

## PNEUMONIA: A COMPREHENSIVE STUDY

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### ABSTRACT

Pneumonia is classified as either Community-Acquired Pneumonia (CAP) or Hospital-Acquired Pneumonia (HAP), which includes Ventilator-Associated Pneumonia (VAP). Pneumonia is an acute respiratory infection that affects the alveoli and distal bronchi of the lungs. Due to ambiguous diagnostic criteria, aspiration pneumonia—which accounts for 5–15% of CAP cases—continues to be underestimated in HAP. The microbial etiology of HAP and VAP is different from that of CAP; HAP is frequently linked to *Staphylococcus aureus*, which includes MRSA, *Pseudomonas aeruginosa*, and *Acinetobacter* species, while CAP is typically caused by *Streptococcus pneumoniae*, respiratory viruses, and *Haemophiles influenzae*. Because HCAP and HAP share many risk factors, the classification of Healthcare-Associated Pneumonia (HCAP) has lost some of its significance. The CAP disease is explained in handful words so as to understand the overview of CAP. Mild cases of CAP can be managed outpatient, but severe cases (sCAP) necessitate intensive care and may require mechanical ventilation. Although they do not directly quantify pneumonia severity, prognostic measures such as the Pneumonia Severity Index (PSI) aid in outcome prediction. *S. pneumoniae* is the main cause of severe CAP, which frequently results in a high in-hospital mortality rate. In a small percentage of cases, MRSA and *P. aeruginosa* also play a significant role. Recent research emphasizes the growing significance of *Legionella* and viral infections in sCAP, with molecular diagnostics improving pathogen detection. Prolonged mechanical ventilation is followed by ventilator-associated pneumonia (VAP), the most common nosocomial infection in critical care. In this paper VAP and HAP is also described so as to gain attention of readers on the Epidemiology of pneumonia. Early in the hospital stay is when VAP prevalence is highest, and it greatly increases ICU morbidity and mortality. HAP, which is pneumonia that appears 48 hours after admission, is a serious problem for hospitalized patients, especially in intensive care units (ICUs) where it is frequently associated with mechanical ventilation. <sup>(1) (2)</sup>

**Keywords:** - pneumonia, CAP, VAP, HAP, hospitals, patients, epidemiology, virus

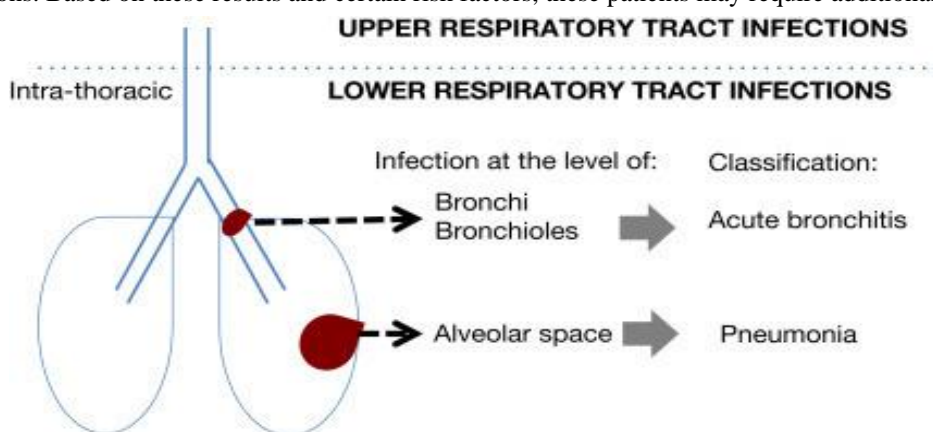
### 1. INTRODUCTION

Pneumonia is a common acute respiratory infection that affects the alveoli and distal bronchi of the lungs. The disease is broadly divided into Community-Acquired Pneumonia (CAP) or Hospital-Acquired Pneumonia (HAP, which includes ventilator-associated pneumonia (VAP)). Aspiration pneumonia accounts for 5-15% of all CAP cases; however, its prevalence among HAP patients is unknown. The lack of robust diagnostic criteria for aspiration pneumonia may explain why the true burden of this type of pneumonia is unknown<sup>1</sup>. The microorganisms that cause CAP and HAP are significantly different. The most common microorganisms that cause CAP are *Streptococcus pneumoniae*, respiratory viruses, *Haemophiles influenzae*, and other bacteria such as *Mycoplasma pneumoniae* and *Legionella pneumophila*. In contrast, the most common microorganisms in HAP are *Staphylococcus aureus* (including both methicillin-susceptible *S. aureus* (MSSA) and methicillin-resistant *S. aureus* (MRSA)), *Enterobacter* ales, non-fermenting Gram-negative bacilli (such as *Pseudomonas aeruginosa*) and *Acinetobacter*. Because of patient risk factors, the microbial etiology of healthcare-associated pneumonia (HCAP) is more similar to that of HAP than that of CAP. However, the difficulty of standardizing risk factors in this population, combined with the heterogeneity of post-hospital care worldwide, suggests that the concept of HCAP is of little use, and HCAP has not been included in recent CAP and HAP guidelines. Differences in the microbiology of CAP and HAP depend on whether the pneumonia is community or healthcare acquired and on host risk factors, including abnormal gastric and oropharyngeal colonization. In addition, the etiopathogenesis of CAP differs from that of HAP. <sup>(3)</sup>

In general, mild CAP is treated as an outpatient, moderate CAP in hospital wards and severe CAP in intensive care units (ICU) with or without mechanical ventilation<sup>6</sup>. The need for mechanical ventilation is used in randomized clinical trials as an interesting predictor and subclassification of stratification. Both CAP<sup>7</sup> and HAP<sup>4</sup> can be present in either immunosuppressed or immunodeficient patients. To date, the majority of research data has been based on studies of immunocompetent patients, and we therefore rely on such sources in this introduction. Still, researchers are interested in CAP, HAP, and VAP in immunocompromised patients, and additional research will likely be conducted in this area. Severe community-acquired pneumonia (sCAP) is the most life-threatening form of community-acquired pneumonia (CAP) characterized by high morbidity and mortality. The most widely accepted criteria for defining sCAP come from the consensus guidelines of the Infectious Diseases Society of America (IDSA) and American Thoracic Society (ATS) for the management of CAP in adults. Individuals in need of intensive care (ICU) are those who meet three of the nine minor criteria, are in need of mechanical ventilation, or require vasopressor assistance in shock. Prognostic assessment

tools such as the Pneumonia Severity Index (PSI) can predict outcome based on CAP, but are not a direct measure of pneumonia severity because they are calculated from both acute and chronic disease variables. Thus, patients with low PSI scores and no comorbidities may require intensive care, while patients with high PSI scores due to chronic disease may not require intensive care. The burden of SCAP was recently demonstrated in a secondary analysis of a prospective population-based cohort study of CAP patients hospitalized in the United States. The authors found that 23% required intensive care, of which 24% required invasive mechanical ventilation and 20% required noninvasive mechanical ventilation (NIMV). The authors reported an ICU incidence of CAP of 145 cases per 100,000 adults per year.<sup>(1)</sup>

The study with a large population of sCAP patients from a single center confirmed a very high in-hospital mortality, especially in those with septic shock and the need for mechanical ventilation (mortality 38%). The most common cause of sCAP is *Streptococcus pneumoniae*. Other non-nuclear CAP pathogens, such as methicillin-resistant *Staphylococcus aureus* (MRSA), *Pseudomonas aeruginosa*, and other Gram-negative bacteria, cause a variable proportion of sCAP. Viruses are probably more common pathogens than previously recognized. The actual percentage of causative viruses in sCAP will be determined by new studies using molecular PCR platforms. *Legionella pneumophila* is another pathogen commonly seen in sCAP. The specific recommendations of SCAP are included in the general guidelines of CAP. Many patients with sCAP fall into the category of immunocompromised hosts due to immunosuppressive disease or treatment and these patients require aggressive diagnostic testing to identify potential pathogens not commonly seen in traditional sCAP populations. Based on these results and certain risk factors, these patients may require additional treatment.



### SYMPTOMS OF PNEUMONIA

Pneumonia can present with mild to severe signs and symptoms, contingent on the type of germ that caused the illness, your age, and general health. Even if they last longer, minor symptoms and indications are sometimes mistaken for cold or flu symptoms.

Pneumonia symptoms and indicators could include:

1. chest pain while inhalation or coughing
2. Perplexity or shifts in consciousness (in adults 65 years of age and above)
3. cough that could result in phlegm
4. Weary
5. fever, perspiration, and chills that shake
6. lower than average body temperature (in persons with weakened immune systems and adults over 65)
7. diarrhea, vomiting, or nausea
8. Breathlessness

### Epidemiology

#### 1. VAP (ventilator-associated pneumonia)

New pneumonia that appears 48 hours after endotracheal intubation is called ventilator-associated pneumonia (VAP), the most prevalent and deadly nosocomial infection in critical care. Importantly, patients might have already undergone the procedure by the time VAP manifests.

Bacterial pneumonia that develops in individuals who have been on mechanical ventilation for longer than 48 hours is known as ventilator-associated pneumonia (VAP). It falls between 6 to 52%, and under some conditions, it can even reach 76%. Pneumonia that develops 48 hours or more after admission and did not appear to be incubating at the time of admission is known as hospital-acquired pneumonia (HAP). In addition to adding to the hospital's financial burden, the presence of HAP lengthens hospital stays by an average of 7 to 9 days for each patient. Early in a hospital stay, the

risk of ventilator-associated pneumonia (VAP) is highest. It is estimated to be 3% per day during the first five days of ventilation, 2% per day between days 5–10, and 1% per day thereafter.

Adults worldwide experience 5 to 10 occurrences of VAP for every 1,000 hospital admissions each year, while 10–25% of all patients requiring mechanical ventilation suffer from VAP<sup>3</sup>. After urinary tract infections, HAP is the second most common infection in hospitals, and VAP is the most common cause of nosocomial infection and ICU mortality<sup>3,4</sup>. Elderly, post-surgical, and immunocompromised patients had the highest incidence of HAP<sup>20</sup>. The incidence of non-ventilator-associated HAP is estimated to be 3.63 instances per 10,000 patient dies in the world, while the incidence of VAP is expected to vary from 2 to 6 cases per 1,000 ventilator-days<sup>21(7)</sup>.

## 2. HAP (Hospital-Acquired Pneumonia)

HAP is defined as a new pneumonia in nonincubated patients that appears more than 48 hours after admission and is characterized by a lower respiratory tract infection confirmed by the development of a new pulmonary infiltrate on imaging. One of the most common and serious medical consequences for patients admitted to intensive care units is hospital-acquired pneumonia (HAP). It generally manifests in relation to mechanical ventilation and invasive airway treatment.<sup>(7)</sup>

HAP, or lung parenchyma infection, appears 48 hours after hospital admission. HAP is a significant contributor to hospitalized patients' mortality, morbidity, and resource use, especially in the case of individuals with serious underlying medical illnesses receiving ICU care.

Urinary tract infections (UTIs) are the most common infection in hospitals, but HAP is still the second most common illness and has a significant impact on both the medical and financial fronts. Furthermore, it's important to note that patients requiring mechanical ventilation have a ten-fold increased risk of acquiring HAP, despite the fact that the frequency of this syndrome is higher in non-ventilated patients.

Treatment-related and patient-related factors can be used to group factors that raise the risk of HAP (Table 1). The principal mechanism responsible for HAP is oropharyngeal colonization. On the other hand, oropharyngeal colonization—which might be present at ICU admission or develop throughout an ICU stay—has received a lot of attention in critically sick patients<sup>53</sup>. According to a Japanese study, 38% of residents in long-term care institutions had oral colonization by antibiotic-resistant bacteria, primarily *Acinetobacter* spp., *Enterobacter* ales, and *Pseudomonas* spp. The possibility of pneumonia<sup>54</sup> exists when these infections are present. In fact, according to recent international guidelines, patients who have a higher risk of HAP as a result of antibiotic-resistant organisms should have their prior colonization by these pathogens taken into account.<sup>(5)</sup>

In the majority of patients, colonization and biofilm formation appeared within 12 hours of intubation and persisted for more than 96 hours<sup>55</sup>. The study also demonstrated that colonization in patients receiving mechanical ventilation occurred in the oropharynx and stomach initially, followed by the lower respiratory tract and, finally, the endotracheal tube<sup>55</sup>. These findings support a significant link between intubation and VAP etiology. The chance of getting HAP can increase six to twenty-one times with intubation and mechanical breathing, peaking within the first five days of intubation<sup>53</sup>. Endotracheal tubes act as a reservoir for harmful microbes, allow bacteria to enter the lower respiratory system directly, and disrupt the host's natural defense mechanisms.

## 3. CAP (Community-Acquired Pneumonia)

There are several ways that infectious pathogens enter the lower respiratory tract: by inhaling aerosolized material, by aspirating microorganisms found in oral secretions, and, less frequently, by hematogenous seeding to the lungs. An immune system that is still functioning normally can deal with these breaches. The purpose of the upper airways is to filter out inhaled microorganisms through ciliated epithelium and mucous-producing cells, and to trap them in the form of nose hairs and turbinate. Local host defense is significantly influenced by the bacterial interference caused by the resident flora and the local production of complement. Although secretory IgA is a rather weak opsonin, it has antiviral and antibacterial properties.<sup>(8)</sup>

Antibiotic-resistant gram-negative bacteria (such *P. aeruginosa* and *Klebsiella pneumoniae*) and MRSA are the main causes of CAP<sup>2,66</sup>. Clinical managers must identify risk factors for these diseases and start appropriate empirical medication in response, as antibiotic resistance complicates clinical management (Box 3). Immunosuppression, past antibiotic usage, prior hospitalization, use of gastric acid-suppressing medications, tube feeding, and non-ambulatory status<sup>67</sup> are the key risk factors for multidrug-resistant (MDR) infections in CAP. Antibiotic-resistant pathogen infection risk can be assessed using a variety of scoring methods.

## Diagnosis of HAP/CAP/VAP

As of right now, HAP/VAP lacks a widely acknowledged or recorded gold standard diagnostic criterion. Many clinical and paraclinical techniques have been investigated throughout time to diagnose hospital-acquired pneumonia and its

subtypes, but none of them have been able to meet the necessary requirements for both specificity and sensitivity. Furthermore, the literature review and, more crucially, the patient's outcome are significantly impacted by the low diagnostic accuracy of the tests used by clinicians to identify VAP.

Due to a lack of available diagnostic tests and a wide differential diagnosis for patients exhibiting rising oxygen requirements, leukocytosis, and secretions while in the intensive care unit (ICU), HAP and VAP can be difficult to diagnose early. A productive cough and fevers, or a deterioration in breathing after an aspiration event that was either observed or suspected in the hospital, may indicate the development of pneumonia. The IDSA/ATS guidelines recommend utilizing clinical criteria alone for the management of HAP and VAP, while scoring systems like the Clinical Pulmonary Infection Score are utilized to guide the management of community-acquired pneumonia. When a patient exhibits clinical signs of infection along with a new or developing radiologic infiltrate, the diagnosis of HAP/VAP/HCAP is suspected. Clinical signs and symptoms include purulent sputum, leukocytosis, sudden start of fever, and increased oxygenation needs.

The patient has a fever and a productive cough, which makes the diagnosis of HAP/VAP/HCAP difficult to make on clinical grounds alone. For HAP and VAP, there is a high sensitivity but a low specificity when using the diagnostic criteria of a radiologic infiltrate and at least one clinical sign (such as fever, leukocytosis, or purulent tracheal secretions). The specificity is increased when indications and symptoms are combined. It is quite possible that hospitalized patients—including those on ventilation—have upper respiratory tract colonization. Although infection comes before colonization, tracheal aspirate cultures should be routinely monitored. <sup>(10)</sup>

## 2. CONCLUSION

Pneumonia is a very frequent and deadly illness, and despite a wealth of published data indicating that clinicians are not very accurate when using radiological gold standards to diagnose the condition, the diagnosis is still difficult. Furthermore, CT studies that indicate up to 40% of cases may be misinterpreted as pneumonia or not are challenging the gold standards of traditional chest radiography. <sup>(3)</sup>

Antibiotics and vaccinations against major respiratory pathogens are readily available, yet community-acquired pneumonia (CAP) is still a serious and rising medical issue in the industrialized world, with a high rate of complications and fatality. Future results could be enhanced by routinely using biomarkers to enhance risk stratification, customize care for specific patients, and potentially modulate inflammation linked to CAP. More basic research on host-microbial interactions in the lung is needed in addition to clinical trials of various management and prevention medications. This will help clinicians completely understand why CAP develops and will facilitate the development of novel therapeutic techniques. <sup>(7)</sup>

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