15.14C: Pneumocystis Pneumonia

Pneumocystis pneumonia (PCP) or pneumocystosis is a form of pneumonia, caused by the yeast-like fungus Pneumocystis jirovecii.

Learning Objectives

- Review the symptoms associated with pneumocystis pneumonia and the methods of diagnosis

Key Points

- Pneumocystis jirovecii is a pathogen that is specific to humans.
- Pneumocystis is commonly found in the lungs of healthy people, but, being a source of opportunistic infection, it can cause a lung infection in people with a weak immune system.
- Symptoms of PCP include fever, non-productive cough, shortness of breath, weight loss, and night sweats.

Key Terms

- Pneumocystis pneumonia: Pneumocystis pneumonia (PCP) or pneumocystosis is a form of pneumonia, caused by the yeast-like fungus Pneumocystis jirovecii. This pathogen is specific to humans; it has not been shown to infect other animals.
- Opportunistic: An opportunistic infection is an infection caused by pathogens, particularly opportunistic pathogens—those that take advantage of certain situations—such as bacterial, viral, fungal or protozoan infections that usually do not cause disease in a healthy host, one with a healthy immune system. A compromised immune system, however, presents an “opportunity” for the pathogen to infect.
Symptoms: A symptom is a departure from normal function or feeling which is noticed by a patient, indicating the presence of disease or abnormality. A symptom is subjective, observed by the patient, and cannot be measured directly.

Pneumocystis pneumonia (PCP) or pneumocystosis is a form of pneumonia, caused by the yeast-like fungus (which had previously been erroneously classified as a protozoan) Pneumocystis jirovecii. This pathogen is specific to humans; it has not been shown to infect other animals. Other species of Pneumocystis that parasitize other animals have not been shown to infect humans.

Figure: Pneumocystis jirovecii pneumonia: Pneumocystis jirovecii cysts from bronchoalveolar lavage, stained with Toluidin blue O stain

Pneumocystis is commonly found in the lungs of healthy people, but being a source of opportunistic infection, it can cause a lung infection in people with a weak immune system. Pneumocystis pneumonia is especially seen in people with cancer, HIV/AIDS and the use of medications that affect the immune system.

Nomenclature of Pneumocystis Pneumonia

The older name Pneumocystis carinii (which now only applies to the Pneumocystis species that is found in rats), is still in common usage. As a result, Pneumocystis pneumonia (PCP) is also known as Pneumocystis jirovecii pneumonia and (incorrectly) as Pneumocystis carinii pneumonia.

Regarding nomenclature, when the name of Pneumocystis pneumonia changed from P. carinii pneumonia to P. jirovecii pneumonia, it was at first felt that it could no longer be referred to as “PCP”. However, because the term PCP was already in common usage, it was rationalized that the term PCP could continue to be used, as it stood for PneumoCystis (jirovecii) Pneumonia.

Symptoms of Pneumocystis Pneumonia

Symptoms of PCP include fever, non-productive cough (because sputum is too viscous to become productive), shortness of breath (especially on exertion), weight loss, and night sweats. There is usually not a large amount of sputum with PCP unless the patient has an additional bacterial infection. The fungus can invade other visceral organs (such as the liver, spleen, and kidney), but only in a minority of cases.

Pneumothorax is a well-known complication of PCP. An acute history of chest pain with breathlessness and diminished
breath sounds is typical of pneumothorax.

The risk of pneumonia due to Pneumocystis jirovecii increases when CD4 positive cell levels are less than 200 cells/μl. In these immunosuppressed individuals the manifestations of the infection are highly variable. The disease attacks the interstitial, fibrous tissue of the lungs, with marked thickening of the alveolar septa and alveoli, leading to significant hypoxia which can be fatal if not treated aggressively. In this situation LDH levels increase and gas exchange is compromised. Oxygen is less able to diffuse into the blood, leading to hypoxia. Hypoxia, along with high arterial carbon dioxide (CO₂) levels, stimulates hyper-ventilatory effort, thereby causing dyspnea (breathlessness).

---

Diagnosis and Treatment of Pneumocystis Pneumonia

The diagnosis can be confirmed by the characteristic appearance of the chest x-ray, which shows widespread pulmonary infiltrates, and an arterial oxygen level (PaO₂) that is strikingly lower than would be expected from symptoms. Gallium 67 scans are also used in the diagnosis. They are abnormal in approximately 90% of cases and are often positive before the chest x-ray becomes abnormal. The diagnosis can be definitively confirmed by histological identification of the causative organism in sputum or bronchio-alveolar lavage (lung rinse). Staining with toluidine blue, silver stain, periodic-acid schiff stain, or an immunofluorescence assay will show the characteristic cysts. The cysts resemble crushed ping-pong balls and are present in aggregates of 2 to 8 (and not to be confused with Histoplasma or Cryptococcus, which typically do not form aggregates of spores or cells). A lung biopsy would show thickened alveolar septa with fluffy eosinophilic exudate in the alveoli. Both the thickened septa and the fluffy exudate contribute to dysfunctional diffusion capacity which is characteristic of this pneumonia.

Pneumocystis infection can also be diagnosed by immunofluorescent or histochemical staining of the specimen, and more recently by molecular analysis of polymerase chain reaction products comparing DNA samples. Notably, simple molecular detection of Pneumocystis jirovecii in lung fluids does not mean that a person has Pneumocystis pneumonia or infection by HIV. The fungus appears to be present in healthy individuals in the general population.

Antipneumocystic medication is used with concomitant steroids in order to avoid inflammation, which causes an exacerbation of symptoms about four days after treatment begins if steroids are not used. By far the most commonly used medication is trimethoprim-sulfamethoxazole, but some patients are unable to tolerate this treatment due to allergies. Other medications that are used, alone or in combination, include pentamidine, trimetrexate, dapsone, atovaquone, primaquine, pafuramidine maleate (under investigation), and clindamycin. Treatment is usually for a period of about 21 days. However, pneumocystis pneumonia can be prevented by the drug TMP-SMX.

Pentamidine is less often used as its major limitation is the high frequency of side effects. These include acute pancreatitis, renal failure, hepatotoxicity, leukopenia, rash, fever, and hypoglycemia.