritic chest pain	At least ***one*** of the following: • Identification of matching *Candida* spp. from blood and one of the following: sputum, endotracheal aspirate, BAL or protected specimen brushing.[11,12,13] • Evidence of fungi (excluding Candida and yeast not otherwise specified) from minimally-contaminated LRT specimen (specifically BAL, protected specimen brushing or endotracheal aspirate) from one of the following: – Direct microscopic exam – Positive culture of fungi – Non-culture diagnostic laboratory test **OR** Any of the following from: **LABORATORY CRITERIA DEFINED UNDER PNU2**

Figure 1: Pneumonia Flow Diagram for Patients of Any Age

Facility ID#_____Event #_____ Event Date __/__/___

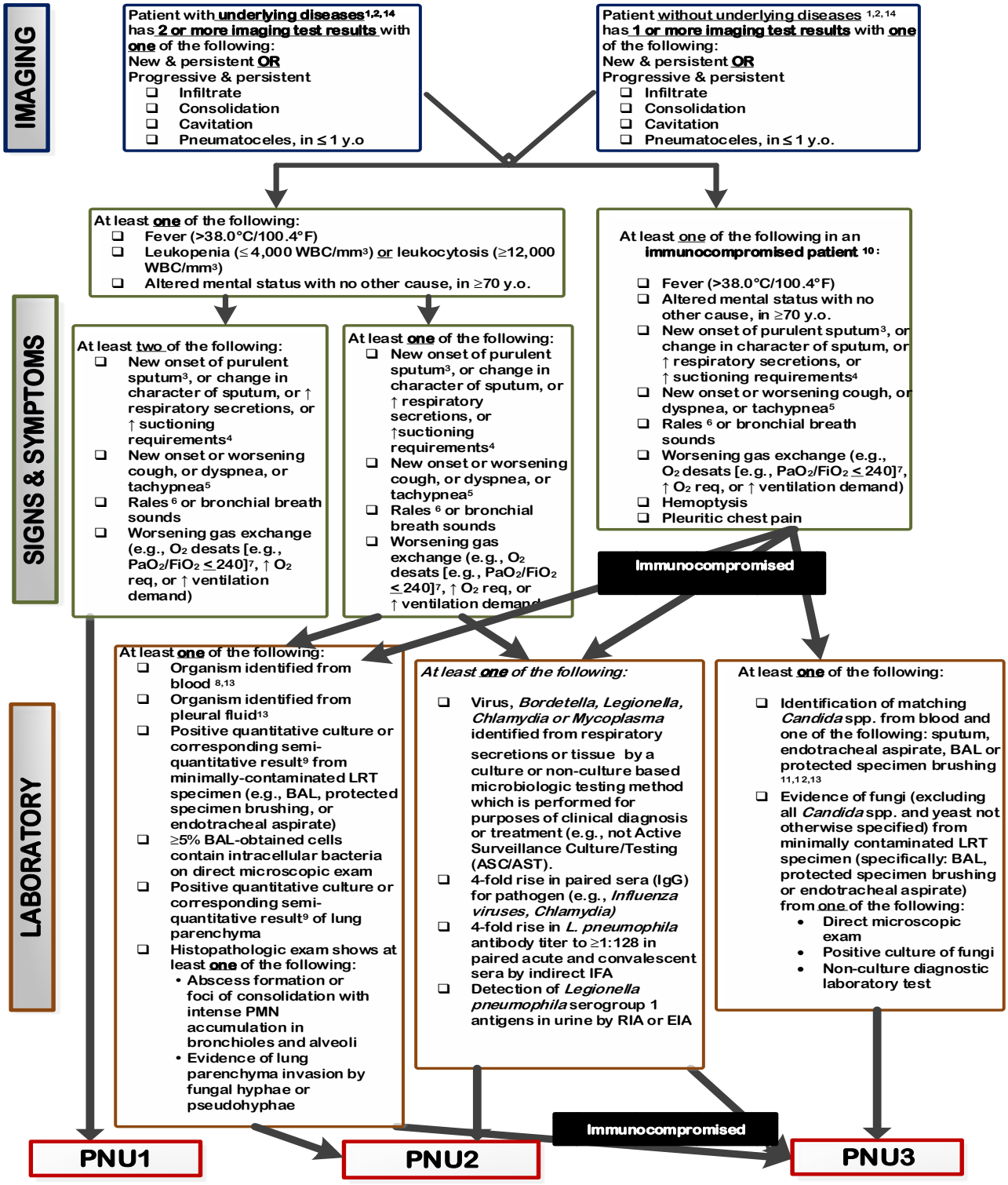
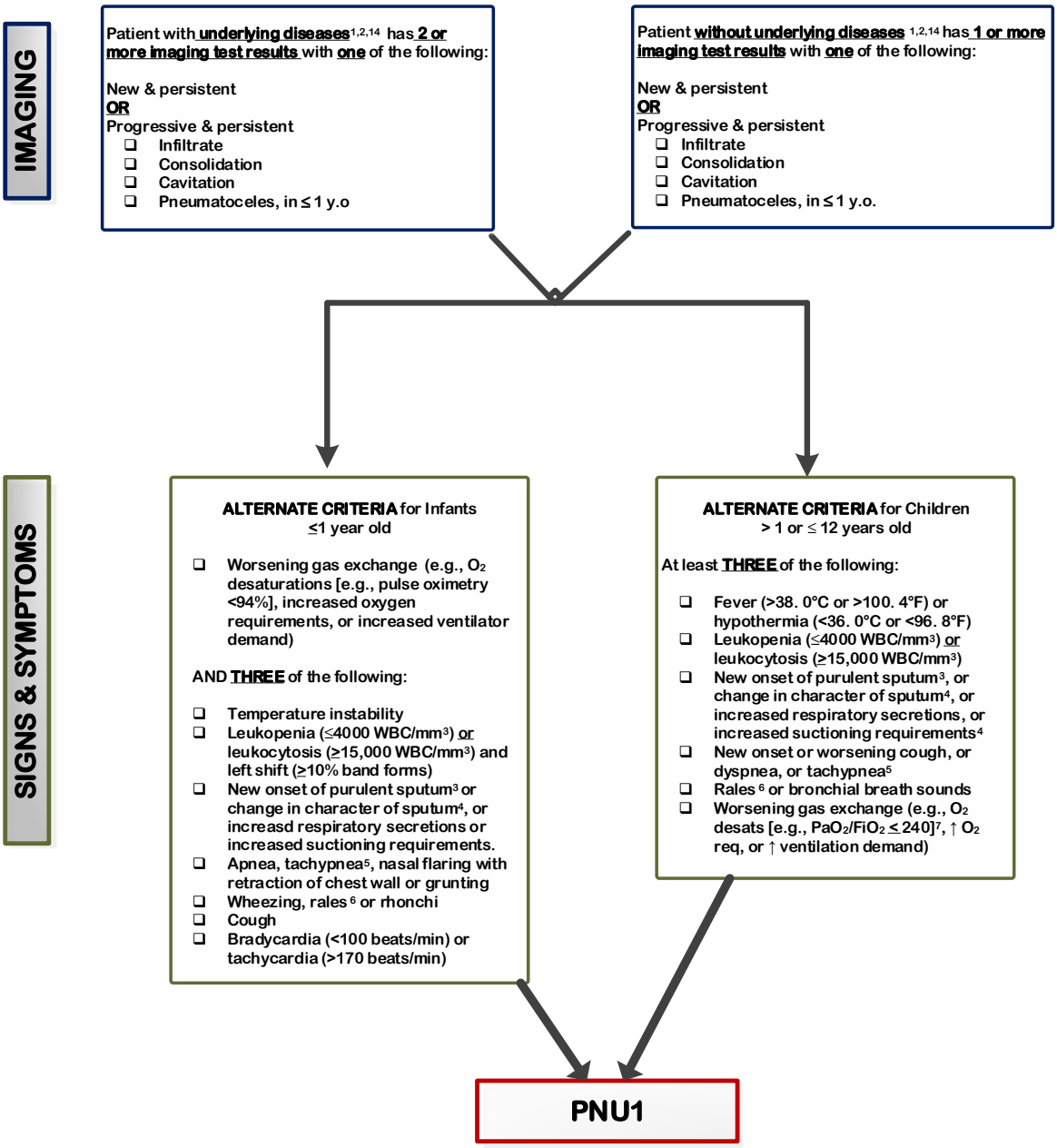


Figure 2: Pneumonia Flow Diagram, Alternative Criteria for Infants and Children

Facility ID#_____Event #_____ Event Date __/__/____



Footnotes to Algorithms and Flow Diagrams:

1. To help confirm difficult cases, multiple imaging test results spanning over several calendar days must be considered when determining if there is imaging test evidence of pneumonia. Pneumonia may have rapid onset and progression, but does not resolve quickly. Imaging test evidence of pneumonia will persist. Rapid imaging resolution suggests that the patient does not have pneumonia, but rather a non-infectious process such as atelectasis or congestive heart failure.
    - In non-ventilated patients, the diagnosis of healthcare-associated pneumonia may be quite clear on the basis of signs, symptoms and a single definitive chest imaging test result. Therefore, in a patient without underlying pulmonary or cardiac disease and when there is only one imaging test available, if it is an eligible finding, the imaging test evidence requirement can be met.
    - In patients without underlying disease if more than one imaging test is available serial imaging test results must also be evaluated and demonstrate persistence.
    - In patients with underlying disease, serial chest imaging test results must be examined to help separate infectious from non-infectious pulmonary processes. In patients with pulmonary or cardiac disease (for example: interstitial lung disease or congestive heart failure), the diagnosis of pneumonia may be particularly difficult. For example: Pulmonary edema from decompensated congestive heart failure may simulate the presentation of pneumonia.

2. Note that there are many ways of describing the imaging 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. If provided and the findings are not documented as attributed to another issue (for example: pulmonary edema, chronic lung disease) they are eligible for meeting imaging test evidence of pneumonia.

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). Refer to the table below if your laboratory reports these data semi-quantitatively or uses a different format for reporting Gram stain or direct examination results (for example: “many WBCs” or “few squamous epithelial cells”). This laboratory confirmation is required since written clinical descriptions of purulence are highly variable.

How do I use the purulent respiratory secretions criterion if …	Instruction
My laboratory reports counts of "white blood cells" or "polymorphonuclear leukocytes" or "leukocytes" rather than counts of "neutrophils"?	Assume that counts of cells identified by these other descriptors (for example "white blood cells") are equivalent to counts of neutrophils, unless the laboratory tells you this is not the case.
My laboratory reports semi-quantitative results (not quantitative results) for numbers of neutrophils and squamous epithelial cells?	Check with the laboratory to get information about what quantitative ranges the semi-quantitative reports correspond to.
My laboratory cannot provide additional information on how its semi-quantitative reporting corresponds to quantitative reporting ranges for neutrophils and squamous epithelial cells?	Use the following direct examination results to meet the purulent respiratory secretions criterion: many, heavy, numerous 4+, or ≥25 neutrophils per low power field (lpf) [x100], AND no, rare, occasional, few, 1+ or 2+, or ≤10 squamous epithelial cells per lpf [x100] [19].
My laboratory reports only the numbers of neutrophils present, without reporting the number of squamous epithelial cells?	In this situation, the purulent secretions criterion may be met using the specified quantitative and semi-quantitative thresholds for neutrophils alone (specifically many, heavy, numerous, 4+, or ≥25 neutrophils per lpf [x100]).
My laboratory uses different reporting thresholds for neutrophils and squamous epithelial cells (for example: maximum report of ≥ 20 neutrophils per low power field [x100], or minimum report of ≤ 15 squamous epithelial cells per low power field [x100])?	In this situation, the purulent secretions criterion may be met using the laboratory's specified maximum quantitative threshold for neutrophils, and/or minimum quantitative threshold for squamous epithelial cells.
My laboratory processes respiratory specimens such as bronchoalveolar lavage fluid using a centrifugation procedure (for example, "cytospin"), and there is no quantitation or semi-quantitation of neutrophils or white blood cells in the direct examination report?	In this situation, a report indicating the presence of white blood cells, without quantitation, is sufficient to meet the purulent secretions criterion.

4. 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 40th 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 (PaO_2) to the inspiratory fraction of oxygen (FiO_2).
8. Coagulase-negative *Staphylococcus* species, *Enterococcus* species and *Candida* species or yeast not otherwise specified that are identified from blood cannot be deemed secondary to a PNEU, unless the organism was also identified from pleural fluid (where specimen was obtained during thoracentesis or initial placement of chest tube and NOT from an indwelling chest tube) or lung tissue. This applies when meeting PNU2 or when meeting PNU3 with the laboratory findings found in PNU2.

Identification of matching *Candida* spp. from blood and sputum, endotracheal aspirate, BAL or protected specimen brushing with specimen collection dates in the same IWP (see footnote 11) can be used to satisfy PNU3 definition for patients meeting the immunocompromised (see footnote 10).

9. Refer to threshold values for cultured specimens with growth of eligible pathogens (Table 5).

   Notes:

   - A specimen that is not obtained through an artificial airway (specifically endotracheal tube or tracheostomy) from a ventilated patient is not considered minimally contaminated and is not eligible for use in meeting the laboratory criteria for PNU2. Sputum or tracheal secretions collected from a non-ventilated patient are not minimally-contaminated specimens.
   - The following organisms can only be used to meet PNEU definitions when identified from pleural fluid obtained during thoracentesis or initial placement of chest tube (not from an indwelling chest tube) or lung tissue:
     - Coagulase-negative *Staphylococcus* species
     - *Enterococcus* species
     - *Candida* species or yeast not otherwise specified. Exception: identification of matching *Candida* spp. from blood and sputum, endotracheal aspirate, BAL or protected specimen brushing with specimen collection dates in the same IWP can be used to satisfy PNU3 definition for immunocompromised patients (see footnote 10)

10. Immunocompromised patients include only

    - those with neutropenia defined as absolute neutrophil count or total white blood cell count (WBC) $<500/mm^3$
    - those with leukemia, lymphoma or who are HIV positive with CD4 count <200
    - those who have undergone splenectomy
    - those who have a history of solid organ or hematopoietic stem cell transplant
    - those on cytotoxic chemotherapy
    - those on enteral or parenteral administered steroids (excludes inhaled and topical steroids) daily for >2 weeks on the date of event

11. Blood specimen and sputum, endotracheal aspirate, BAL or protected specimen brushing specimens must have a collection date that occurs within the Infection Window Period.

12. Semi-quantitative or non-quantitative cultures of sputum obtained by deep cough, induction, aspiration, or lavage are acceptable.

13. Identification of organism by a culture or non-culture based microbiologic testing method which is performed for purposes of clinical diagnosis or treatment (for example: not Active Surveillance Culture/Testing (ASC/AST).

14. If the imaging test result is equivocal for pneumonia, check to see if subsequent imaging tests are definitive. For example, if a chest imaging test result states infiltrate vs. atelectasis and a subsequent imaging test result is definitive for infiltrate—the initial imaging test would be eligible for use. In the absence of finding a subsequent imaging result that clarifies the equivocal finding, if there is clinical correlation then the equivocal imaging test is eligible for use.

Table 5: Threshold values for cultured specimens used in the diagnosis of pneumonia

Specimen collection/technique	**Values***
Lung tissue†	≥10^4 CFU/g tissue
Bronchoscopically (B) obtained specimens	
Bronchoalveolar lavage (B-BAL)	≥10^4 CFU/ml
Protected BAL (B-PBAL)	≥10^4 CFU/ml
Protected specimen brushing (B-PSB)	≥10^3 CFU/ml
Nonbronchoscopically (NB) obtained (blind)specimens	
NB-BAL	≥10^4 CFU/ml
NB-PSB	≥10^3 CFU/ml
Endotracheal aspirate (ETA)	≥ 10^5 CFU/ml

CFU = colony forming units
g = gram
ml = milliliter

*Consult with your laboratory to determine if reported semi-quantitative results match the quantitative thresholds. In the absence of additional information available from your laboratory, a semi-quantitative result of "moderate" or "heavy" or "many" or "numerous" growth, or 2+, 3+ or 4+ growth is considered to correspond.
†Open-lung biopsy specimens and immediate post-mortem specimens obtained by transthoracic or transbronchial biopsy

Numerator Data: The *Pneumonia (PNEU)* form (CDC 57.111) is used to collect and report each VAP that is identified during the month selected for surveillance. The Instructions for Completion of Pneumonia (PNEU) form contains brief instructions for collection and entry of each data element on the form. The pneumonia form includes patient demographic information and information on whether or not mechanically-assisted ventilation was present. Additional data include the specific criteria met for identifying pneumonia, whether the patient developed a secondary bloodstream infection, whether the patient died, the organisms identified from culture or non-culture based microbiologic testing methods, and the organisms' antimicrobial susceptibilities.

Reporting Instruction: If no VAPs are identified during the month of surveillance, the "*Report No Events"* box must be checked on the appropriate denominator summary screen, for example: Denominators for Intensive Care Unit (ICU)/Other Locations (Not NICU or SCA/ONC), etc.

Denominator Data: Device days and patient days are used for denominators (see Key Terms chapter). Ventilator days, which are the number of patients managed with a ventilatory device, are collected daily, at the same time each day, according to the chosen location using the appropriate form (CDC 57.116, 57.117, and 57.118). These daily counts are summed and only the total for the month is entered into NHSN. Ventilator days and patient days are collected for each of the locations where VAP is monitored.
When denominator data are available from electronic sources (for example: ventilator days from respiratory therapy), these sources may be used as long as the counts are not substantially different (+/- 5%) from manually-collected counts, validated for a minimum of three months.
When converting from one electronic counting system to another electronic counting system, the new electronic system should be validated against manual counts as above. If electronic counts for the new electronic system are not within 5% of manual counts, resume manual counting and continue working with IT staff to improve design of electronic denominator data extraction (while reporting manual counts) until concurrent counts are within 5% for 3 consecutive months.
Note: This guideline is important because validating a new electronic counting system against an existing electronic system can magnify errors and result in inaccurate denominator counts.

Data Analyses:
All data that is entered into NHSN can be analyzed at event or summary level. The data in NHSN can be visualized and analyzed in various ways i.e., descriptive analysis reports for both the denominator and numerator data.

Types of VAP Analysis Reports

VAP Rate

The VAP rate per 1000 ventilator days is calculated by dividing the number of VAPs by the number of ventilator days and multiplying the result by 1000 (ventilator days).

$$\text{VAP Rate per 1000 ventilator days} = \frac{No.\ of\ VAPs}{No.of\ Ventilator\ Days} * 1000$$

Device Utilization Ratio

The Ventilator Utilization Ratio is calculated by dividing the number of ventilator days by the number of patient days. These calculations will be performed separately for the different types of ICUs, SCAs, and other locations in the institution.

$$\text{DUR} = \frac{No.\ of\ Ventilator\ Days}{No.\ of\ Patient\ Days}$$

Descriptive Analysis Output Options

Descriptive analysis output options of numerator and denominator data, such as line listings, frequency tables, and bar and pie charts are also available in the NHSN application.

Line List: https://www.cdc.gov/nhsn/pdfs/ps-analysis-resources/linelists.pdf
Frequency Tables: https://www.cdc.gov/nhsn/pdfs/ps-analysis-resources/frequencytables.pdf
Bar Chart: https://www.cdc.gov/nhsn/pdfs/ps-analysis-resources/BarCharts.pdf
Pie Chart: https://www.cdc.gov/nhsn/pdfs/ps-analysis-resources/PieChart.pdf

Guides on using NHSN analysis features are available at: www.cdc.gov/nhsn/PS-Analysis-resources/reference-guides.html.

VAP Measures Available in NHSN

Measure	**Calculation**	**Application**
VAP Rates	The number of VAPs for a location x 1000 The number of Ventilator Days for a location	Location specific measure only
DUR	The Ventilator Days for a location The Patient Days for that location	Location specific measure only

NHSN Group Analysis:
NHSN Group Users can perform the same analysis as facility level users in NHSN. A few helpful tools in NHSN for groups are listed in the resources below. These tools are guides on how to start and join a Group; how to create a template to request data from facilities; how to determine the level of access granted by the facility following the previous steps, and how to analyze the facilities data.

Group Analysis Resources:

NHSN Group Users Page: https://www.cdc.gov/nhsn/group-users/index.html

Group User's Guide to the Membership Rights Report:
https://www.cdc.gov/nhsn/pdfs/ps-analysis-resources/GroupAnalysisWebinar.pdf

Group User's Guide to the Line Listing- Participation Alerts:
https://www.cdc.gov/nhsn/pdfs/ps-analysis-resources/group-alerts.pdf

References:

[1]Magill SS., O'Leary E., Janelle SJ., et al. "Changes in Prevalence of Health Care–Associated Infections in U.S. Hospitals". New England Journal of Medicine 2018: 379: 1732-44.

[2] Magill SS, Klompas M, Balk R, et al. "Developing a new, national approach to surveillance for ventilator-associated events". Critical Care Medicine 2013;41:2467-75.