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Implementation Guideline

Non-ventilator health care-associated pneumonia (NV-HAP): The infection preventionist's role in identifying NV-HAP

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A B S T R A C T

One of the fundamental challenges in nonventilator health care-associated pneumonia (NV-HAP) surveillance is identifying cases and standardizing surveillance protocols. This section highlights clinical pneumonia definitions and current surveillance definitions, as well as the difficulty in case finding methodologies. In addition, we review current microbiology and molecular testing methods. Further, we explore future opportunities to leverage the electronic health care record in attempt to identify a reliable less burdensome data identification and collection methodology. Finally, we highlight the importance of a collaborative approach to prevention of NV- HAP, as well as strategies to assist the IP with facilitating interdisciplinary communication and uptake of evidence-based implementation strategies.

One of the fundamental challenges in nonventilator health care-associated pneumonia (NV-HAP) surveillance is identifying cases and standardizing surveillance protocols. This section highlights clinical pneumonia definitions, current surveillance definitions, and potential opportunities for electronic data capture. The IP (IP) plays an important role in interdisciplinary team collaborations and communication of key surveillance findings.

PNEUMONIA DEFINITIONS

The following are clinical definitions of pneumonia found in current literature. See Table 1 for a comparison of selected types of pneumonia based on onset.

Pneumonia: Levison defines pneumonia as an infection of the pulmonary parenchyma caused by various organisms; it is not a single disease but a group of specific infections, each with its own epidemiology, pathogenesis, presentation, and clinical course.[1] According to the American Thoracic Society (ATS) and Infectious Diseases Society of America (IDSA), pneumonia is defined as the presence of new lung infiltrate and clinical evidence that the infiltrate is of an infectious origin, such as the new onset of fever, purulent sputum leukocytosis, and decline in oxygenation.[2]

Community-acquired pneumonia (CAP): CAP is pneumonia acquired in the community or diagnosis of pneumonia within 48 hours of admission to the hospital.[3]

Hospital-acquired pneumonia (HAP): HAP is pneumonia that develops more than 48 hours after hospital admission and was not incubating at the time of admission.[4]

Health care-associated pneumonia (HCAP): HCAP was defined as pneumonia acquired by an individual with a specific type of health care contact in the recent past, including hospitalization for 2 or more days within the preceding 90 days, residence in a long-term care or extended care facility, receipt of home infusion therapy, chronic dialysis treatment within 30 days, or wound care. These individuals were once thought to be at increased risk of infection caused by multidrug-resistant organisms.[5] However, HCAP was eliminated from the 2016 ATS/IDSA pneumonia management guidelines because multiple studies demonstrated that many patients with HCAP were not at risk for developing multidrug-resistant organisms.[6]

Ventilator-associated pneumonia (VAP): VAP is a pneumonia occurring in a patient who is on mechanical ventilation for more than 2 calendar days on the event date with day of mechanical ventilation onset defined as Day 1.[7] It is important to distinguish VAP from HAP that compromises the patient's respiratory status to the point that mechanical ventilation is required.

Aspiration pneumonia: Aspiration pneumonia develops due to misdirection of oropharyngeal or gastric contents into the larynx and lower respiratory tract.[8]

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Table 1
Onset of selected types of pneumonia

Type	Onset
CAP	≤48 hours of admission to the hospital
HAP	>48 hours (2 days) following admission to the hospital
HCAP	≤48 hours of admission to the hospital in a patient with recent health care exposure (*no longer included in ATS/IDSA pneumonia classification scheme*[6])
VAP	≥48 hours (2 days) following initiation of mechanical ventilation

CAP, community-acquired pneumonia; *HCAP*, health care-associated pneumonia, *HAP*, hospital-acquired pneumonia; *VAP*, ventilator-associated pneumonia.

Long-term care facility–associated pneumonia: In long-term care residents, this type of pneumonia is defined as chest radiographic evidence of pneumonia, probable pneumonia, or presence of an infiltrate *plus* 2 of the following: new or increased cough; new or increased sputum production; fever; pleuritic chest pain; new or increased findings on chest examination; or one of the following indications of change in status or breathing difficulty: new/increased dyspnea or respiratory rate greater than 25 breaths per minute or worsening mental or functional status.[9]

CLINICAL DIAGNOSIS

The diagnosis of pneumonia can be challenging, especially in critically ill patients or patients with other concurrent acute or chronic respiratory conditions. Clinicians frequently assess clinical signs, microbiological findings, and radiologic findings when determining the presence or absence of pneumonia.

Microbiologic/molecular testing

Currently, there is no gold standard test to definitively diagnose pneumonia in mechanically ventilated or nonventilated patients. The 2016 IDSA/ATS guidelines[6] provide the following recommendations related to the microbiologic component of pneumonia diagnosis*:*

Collection of microbiologic specimens: Noninvasive sampling with semi-quantitative cultures is recommended rather than invasive sampling with quantitative cultures or noninvasive sampling with quantitative cultures (weak recommendation, low-quality evidence). This recommendation was based on the speed with which noninvasive specimens can be collected, decreased incidence of complications, reduced use of resources, and lack of evidence that invasively collected specimens and quantitative cultures lead to improved patient outcomes.

Clinical criteria vs use of biomarkers: Clinical criteria should be used alone to diagnose VAP and HAP (strong recommendation, moderate-quality evidence). Use of biomarkers in addition to clinical criteria was not recommended because sensitivity and specificity of serum procalcitonin testing and soluble triggering receptor expressed on myeloid cells-1 did not reach predetermined thresholds, and the tests may cloud the diagnosis, resulting in nonidentification of the true infection source or unnecessary antimicrobial therapy.[6]

Alby and Mitchell describe the use of molecular tests for the identification of lower respiratory tract infections. Multiplex molecular panels are used to conduct a version of syndromic surveillance related to a particular set of symptoms related to a body site (commonly blood, stool, or the upper respiratory tract).[10]

Recently, 2 molecular tests have been approved by the US Food and Drug Administration for detection of lower respiratory tract infection:[10]

The FilmArray Pneumonia Panel (BioFire Diagnostics) can detect common bacterial and viral pathogens and selected antibiotic resistance markers. It can be used to evaluate both sputum and bronchoalveolar lavage (BAL) samples.

The Unyvero molecular test system (Curetis) can detect 19 bacterial targets and 10 resistance markers from endotracheal aspirates.

Although molecular testing has the potential to improve diagnosis and treatment of pneumonia, the sensitivities of some targets may be a concern. Also, because both hospital and community pathogens can be present, it may be challenging to identify when to perform the test and which patient populations would benefit most.[10] Microbiological testing is further discussed in Section 2 of this guide.

Clinical signs and symptoms

Clinical signs that are frequently considered to be "clues" of infection or, in certain combinations, indicative of a respiratory tract infection include:[7]

Fever

Leukopenia or leukocytosis

Increased oxygen need

Altered mental status in patients older than age 70 years

New onset or change in sputum, cough, or lung sounds

Radiological studies

Upon identification of clinical signs and symptoms indicative of lower respiratory tract infection, radiological studies can provide supporting evidence of pneumonia (see Table 2).[7] The radiographic patterns of HAP and VAP can be variable and even confusing. X-ray findings may also indicate atelectasis, pulmonary infarction, pulmonary edema, or acute respiratory distress syndrome. Chest X-ray is most valuable when used to rule out pneumonia.[11]

Because chest X-ray results may be inconclusive in establishing a diagnosis of pneumonia, supplemental studies such as computerized tomography (CT) may provide additional clarification. Esayag et al described the challenges associated with obtaining chest radiographs in bedbound patients and compared X-ray and CT scan results. They determined that when a chest radiograph was interpreted as normal, a noncontrast-enhanced high-resolution chest CT scan improved pneumonia diagnostic accuracy by 30%.[12] Two studies that evaluated the use of chest CT scan in patients with suspected CAP demonstrated that this test modality increased accuracy of diagnosis when combined with chest X-ray.[13,14] It is important to note that chest CT scan has disadvantages, including cost and increased radiation exposure for the patient.

Lung ultrasound has been shown to be effective in the assessment of lung conditions, including pneumonia, and may be useful in bedside diagnosis of that infection. A recent meta-analysis of 5 studies demonstrated that lung ultrasound had high sensitivity and specificity for pneumonia diagnosis, exclusive of interstitial pneumonia (which was not studied).[15] Advantages of ultrasound as a diagnostic tool include rapid turnaround time, usefulness in resource-poor settings, and elimination of the requirement for patient transport.

Table 2
NHSN categories of hospital-acquired pneumonia

Category	Definition
PNU1	Clinically defined pneumonia
PNU2	Common bacterial or filamentous fungal pathogens Viral, *Legionella*, and other bacterial pneumonias
PNU3	Pneumonia in immunocompromised patients

NHSN, The National Health care Safety Network.

SURVEILLANCE

Surveillance definitions vs clinical diagnoses

Surveillance definitions are designed to study and identify trends in a population. The consistent application of standardized criteria allows confidence in aggregation and analysis of data. In contrast, clinical diagnoses are patient-specific. Unlike surveillance definitions, *all* available diagnostic data are considered in a clinical diagnosis, including clinical, epidemiological, and laboratory data that are outside of the scope of a surveillance definition. Therefore, a clinical diagnosis may be made even when a surveillance definition may not be met.[16]

Subsequently, a surveillance definition may be met even when a clinical diagnosis has been ruled-out due to the utilization of additional data and information. Failure to meet one type of definition should not override a conclusion for the second. Clinical diagnoses may be easier to define than surveillance definitions; however, because they are not standardized, patient-specific diagnoses omit important information used to identify to trends, risk factors, or potential opportunities for improvement in a given population.

National Healthcare Safety Network and pneumonia surveillance

The National Healthcare Safety Network (NHSN) health care-associated infection (HAI) surveillance definitions are familiar to many IPs in varied care settings. NHSN describes 3 categories of HAP, as described in Table 2; refer to the NHSN Patient Safety Manual[7] for specific algorithms.

All site-specific algorithms commence with radiological findings and provide inclusion signs and symptoms, as well as laboratory findings as components of surveillance definitions. In some instances, the surveillance definitions include variations based on the age of the patient. Two helpful tools provided by NHSN in the Patient Safety Manual are a pneumonia flow diagram for patients of any age and an alternative criteria algorithm for infants and children.[7]

PNEUMONIA SURVEILLANCE AND THE INFECTION PREVENTION PROGRAM

Infection surveillance is a basic component of an infection prevention program.[17] Multiple studies have demonstrated the positive impact of surveillance for infections on the incidence of HAIs.[18]

Conducting surveillance has multiple aims, including:[19]

Establishment of baseline metrics

Identification of infection clusters and outbreaks

Identification of opportunities to prevent or manage HAIs

Measurement of the efficacy of improvement initiatives and strategies

The surveillance plan should be based on epidemiological evidence, focus on the assessment of infection risk factors, and align with current recommended practices and guidelines. Surveillance related to process measures implemented to improve patient safety is also a significant component of the infection prevention program. Implementation of the plan should include mitigation of risk and progress metrics.

As described in the Pneumonia Definitions at the start of this section, identification of pneumonia is challenging for clinicians. This in turn makes it challenging to identify cases for surveillance purposes.

For the IP performing surveillance for HAP, the choice of the marker or markers that would suggest a potential reportable case of pneumonia is an important decision. Ideally, the marker should be easily identified and obtained from the electronic medical record, and have high predictive power for pneumonia diagnosis. Selected potential triggers are listed in Table 3.

Table 3
Selected information sources in pneumonia surveillance

Surveillance element	Potential sources of information
Radiographic	Positive chest X-ray reports Positive chest CT scans
Laboratory	Positive respiratory culture results Positive blood culture results Molecular test results Positive urine test for *Legionella pneumophila* serogroup 1 antigens Serological evidence
Administrative	Radiographic test orders with indication related to pneumonia or consolidation Antimicrobial treatment orders with indication related to pneumonia ICD-10-CM discharge codes associated with pneumonia, not described as present on admission

An exciting development in NV-HAP surveillance is described by Ji et al.[20] The authors conducted a cohort study in acute care hospitals that assessed multiple surveillance strategies using various combinations of easily abstracted clinical parameters for outcome measures and NV-HAP diagnosis. The authors proposed a surveillance definition that includes worsening oxygenation, administration of a new antibiotic for a minimum of 3 days, fever or abnormal white blood cell count (less than 4,000/mcL or more than 12,000/mcL), and chest imaging order. Application of this surveillance definition in the study population of more than 300,000 patients admitted to acute care yielded a pneumonia incidence rate of 0.6 events per 100 admissions (similar to incidence rates reported by other investigators) and aligned with incidence rates identified during multistate point prevalence surveys conducted by the Centers for Disease Control and Prevention.

Although the authors concluded that additional validation studies are needed,[20] their work suggests the real possibility of concurrent pneumonia surveillance based on clinical parameters that are readily available as discrete fields in the electronic medical record, eliminating reliance on interpretation of radiological studies or collection of respiratory specimens for microbiological testing. The ability to identify NV-HAP cases in real time would allow the IP to quickly provide HAI metrics to stakeholders, identify clusters of infections, inform and participate in multidisciplinary prevention efforts, and assess the effectiveness of improvement strategies. Challenges with discrepancies between clinical and surveillance definitions encumber interdisciplinary improvement plans.

INTERDISCIPLINARY COLLABORATION

Collaboration between IPs and their clinical partners can expedite the identification of potential NV-HAP cases. Health care workers who participate in the patient's care are in a great position to provide input about patients who may have developed NVHAP. These collaborative partners may include:

Respiratory and other therapists

Pharmacists

Nursing staff

Medical and surgical providers

Case managers

Laboratory personnel

Research demonstrates the value of collaboration in improving patient care.[21-23] In a study conducted in the Netherlands, investigators concluded that cross-functional teams were better able to improve quality of care and that there is a need to improve collaboration efforts among health care professionals.[21] The Joint Commission has published data indicating that communication was the third most-frequent root cause for sentinel events during calendar year 2015.[22] Thus, establishment of a collaborative relationship with colleagues to identify potential pneumonia cases is an important first step toward the creation of a performance improvement team that can ultimately plan and implement HAP prevention strategies.

Key Points

Using current definitions, surveillance for NV-HAP is time- and labor-intensive.

Due to surveillance challenges, comparison of NV-HAP rates between hospitals is almost impossible currently.

Criteria for clinical diagnosis and case definition of pneumonia are not identical.

Ideally, markers used for NV-HAP case definition should be easily identified and obtained from the electronic medical record and have high predictive power for pneumonia diagnosis.

IPs should develop collaborative, interdisciplinary relationships to further identification of NV-HAP cases and plan and implement prevention strategies.

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