# Findings of lung infections using chest computed tomography in immunocompromised patients with respiratory illnesses

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**ABSTRACT**

In immunocompromised individuals, one of the most common reasons for a high mortality rate is respiratory infections and the problems that can follow them. Although chest radiographs and computed tomography are the diagnostic tools that are most commonly used for the early diagnosis of lung manifestations of infections, they lack the specificity for the wide range of chest infections that can occur in immunocompromised patients. Despite this, chest radiographs and computed tomography are commonly used. It is possible to speed up the process of early and accurate diagnosis in order to facilitate the subsequent implementation of the appropriate management strategy by performing a systematic analysis of the imaging findings in correlation with the clinical settings as well as a comparison with the older images. The findings of computed tomography exams performed on immunocompromised individuals who suffered from respiratory infections will be presented here in relation to a variety of clinical contexts.

**Keywords:** Chest infection; Pneumonia; Immunocompromised patient; AIDS; Cancer drugs; Computed tomography.

## INTRODUCTION

In immunocompromised hosts (ICH), which include patients undergoing chemotherapy treatment (for cancer), receiving immunosuppressive therapy (post-transplantation patients, patients with rheumatologic disorders), or suffering from acquired immunodeficiency diseases (AIDS, post-splenectomy), infections are very common. The population of immunocompromised hosts is growing worldwide.

Pneumonitis refers to inflammation of the lungs and can develop in an immunocompromised patient (ICP) as a result of the advancement of the underlying disease, the presence of infections, or as a secondary effect of non-infectious causes such as drug-induced toxicities [1-5,21]. Pneumonia is the medical term for inflammations of the lungs that are caused by infections. Because of the underlying noninfectious inflammatory disease of the lung, which further weakens the immune system of the body, the infection that occurs in ICH can either be primary or secondary in nature.

In more than two thirds of the ICPs, respiratory infections are among the most significant issues. Drug toxicity is another prominent issue. These are the principal reasons of therapy failure of the underlying diseases, and they frequently pose a risk to the patient's life. Additionally, they are

associated with significant mortality and morbidity rates. As a result, a diagnosis that is precise and accomplished in a short amount of time is an essential component of the management team.

**CLASSIFICATIONS OF PNEUMONIA**

Community-acquired pneumonia (also known as nosocomial pneumonia, HAP), hospital-acquired pneumonia (also known as nosocomial pneumonia, VAP), and ventilator-associated pneumonia (CAP) are the three subtypes of pneumonia that can be distinguished from one another based on the manner in which the infection was acquired. On the basis of clinical characteristics and scoring systems like the Pneumonia Severity Index (PSI) or the CURB-65 [6, pneumonia can be further classified as mild, moderate, or severe. These scientifically proven scoring systems offer assistance to medical practitioners in the process of determining the clinical outcomes.

A further approach of classifying patients separates them into groups that are either typical or atypical, depending on the clinical presentations, and the predicted pathogens differ in accordance with these groupings. A patient is deemed to have typical pneumonia if they exhibit with traditional symptoms such as fever, rigours, chills, cough with expectoration, chest discomfort, and dyspnea, and if their chest radiography findings are suggestive of common bacterial infections. On the other hand, atypical pneumonia typically manifests itself as a persistent low-grade fever without the other symptoms and indications that are characteristic of pneumonia. The etiologic pathogen could be a bacterium, virus, fungus, or any other opportunistic organism. All of these are possibilities.

**RADIOLOGICAL PATTERNS OF PNEUMONIA**

Imaging patterns are used to categorise pneumonia into lobar pneumonia, bronchopneumonia, and interstitial or atypical pneumonia. Lobar pneumonia is the most common kind of pneumonia. In most cases, bacteria are to blame for lobar and bronchopneumonia. On the other hand, viruses, parasites, and fungi are more likely to be the causative agents of interstitial pneumonia. On the other hand, one must never forget to take into account overlapping imaging features.

**Lobar pneumonia:** On a chest x-ray, lobar pneumonia appears as a homogenous consolidation with an air bronchogram involving either one or, less frequently, many lobes. Consolidation of one or more segments of a lobe is characteristic of segmental pneumonia. In rare cases, segmental pneumonia can appear as round pneumonia, which mimics the appearance of a lung tumour. The presence of both frank consolidation and an air bronchogram has been linked to a greater risk of bacteremia.

**Bronchopneumonia:** On a radiograph, bronchopneumonia can be recognised by its patchy appearance, which is characterised by peri-bronchial thickening and poorly defined air-space opacities. Bronchopneumonia is also known as multifocal pneumonia or lobular pneumonia. Consolidation of the pulmonary bronchioles and alveoli can lead to the development of centrilobular nodular opacities or air-space nodules as the severity of the sickness increases. The consolidation might advance further and eventually combine into a lobular or lobar pattern of involvement. This might happen. In most cases, an air bronchogram will not

be present. The infectious agents that are known to be responsible for this pattern of pneumonia are extremely damaging.

As a result, you run the risk of developing abscesses, pneumatoceles, and pulmonary gangrene. In terms of its aetiology, bronchopneumonia can be traced back to inflammation of the major airways (bronchitis), which can manifest as either patchy or lobular involvement.

**Interstitial pneumonia:** Focal and diffuse kinds are both included in the diagnostic criteria for interstitial pneumonia. The radiological appearance is due to edoema and an inflammatory cellular infiltration that has occurred in the interstitial tissue of the lung. The pathological development of interstitial pneumonia can generally take either of two forms:

(1) An insidious infectious course that results in lymphatic infiltration of alveolar septa without parenchymal abnormality; or

(2) An acute or rapidly progressive disease that results in diffuse alveolar damage that affects the interstitial and air spaces. This disease presents itself radiographically as a reticular or reticulo-nodular pattern.

## IMPORTANCE OF CLINICAL INFORMATION IN RADIOLOGICAL INTERPRETATION

CXR is a vital tool for the quick diagnosis of lung abnormalities, and it also has the potential to assist in the monitoring of the patient's response to treatment. On the other hand, it does not have a high level of specificity and frequently fails to identify early and subtle indications of lung infections. Computed tomography (CT) of the chest has become a mainstay tool for detecting early lung immunosuppressive drugs combined with Histamine 2 receptor blockers that reduce gastric acidity. This, in turn, leads to increased colonisation by gramme negative bacilli, such as Pseudomonas, Klebsiella, E. coli, and Acinetobacter. CT of the chest has become a mainstay tool for detecting early lung immunosuppressive drugs. Legionella and gram-negative infections have been linked to ventilation systems as well as central air conditioning and heating systems. In vulnerable hosts, the risk of S. aureus, P. aeruginosa, and Candida is increased when catheterization and drainage procedures are performed.

The specific pathogen is also determined to a greater extent by the sort of immunological deficiency that is present. Defects in the complement system can lead to infections caused by bacteria that are extracellular or encapsulated. The lack of phagocytosis is most commonly related with illnesses caused by bacteria and fungi. ICH patients who have a humoral immune deficit are at an increased risk of contracting encapsulated bacterial infections, such as those caused by S. aureus, S. pneumoniae, H. influenza, and PJP. On the other hand, people who have cell-mediated immunodeficiency or T-cell defects, either because of an underlying primary disease or secondarily due to viral infections like CMV or Epstein-Barr virus, have a much increased risk of developing opportunistic infections. Pathogenic agents are identified in patients with AIDS based on the CD4 cell count, which indicates whether the count is below 100 (indicating viral and fungal infections) or above 100. (PCP and Mycobacterium). Immune Defects brought on by Splenectomy or hypo-splenismp make a person more susceptible to infection with encapsulated pathogens such as S. pneumoniae, H. influenza, and S. aureus [13–15].

**EVALUATION OF THE RADIOLOGICAL FINDINGS IN RESPIRATORY INFECTIONS**

Whenever it is clinically necessary to do so, the radiological diagnosis should be validated by further specialised laboratory tests such as polymerase chain reactions (PCR), serology, immunoassays (ELISA), and the galactomannan test. Bronchoscopy combined with broncho-alveolar lavage is an effective method for detecting and confirming the presence of PCP, Candida, and other infections. The ability to correctly interpret abnormal radiological findings can be hindered by a number of variables, including a lack of sufficient clinical information and an inability to get previous radiological imaging for comparison. In addition, the correct evaluation of radiological changes is made more difficult by the overlapping imaging characteristics of various organisms, the lack of experience of the radiologist, the presence of subtle findings that are challenging to correlate, and the presence of co-morbidities (such as congestive heart failure, cor pulmonale, radiation-induced changes, and so on). As a result, it is recommended that one approach the radiological diagnostic in a manner that is both comprehensive and holistic. When it comes to the early diagnosis of respiratory infections, the CXR and chest CT are the diagnostic instruments of choice. The evaluation of complications such as pneumothorax and thoracocentesis can both benefit from the use of chest ultrasonography, which is also helpful when assessing the presence of para-pneumonic effusions. When a normal chest x-ray cannot be interpreted properly or does not provide enough information, the non-enhanced CT chest is the test of choice. There are specific radiographic characteristics that are suggestive of pneumonia, and the presence of certain "special imaging signals" can help to definitively establish the diagnosis [9].

**Consolidation:** On CXR and CT scans, consolidation is the most prevalent finding and also the one that is easiest to interpret. It is typically caused by bacteria and is characterised by the opacification of the air spaces that it occupies as its primary symptom. When the walls of the bronchioles are effaced by the surrounding consolidation, air tracks, also known as bronchioles, can be seen. This is a reliable indicator of a lung infection and is referred to as the air bronchogram sign. Other medical diseases, such as non-obstructive atelectasis, neoplasia, aspiration, and organising pneumonia, can also exhibit focal consolidation in the lungs.

**Silhouette sign:** Another indicator that is particularly helpful in spotting the minor changes that come with a chest infection is the silhouette sign. The blurring of the regular air interfaces of the thorax is the defining characteristic of this indication. This sign is best exhibited in the areas of the thoracic aperture, thoracic wall, para-mediastinal gaps, and pericardiac spaces. In addition to that, it can be observed in lesions that take up space, atelectasis, and localised effusions. When a cavitating or non-cavitating nodule is connected with a pulmonary vessel, a feeding vessel sign is seen on a CT scan [10]. This feeding vessel sign is a highly valuable indicator of septic emboli.

**Air fluid level sign:** The air fluid level sign is most commonly brought on by S. aureus and Klebsiella infections, both of which are associated with abscess and empyema. On a CT scan with contrast, the wall of this cavitation can show an enhancement in a homogeneous manner. Empyema is commonly suspected when a chest wall or

fissure-based focal opacity is present; this finding is also known as the split pleural sign. It is also possible to show it with an example of a hemothorax, pleurodesis, or post-lobectomy condition.

## PRACTICAL APPROACH

According to what was stated before, it is not always simple to identify a particular bacteria as the root cause of the pneumonia based solely on the outcomes of the imaging tests. In addition, preexisting pulmonary lung abnormalities, cardiac insufficiency, atelectasis, and pleural effusions have the potential to obscure the new changes that are the direct result of the active infection. Pneumonia with frank lobar consolidations are becoming less common as a result of the regular follow-up schedule of our ICPs (which is common in many western nations) rare in modern times; very seldom done. Patchy, segmental, or nonsegmental consolidations are the typical radiological picture of typical bacterial pneumonia in the event of ICH with an initial onset of fever. Nonsegmental consolidations are the least common type.

## INFECTION MIMICS

It is essential and of the utmost significance for radiologists to be aware of lung alterations, particularly those that may be mistaken for lung infections. Several other illnesses, such as cardiogenic disorders, cryptogenic organising pneumonia (COP), progressive cancer disease with lymphangitis, and chemotherapy-associated lung alterations are the culprits behind these. Recognizing the pertinent findings, connecting them with the clinical findings, and determining the appropriate course of treatment can therefore give a full differential diagnosis and, as a result, play an essential role in the care of the patient.

Infiltrates (interstitial, alveolar, or both), pulmonary edoema, and hypersensitivity pattern and alterations owing to cardiotoxic CHF are some of the ways that the influence of medication toxicities might show up on the lung. It's possible that these observations are merely coincidental and asymptomatic, or they could reveal themselves as increasing dyspnea. Neutropenia and fever are two side effects that have been linked to the use of some of the more recent pharmaceuticals [20].

It is fairly uncommon for chemotherapy to generate patchy pneumonitis, and this should be taken into consideration as part of the differential diagnosis when dealing with lung parenchymal alterations [21]. These are the modifications that are expected to occur in the later phases of the chemotherapy regimen.

Paclitaxel and anti-EGFR medicines, on the other hand, might show the same alterations in the earlier cycles of chemotherapy. Numerous cytotoxic medicines, as well as novel therapies, might demonstrate GGO and consolidation (mTOR antagonists, such as Everolimus, Temsirolimus, or Bleomycin), or a picture that resembles COP. Some medications, such as gemcitabine, have the potential to produce capillary leakage syndrome, and a select few compounds have the potential to cause interstitial alterations in patients with heart failure (Doxorubicin).

## CONCLUSIONS

A particularly sensitive radiological method for detecting the early indications of respiratory infections in sick ICPs is the CT chest examination. A complete strategy that takes into consideration the clinical situation, previous infections, and treatment

history can considerably increase the specificity of the interpretation. This improvement can be achieved by taking into account all of the relevant factors. When performed correctly, a CT scan is an extremely helpful instrument for the early detection and differential diagnosis of lung infections in ICPs, and consequently for the subsequent reduction in morbidity and mortality among especially vulnerable patients.

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