CHAPTER 2

Definition and pathophysiology of hospital-acquired pneumonia

The committee for The Japanese Respiratory Society guidelines in management of respiratory infections

The Japanese Respiratory Society

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DEFINITION

Hospital-acquired pneumonia (HAP), or nosocomial pneumonia (NP) has been defined\(^1,2\) as pneumonia that develops 48 h or more after admission to a hospital and does not include pneumonia that a patient had contracted when admitted or before being admitted. However, care should be exercised in diagnosing pneumonia caused by *Legionella pneumophila* as HAP if the patient develops it within nine days after admission, because its latency period is relatively long (i.e., between two and 10 days).\(^3\)

Patients with community-acquired pneumonia (CAP) experience such symptoms as fever, cough, sputum, and chest pain, and their chest X-rays reveal ‘infiltration’ (abnormal shadowing). Patients are diagnosed with pneumonia clinically on the basis of their symptoms (such as fever, cough, sputum, and chest pain) and their chest X-ray findings. A raised CRP, leukocytosis, and raised erythrocyte sedimentation rate (ESR) assist to confirm the diagnosis of pneumonia. If the causative bacteria are isolated and identified, the diagnosis of pneumonia is definitive.

In contrast, it is difficult to make the diagnosis of HAP, and no gold standard is available because patients often exhibit symptoms of their underlying disease that mask the symptoms and signs of pneumonia. It is also often difficult to perform diagnostic imaging (such as chest X-ray or chest CT) or to acquire appropriate images, while laboratory results attributable to the underlying disease occasionally interfere with or obscure those of HAP. We have no choice without making the diagnosis of HAP based on the diagnostic criteria for ordinary pneumonia. The diagnosis of HAP can be made on the basis of an overall assessment. Clinically speaking, it is important to institute proper treatment promptly whenever pneumonia is suspected. However, the diagnosis of HAP must be made in accordance with certain diagnostic criteria, if research results are going to be publicized or statistical data are being compiled. If so, we propose criteria for the diagnosis outlined in Table 1.

Patients with a variety of underlying disorders are admitted to hospitals, and many of these disorders increase the patients’ susceptibility to infection. They are especially susceptible to pneumonia, which accounts for the high prevalence of HAP among inpatients. However, HAP does not always involve hospitalized patients, and may, for example, involve hospital employees (such as health care workers, including physicians and nurses), hospital visitors (such as patients’ family members and friends), and medical students who are in a hospital at least temporarily. When such persons develop pneumonia, it is classified as HAP as long as there is a definitive causal relationship between the hospital environment and the pneumonia.\(^4\) Thus, it is incorrect to restrict the term HAP to inpatients only. In other words, HAP refers to pneumonia that has occurred as a result of being in the hospital environment, regardless of the person affected. In this guideline, however, we describe ‘pneumonia that inpatients develop’ in accordance with the conventional classification of pneumonia.

The definition and aetiology of HAP are illustrated schematically in Figure 1. Factors contributing to contracting HAP are basically classified into three categories: (i) inhalation; (ii) aspiration; and (iii) bacterial translocation. Patients develop HAP as a result of aspiration (aspiration-pneumonia), inhalation of contaminated aerosols, or bacterial translocation primarily via the intestinal tract.\(^3\) In terms of the incidence of HAP, the first two categories play an important role in the aetiology of HAP.

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PATHOPHYSIOLOGY

The incidence of HAP is the second highest among hospital-acquired infections, and HAP is the number one cause of death among inpatients who develop a hospital-acquired infection. The pathophysiology of HAP is outlined in Table 2. These aetiological factors help us to design strategies to prevent HAP.

Susceptibility of the host to infection

In patients who have organic disorder of the respiratory system, and local impairment of immunity, *Haemophilus influenzae* and *Streptococcus pneumoniae* tend to grow as a result of retention of secretions in the respiratory tract. Isolated bacteria strains from these patients are frequently resistant to antibacterial agents, because of a past history of frequent use of antibacterial agents.

Systemic factors (susceptibility of the host to infection) include cellular immunosuppression and neutropenia. There are some differences in the frequency of causative microorganisms according to these systemic factors. Among patients with cellular immunosuppression, pneumonia is usually caused by fungi (*Cryptococcus* and *Candida*), protozoa (*Pneumocystis carinii*), viruses (Cytomegalovirus), *Legionella*, and *Mycobacterium tuberculosis*. Pneumonia is usually caused by bacteria (*Staphylococcus*, *enterobacteria*, *Pseudomonas aeruginosa*, etc.) and fungi (*Candida* and *Aspergillus*) among patients with neutropenia.

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**Table 1** Criteria for diagnosis of hospital-acquired pneumonia (HAP) in adults

A new or progressive infiltration shadow is seen on a chest X-ray at 48 h or more after admission and one or more of the conditions listed below is fulfilled

- Corresponding symptoms (fever, chest pain, etc.) or laboratory data (increases in CRP, WBC count, and ESR)
- Isolation of the causative organism from sputum*, blood, bronchoscopic bronchoalveolar lavage (BAL), bronchoscopic protected specimen brush (PSB), or biopsy specimens
- Isolation or detection of a virus or viral antigen from airway secretions. (The possibility of mixed infection should be considered.)
- A four fold or greater increase in serum antibody titre or an increase in IgM antibody. (The possibility of mixed infection should be considered.)
- Histopathological findings of pneumonia. (* When an organism isolated from sputum is considered the causative organism of that particular case of pneumonia.)

Early diagnosis of pulmonary tuberculosis is important to hospital-acquired infection of *M. tuberculosis*. HAP is necessary to be made differential diagnosis from obstructive pneumonia, atelectasis, lung cancer, or other diseases.

![Figure 1 Pathogenic factors and definition of hospital-acquired pneumonia.](image-url)
Definition and pathophysiology of hospital-acquired pneumonia

**Table 2** Aetiology of hospital-acquired pneumonia: pathophysiology

<table>
<thead>
<tr>
<th>Susceptibility of the host to infection</th>
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<tr>
<td>Local factors: underlying respiratory diseases such as bronchiectasis, pulmonary emphysema and sequelae of pulmonary tuberculosis</td>
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<tr>
<td>Systemic factors: such as cellular immunosuppression and neutropenia</td>
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**Excessive invasion by microorganisms**

Host factors: aspiration (dysphagia), and bacterial translocation

Factors associated with the use of a medical device: inhalation (contaminated respirator or nebuliser), injection (bacterial invasion via any of a variety of catheters)

**Environmental factors**

Crossover infection (patients and health care workers), infection via a water-supply system (*Legionella*), and population exposures to infection

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**Excessive invasion by microorganisms**

The incidence of pneumonia is higher when the respiratory system is invaded by excessive numbers of microorganisms. Host major factors are dysphagia (i.e. dysphagia among the elderly, central nervous system disorders, destruction of gastric acid barriers by antacids, and a decreased cough reflex due to sedation while on a respirator), systemic factors (i.e. intestinal mucosal injury due to use of antitumor agents), and bacterial translocation due to neutropenia. Other factors are associated with contamination of medical devices (respiratory: contaminated respirators, nebulisers for inhalation; systemic: contaminated intravenous lines and a variety of catheters), as well as destruction of mucosal defense systems due to intubation of a catheter. Thus, a variety of factors (mentioned above) are primarily responsible for the etiology of HAP.

**Environmental factors**

Inpatients may get infections from other inpatients, health care workers, such as nurses and physicians, or via the water-supply system in the hospital (by taking a shower, etc.). Many patients have HAP caused by the same bacteria, if the humidifiers and therapeutic nebulisers commonly used in hospitals are contaminated.

Hospital environments, which may be contaminated by MRSA, *Pseudomonas aeruginosa*, other non-glucose-fermenting bacteria, and enterobacteria via patients’ lesions and discharges (such as sputum, urine, and stools) or a variety of medical devices, result in group-infections. When the hospital environment becomes contaminated, not only inpatients but also health care workers (such as physicians and nurses) are at risk of infection. The bacteria are often highly resistant to antibacterial agents and resistant to all forms of treatment. Care should be exercised in the management of patients with immunosuppression (i.e. patients whose host defense system is very weak), because the above bacteria may be brought in from outside by physicians, nurses, visitors, animals, insects, plants, and with food-products.

**REFERENCES**