Community-Acquired, Health Care–Associated, and Ventilator-Associated Pneumonia
Three Variations of a Serious Disease

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KEYWORDS
- Pneumonia  
- Health care–associated pneumonia  
- Ventilator-associated pneumonia  
- Community-acquired pneumonia  
- Hospital-acquired pneumonia

KEY POINTS
- Community-acquired pneumonia (CAP), health care–associated pneumonia (HCAP), and ventilator-associated pneumonia (VAP) are three distinct types of pneumonia that cause significant morbidity and mortality.
- Critical care nurses are key members of the health care team in the treatment as well as in the identification and prevention of complications associated with CAP, HCAP, and VAP.

COMMUNITY-ACQUIRED PNEUMONIA

Community-acquired pneumonia (CAP) refers to pneumonia contracted outside the health care setting. According to one estimate noted in the most recent Infectious Disease Society of America/American Thoracic Society (IDSA/ATS) consensus guidelines, 1 915,900 episodes of CAP occur each year in the United States in adults 65 years of age or older. 2 Furthermore, 20% of all those who develop CAP will require hospitalization, and those with severe CAP may require mechanical ventilation and aggressive multiorgan support. 3

Clinical Presentation

Clinical presentation of CAP may be typical or atypical. The typical presentation is associated with rapid onset of fever, productive cough, shortness of breath, clinical...
signs of pulmonary consolidation (abnormal breath sounds, dullness on percussion), and occasionally pleuritic chest pain.\textsuperscript{4} CAP is usually the result of infection by a common bacterial pathogen such as \textit{Streptococcus pneumoniae}. Atypical pneumonia is usually attributed to less common bacterial, viral, and fungal pathogens that colonize in susceptible individuals, such as the elderly or immunocompromised.\textsuperscript{5} It has a more gradual onset of dry cough and shortness of breath than typical forms of pneumonia and the patient may experience general myalgias and fatigue.\textsuperscript{4} Despite seemingly insignificant pulmonary presentation, the chest radiograph is abnormal in atypical pneumonia.

\textbf{Causative Organisms}

The infecting agent in CAP may be bacterial, viral, or fungal. In otherwise healthy adults (younger than age 60), \textit{Streptococcus pneumoniae} and \textit{Hemophilus influenzae} are common causative agents in CAP.\textsuperscript{5} Bacterial agents such as \textit{Mycoplasma pneumoniae}, \textit{Chlamydia pneumoniae}, and \textit{Legionella pneumophilia} are seen in atypical CAP, as well as viruses (eg, influenza virus, respiratory syncytial virus [RSV], and cytomegalovirus [CMV]). Infections by fungi (eg, \textit{Pneumocystis carinii}) are responsible for a small number of CAP cases and are more likely to occur in immunocompromised patients.\textsuperscript{6}

\textbf{Risk Factors and Severity of CAP}

Several different risk factors are associated with CAP, ranging from patient demographics to concomitant illnesses. Currently, the Pneumonia Severity Index (PSI) is one of two main tools available in emergency departments and outpatient settings to determine the severity of CAP. With the PSI model, patient risk scores are determined on the basis of four risk categories: demographic factors, comorbid conditions, findings on physical examination, and laboratory results (eg, pH, blood urea nitrogen [BUN], Sodium, Glucose, hematocrit, and PO\textsubscript{2}). Points accumulated within each category are totaled and stratified to one of five risk classes, which correlate to a percent risk of mortality. For a patient with the lowest risk (class I), outpatient treatment is recommended, whereas for a patient found to be at high risk (class IV or V), inpatient treatment is recommended.

The other main pneumonia scoring tool is the CURB65. It is simpler than the PSI and was created for quick and easy use in the emergency department or outpatient office. A patient is assigned 1 point for each of five clinical criteria. A score of 1 or 2 would indicate that an individual can safely be treated as an outpatient, whereas scores of 3 to 5 would suggest inpatient treatment. The five clinical criteria are as follows:

- C Confusion
- U Blood urine nitrogen ≥20 mg/dL
- R Respiratory rate ≥30 breaths/min
- B Systolic blood pressure <90 mm Hg or diastolic blood pressure ≤60 mm Hg
- 65 Age ≥65 years

Along with sound clinical judgment, CURB65 and PSI are valuable tools for determining site of care and are strongly recommended by the IDSA/ATS consensus guidelines.\textsuperscript{7} However, recent studies caution that limitations arise when looking at 30-day mortality as an outcome.\textsuperscript{8} For example, nearly 50% of pneumonia-related deaths and 25% of deaths occurring within 30 days are related to comorbidities rather than directly caused by pneumonia. These prediction models may underestimate the
severity of illness in the young and have been found to perform less well when considering outcomes such as intensive care unit (ICU) admission, mechanical ventilation, and need for vasopressors.

**Diagnostic Testing**

When a patient is admitted to the hospital for CAP, a chest radiograph should be performed on admission and is essential for detecting pulmonary infiltrates. Complete blood counts and routine chemistries should also be performed, as well as two sets of pretreatment blood cultures. CAP consensus guidelines also support pretreatment Gram stain and culture on expectorated sputum for inpatients. For patients with severe CAP requiring intubation, an endotracheal aspirate for sputum analysis should be obtained. In addition, urinary antigen testing for *Legionella pneumophila* and *Streptococcus pneumoniae* should be performed for patients with severe CAP. If pandemic influenza is suspected, specific flu testing may be indicated.

**Treatment and Empiric Therapy**

Antibiotic therapy is the main treatment for CAP, with the ultimate goal of killing the infection and resolving the clinical disease. Prompt administration of antibiotic therapy is crucial to favorable CAP outcomes. Early initiation of antibiotics for patients admitted for CAP has been shown to be the single factor most associated with decreased mortality. For patients admitted through the emergency department (ED), the current IDSA/ATS consensus guidelines recommend the first antibiotic dose be administered before the patient leaves the ED.

As a rule, the most potent drugs within a class are preferred, thus helping reduce bacterial selection for antibiotic resistance. Lack of prompt and effective treatment, inappropriate antibiotic choice, or even an insufficient dose with the appropriate antibiotic have all been shown to encourage antibiotic resistance. This may explain why methicillin-resistant *Staphylococcus aureus* (MRSA) has been found to be an occasional causative agent in CAP.

Early in treatment, the infecting agent is often unknown; therefore, broad-spectrum antibiotic therapy may be indicated initially. Empiric antibiotic selection is based on several factors, including age, antibiotic tolerance, comorbidities, concurrent medications, and epidemiologic setting. The IDSA/ATS consensus guidelines make several recommendations based both on patient clinical risks and site of treatment. Intravenous antibiotic therapy is recommended for initial treatment of all individuals requiring inpatient hospital admission, with clear regimen differences between acute and critically ill patients. Once the etiology of CAP has been identified, antimicrobial therapy should be tailored to target the pathogen.

**Duration of Treatment**

Patients treated with intravenous antibiotics should be switched over to oral medication as soon as clinically possible. This will depend on how the patient is improving clinically, with consideration for such factors as hemodynamic stability, state of the gastrointestinal tract, and ability to ingest medication. According to the IDSA/ATS guidelines, duration of treatment will depend on whether or not the initial antibiotic treatment was active against the infecting pathogen, or if complicating extrapulmonary infections were present. At minimum, 5 days of treatment is recommended; the patient must not only be afebrile for 48 to 72 hours, but must also meet no more than one CAP-associated sign of instability. The following are criteria for clinical instability in CAP:
- Temperature ≥ 37.8°C
- Heart rate ≥ 100 beats/min
- Respiratory rate ≥ 24 breaths/min
- Systolic blood pressure ≤ 90 mm Hg
- Arterial oxygen saturation ≤ 90% or Po2 ≤ 60 mm Hg on room air
- Inability to maintain oral intake
- Normal mental status.

ROLE OF NURSES

Laboratory and Diagnostic Studies

Nurses play a major role in managing the care of CAP patients. They are largely responsible for facilitating the flow of laboratory tests and diagnostic studies in the ward and ICU. Timely collection of specimens and proper techniques for handling of samples are vital to quick and accurate identification of pathogens. This includes practicing good hand hygiene and barrier precautions.

Even though studies have shown that hand hygiene is the single most important method for preventing infection, hand hygiene among health care workers is poor.\textsuperscript{10} Compliance has improved somewhat over the last decade, due in large part to the introduction of alcohol-based foams and rubs. However, ongoing surveillance and feedback to nurses and other staff is essential to improving hand hygiene, according to the Centers for Disease Control and Prevention (CDC).\textsuperscript{10}

Treatment Failure and Success

In addition to performing frequent physical assessments and overseeing laboratory and diagnostic procedures, nurses must closely monitor a patient’s response to treatment. Of CAP patients who die, respiratory failure (along with cardiac arrhythmias and sepsis) is a leading cause of death.\textsuperscript{4} A keen ability to recognize new or worsening pulmonary abnormalities, such as hypoxemia, tachypnea, and auscultatory changes, is crucial for identifying treatment failure in CAP.

Recognizing treatment success is important as well, as nurses encourage the patient on the path to recovery. Nurses have the unique privilege of being at the bedside around the clock. They may be the first to recognize when a patient is ready to switch to oral antibiotics, when a central line or indwelling catheter is no longer necessary, or when a patient is ready to leave the ICU. Nurses therefore must be good communicators and facilitators of information to the rest of the clinical team. An important way to do this is to participate in daily rounds.\textsuperscript{10}

Patient Education

A key nursing function is to educate patients about their disease throughout the course of treatment and provide them with the necessary information for discharge. Hospital readmissions are common among CAP patients, and most are due to worsening symptoms and comorbidities.\textsuperscript{11} Some research has shown that CAP patients have not always been equipped with adequate information for recovery.\textsuperscript{12} Patients need to know that their needs are being met and that clinicians are supporting them during their admission. This includes teaching patients the dangerous sign of pneumonia relapse. Patients must be educated on how to recognize fever, worsening cough, and changes in sputum and whom to contact in the event of worsening symptoms. Clinicians may educate best when working within evidence-based guidelines, and when they receive feedback on their performance and that of their peers.\textsuperscript{12}

Influenza plays a major part in CAP education. It is estimated that a yearly flu shot can be 70% to 90% effective in preventing influenza.\textsuperscript{5} A patient’s flu vaccination
status should be addressed in the outpatient office and on hospital admission. Education should focus on the preventive health benefits of the flu shot and stress its importance in lowering the risk of influenza pneumonia and secondary bacterial pneumonias, which are more prevalent during flu season. Influenza vaccination should be offered to patients receiving outpatient treatment, as well as at hospital discharge.

Of equal importance is the immunization of health care workers. All clinical personnel in inpatient, outpatient, and long-term care settings should be immunized annually. Influenza vaccination for health care workers is strongly recommended by the current IDSA/ATS consensus guidelines.

HEALTH CARE–ASSOCIATED PNEUMONIA

With the shift of patient care from the hospital into the community, there are many patients receiving extensive health care interventions either in their homes or extended care facilities who may develop pneumonia. This has given rise to a relatively new category of pneumonia termed “health care–associated pneumonia” (HCAP). HCAP is a distinct category of pneumonia. It affects a different patient population than CAP, and the causative organisms differ from those seen with CAP. HCAP is seen in nonhospitalized patients who develop pneumonia and meet one or more of the following criteria: residents in a nursing home or other long-term care facility; receiving invasive treatment (eg, intravenous therapy, hemodialysis, wound care, or intravenous chemotherapy) within 30 days of the onset of the infection; hospitalization in an acute care hospital for two or more days within the prior 90 days; and/or attendance at a hospital within the prior 30 days or a respiratory related problem.

Causative Organisms

Various causative organisms are associated with HCAP owing to the broad cross section of patients in this category. Many patients with recent or chronic contact with the health care system may be at an increased risk for infection by multidrug-resistant organisms. The most common (29%) isolated pneumonia pathogen among those with HCAP in one long-term care facility was *Staphylococcus aureus*, while in those with CAP, *Streptococcus pneumonia* was the predominant (14%) organism. Patients receiving dialysis are often colonized with a multidrug-resistant organism. A review of infections over 9 years in a chronic dialysis unit at a single hospital revealed that the most common causative organisms were *Staphylococcus aureus*, specifically methicillin-resistant *Staphylococcus aureus* (MRSA), *Pseudomonas aeruginosa*, *Klebsiella* species, *Enterobacter* species, and *Escherichia coli*. Influenza A is a common cause of viral HCAP, and immunocompromised patients may develop fungal pneumonias. Therefore, the type of organism may depend not only upon the setting from which the patient has come, but also the local patterns of infection and resistance.

Treatment and Empirical Therapy

As with CAP, antibiotics are key to the treatment of HCAP. The challenge arises in the proper selection of antibiotic therapy for HCAP. The 2005 IDSA/ATS guidelines recommend initiation of empirical antibiotics, although they recognize that this might result in some patients being given antibiotics for a noninfectious process. The benefits of early treatment, however, outweigh this risk. For this reason, de-escalation of antibiotics occurs as soon as clinical assessment indicates resolution of infection and/or cultures dictate a different course of antibiotics.
HOSPITAL-ACQUIRED PNEUMONIA AND VENTILATOR-ASSOCIATED PNEUMONIA

Hospital-acquired pneumonia (HAP, or nosocomial pneumonia) is pneumonia that occurs 48 hours or more after admission to the hospital with no indication of its presence at the time of admission. VAP is a type of HAP that develops more than 48 hours after endotracheal intubation. Because only about 10% of patients with HAP are not mechanically ventilated, the terms HAP and VAP are often used interchangeably.\(^{16}\)

VAP is the most common nosocomial infection seen in patients in the ICU. Because patients who develop VAP have an increased length of stay by as much as 9 days, an increased cost of care, and possibly mortality rates, compared to critical care patients who do not develop VAP, prevention of this hospital-acquired infection (HAI) is on the forefront of many critical care clinicians’ minds.\(^{16}\) Critical care nurses play a unique role in the prevention of this HAI, as many of the interventions thought to prevent VAP are part of daily nursing care in the ICU.

**Diagnosis**

According to the CDC guidelines, pneumonia is considered “ventilator associated” if it developed while the patient was intubated and ventilated, or within 48 hours before the onset of the event. There is no minimum amount of time that the ventilator needs to be in place for the pneumonia to be considered ventilator associated. The diagnosis of pneumonia is not a simple one. Diagnosis of VAP can be difficult because several of the clinical indicators are nonspecific, such as fever and elevated or depressed white blood cell count. Purulent sputum is seen not only with pneumonia, but can also be seen with tracheobronchitis. Pulmonary infiltrates are not only present with pneumonia, but can also be associated with atelectasis and acute respiratory distress syndrome.\(^{17}\)

**Types of VAP**

VAP is divided into two types: early and late onset. If the occurs pneumonia between 48 and 96 hours after intubation, it is considered an early-onset VAP. Early-onset VAP is usually caused by antibiotic-sensitive organisms. If the VAP develops 96 hours after intubation, it is considered late onset and the causative organisms are usually antibiotic resistant. This later onset VAP is associated with a higher morbidity and mortality rate than the early-onset form.\(^{1}\)

**Incidence**

VAP is the most frequently occurring hospital acquired infection. In 2010, the institutions that report to the National Healthcare Safety Network, an infection surveillance program of the CDC, reported more than 3500 cases of VAP in the United States.\(^{18}\) This infection causes more deaths than central line infections and can add as much as $40,000 to the cost of a hospital stay.\(^{19}\)

**Causes of VAP**

The key to the development of VAP is the aspiration of colonized, potentially pathogenic bacteria from the upper respiratory tract and the stomach. Normally, there is clearance of mucus (and the particles and organisms it contains) from the respiratory tract via coughing and mucociliary clearance of secretions. But the presence of the inflated cuff on an endotracheal tube or tracheostomy tube impairs these protective mechanisms. The presence of a nasogastric or orogastric tube disrupts the gastroesophageal sphincter. Secretions from the oropharynx as well as
from the stomach (via gastric reflux) collect in the subglottic space above the cuff and are then aspirated. For example, the presence of the cuff protects against macroscopic aspiration, but not against microscopic aspiration.\textsuperscript{20,21} The seriousness of this aspiration is compounded by the colonization of pathogenic organisms in the secretions of the mouth and oropharynx, which occurs in patients in ICUs.\textsuperscript{22,23}

Another contributing factor in the development of VAP is dental plaque, which can be a reservoir for potential respiratory pathogens. It develops in mechanically ventilated patients because of lack of chewing and in the absence of saliva. Other factors associated with the development of VAP include age greater than 60 years, chronic obstructive pulmonary disease, multiorgan system failure, and head trauma.\textsuperscript{24}

**Vap Prevention**

Because VAP is associated with poor outcomes, including increased length of time on a ventilator, cost of care, morbidity, and mortality, research has been conducted to identify interventions that can prevent its development. In 2005, the Institute of Health Care Improvement (IHI) began its “100,000 Lives” campaign to encourage hospitals and health care providers to reduce harm and deaths. Part of this campaign included the prevention of VAP through the implementation of a group (or bundle) of research-based interventions.\textsuperscript{25}

**Components of the VAP bundle**

There are five key components to the IHI VAP bundle: (1) head of bed elevation, (2) sedation vacation, (3) oral decontamination, (4) peptic ulcer prophylaxis, and (5) deep vein thrombosis prophylaxis. Other interventions include subglottic use of endotracheal tubes that allow for constant or intermittent subglottic suctioning and endotracheal tubes that have an antimicrobial coating. The role of nurses in VAP prevention is discussed, addressing the first three interventions.

**Head of bed elevation** Because aspiration has been linked to the development of VAP, patient positioning is an important intervention in VAP prevention. It is recommended that the head of the bed (HOB) be elevated because aspiration may be decreased by semirecumbent positioning, particularly in patients receiving enteral feeds. The literature is clear that the supine positioning should be avoided in patients receiving enteral feedings, but it is less clear as to the optimal angle of elevation.\textsuperscript{26,27} The IHI VAP bundle cites at least a 30° angle. A study using radioactive labeled enteral feedings found that endotracheal readings were higher in patients who were completely supine compared to those whose head of bed was at 45°. Three studies\textsuperscript{28–30} examining positioning all used a maximum HOB elevation of 45°. There is no research, however, describing what the minimal angle of HOB elevation can safely be for the prevention of VAP. Care should be taken with HOB elevation, as there can be skin shearing as a result of the patient sliding down in the bed. This may occur less often if the HOB is at a 30° rather than at a 45° angle. When helping pull the patient up in the bed, utilizing an adequate amount of staff may reduce shearing and will reduce the risk of injury to the ICU staff. Compliance with HOB elevation can be monitored by regular rounding by the charge nurse and educational reinforcement of the importance of elevation. In addition, HOB elevation should be maintained if a patient is transported off of the unit for any reason.

**Sedation vacation** Because the presence of an endotracheal tube predisposes a patient to VAP, the sooner the patient can be weaned from the ventilator the better.\textsuperscript{31}
Oversedation has been shown to increase time on the ventilator and increase ICU stay. Stopping or interrupting the sedation on a daily basis has been shown to reduce these times. The nurse should be present when the sedation is reduced to monitor for ventilator asynchrony and possible oxygen desaturation. Care needs to be taken to monitor the patient during the sedation vacation to avoid the development of agitation and possible self-extubation. It has been shown that those who did not have a sedation vacation had a slightly higher self-extubation rate than those for whom sedation was stopped. In addition, family members visiting during a sedation vacation should be aware of the plan to withdraw sedation and the purpose for doing so. They may be able to provide emotional support to the patient during this period. Once the patient is “lightened up,” assessment of readiness to wean can be done. This means that before the sedation vacation coordination with the personnel managing the ventilator at the time needs to occur.

**Mouth care** In 2010, IHI added the use of chlorhexidine (CHG) for oral decontamination. Mouth care twice daily using a CHG oral rinse was shown to reduce VAP rates in patients who underwent cardiac surgery. Care should be taken to ensure that nurses regularly and correctly. Staff may need to be educated about proper application of the CHG to the oral cavity. Unlike moistening the mouth with water for comfort, the nurse must be sure that the CHG comes in contact with the entire oral cavity. Also, suctioning of excess CHG should be performed to avoid inadvertent aspiration or swallowing of drug.

**Other interventions for VAP prevention**
Other interventions to prevent VAP include strict hand washing; tooth brushing twice daily to reduce plaque formation on teeth; and suctioning the oropharynx, particularly before repositioning the patient, as often the HOB is lowered to turn and reposition.

**NURSING CARE**

**Physical Assessment**
Frequent assessment of breath sounds should be performed to identify any new abnormal sounds as well as to assess improvement of aeration. Clearance of secretions should be facilitated either by encouraging coughing and deep breathing or, if the patient is intubated, performing endotracheal suctioning as needed. Assessment of the character and quality of secretions is also important. Particular attention should be paid to very thick secretions that may result in plugging of the airways. Clinicians should ensure adequate hydration to facilitate clearance of secretions.

**Identification of Complications and Treatment Failure**
Early identification of treatment failure can help ensure that interventions and therapies are modified in a timely manner to address changes in the patient’s condition. Because pneumonia is one of the leading causes of sepsis, vital signs should be monitored with particular attention paid to the early indicators of sepsis (eg, fever, heart rate [HR], etc). Monitoring oxygenation via pulse oximetry should be performed along with the vital signs. Ventilator changes should be made based on changes in oxygenation and ventilation.

**Early Ambulation**
Promoting progressive ambulation is important as well. Research has shown that patients who ambulate regularly have shorter lengths of stay than those who do not.
Early ambulation while still on the ventilator may also help in the reduction of the neuromuscular complications of critical illness.\textsuperscript{35} For those patients unable to ambulate, physical therapy should be instituted, including range-of-motion activities.

**Family Participation**

Family members wishing to participate in care may be educated in proper performance range-of-motion activities, rotation of splints, and mouth care. Participation in care allows family members to feel as though they are supporting the recovery of their loved one. This is particularly true if family members have been caretakers of the patient before admission to the hospital.

**Patient and Family Education**

Another key nursing function is patient and family education. Individuals 50 years or older, those at high risk for influenza complications, and those who have household contact with high-risk individuals should be encouraged to obtain an annual influenza vaccine. The pneumococcal vaccine should be recommended for individuals 65 years of age or older and those with concomitant high risk diseases.\textsuperscript{7} Patient education must include support around smoking cessation strategies so they may be successful in quitting.

**SUMMARY**

CAP, HCAP, and VAP are three distinct types of pneumonia that cause significant morbidity and mortality. Critical care nurses are key members of the health care team in the treatment as well as in the identification and prevention of complications associated with CAP, HCAP, and VAP.

**REFERENCES**