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Aspergillosis: A Comprehensive Overview

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Abstract

Aspergillosis is an infection caused by *Aspergillus*, a common mold found indoors and outdoors. However, individuals with weakened immune systems or lung diseases have a higher risk of health problems due to *Aspergillus*. While primarily a respiratory infection, the species of *Aspergillus* can affect different tissues. In birds, it commonly causes pulmonary infections, while in cattle it can result in mycotic abortion. Horses may develop guttural pouch mycosis, while dogs may experience infections in the nasal and paranasal tissues, intervertebral sites, and kidneys. Domestic cats are susceptible to Sino-nasal, Sino-orbital, and pulmonary infections caused by *Aspergillus*. Research efforts have identified various species of *Aspergillus* and their effects since Micheli's initial description of *Aspergillus* in 1729.

Ecology

Aspergillus fumigatus and related species are commonly found in nature and are predominantly saprophytic. However, a few species, including *A. fumigatus*, can cause diseases in humans and other organisms. They are considered opportunistic pathogens, capable of causing infections or allergies in susceptible individuals. However, some *Aspergillus* species can produce aflatoxins, potent toxins that can induce cancer and lead to toxic death in humans, animals, and birds. These fungi thrive within a temperature range of 12 to 48°C, with an optimum growth temperature of 37°C, which contributes to their pathogenicity in humans.

Etiology

There are around 180 species of *Aspergillus*, with approximately 34 known to cause disease. *A. fumigatus* is the most prevalent pathogenic species, accounting for 50% to 70% of aspergillosis cases. However, non-*fumigatus* species such as *A. flavus*, *A. terreus*, *A. niger*, *A. versicolor*, *A.* 1572



nidulans, *A. viridinutans*, and *A. felis* are increasingly causing aspergillosis infections. *A. niger* is less pathogenic due to its large conidia, which have difficulty reaching the lungs. *A. terreus* is resistant to amphotericin B, making infections caused by this species have a poor prognosis.

Transmission

Transmission of *Aspergillus* can occur through impaired immunity, stress, administration of antibiotics, metabolic bone disease, hypovitaminosis A, overcrowding, shipping, starvation, inbreeding, toxicosis, reproductive activity, and traumatic injuries. Inhalation or ingestion of spores, as well as intramammary inoculation and contaminated feed or litter, are common routes of infection.

Pathophysiology and Toxins produced

Invasive aspergillosis occurs when conidia are inhaled and the host's immune defenses determine the outcome. Immunocompetent hosts eliminate the conidia through ciliary clearance and phagocytosis by pulmonary macrophages. However, if the conidia survive, they germinate into hyphae, leading to invasion of the lungs and subsequent clinical symptoms. Dissemination through the bloodstream can affect various organs, including the brain, skin, heart, kidney, liver/spleen, bone, and gastrointestinal tract. Aflatoxin is a potent naturally occurring toxin found in contaminated feed, particularly in grains. It has various subtypes and can be found in milk and eggs through metabolites. Gliotoxin causes cell damage and apoptosis, while Ochratoxins are nephrotoxic and carcinogenic, commonly associated with dried and stored foods (*A. ochraceus*) and certain fruits (*A. carbonarius*). Citrinin and Ochratoxin A together can cause endemic nephropathy and have embryocidal effects. Helvolic acid and fumagillin are antibiotics with specific effects on cells and angiogenesis. Ribotoxins inhibit protein synthesis, and Mitogillin causes cytotoxicity even in low concentrations.

Types of Aspergilloses

- Allergic bronchopulmonary aspergillosis (ABPA): A non-infectious condition where *Aspergillus* causes inflammation in the lungs, resulting in allergy symptoms such as coughing and wheezing.
- Allergic *Aspergillus* sinusitis: *Aspergillus* leads to sinus inflammation and symptoms similar to a sinus infection, including drainage, stuffiness, and headache.
- Aspergilloma: Also known as a "fungus ball," it is a mass of *Aspergillus* that develops in the lungs or sinuses, without spreading to other parts of the body.
- Chronic pulmonary aspergillosis: A long-term condition characterized by cavities in the lungs caused by *Aspergillus*. Fungal balls (aspergillomas) may also be present.
- Invasive aspergillosis: A severe infection primarily affecting individuals with weakened



immune systems, such as organ or stem cell transplant recipients. It mainly affects the lungs but can spread to other body parts.

- Cutaneous (skin) aspergillosis: *Aspergillus* enters the body through skin breaks, leading to infection, particularly in individuals with compromised immune systems.

Clinical Findings and Lesions:

Birds: Primarily bronchopulmonary with respiratory symptoms, dyspnea, and emaciation. Nodules or plaque lesions may be present in respiratory passages, lungs, air sacs, or body cavities.

Ruminants: Symptoms may vary from asymptomatic to bronchopulmonary infection, mastitis, or placentitis, often resembling tuberculosis.

Horses: Guttural pouch and sino-nasal aspergillosis may cause epistaxis, dysphagia, or nasal discharge. Disseminated disease can affect other organs, leading to neurological and visual complications.

Dogs: Nasal aspergillosis is common, with symptoms including nasal pain, discharge, and ulceration. Systemic disease may show generalized signs like lethargy, lameness, and neurologic deficits.

Cats: Sino-nasal and sino-orbital disease is frequently observed, often causing severe facial swelling and potential CNS invasion.

Diagnosis

Direct examination: Clinical specimens, especially tissue scrapings, are cleared with 10% KOH and microscopically observed for *Aspergillus* hyphae.

Histopathological staining: Tissue sections stained with periodic acid–Schiff (PAS), Grocott’s silver or methenamine silver facilitate detection of tissue invasion.

Isolation and identification: Culture and incubation of *Aspergillus* from clinical specimens, along with correlation with clinical signs and histopathology, aid in accurate diagnosis.

Radiographs and imaging: Radiographic changes in affected areas can be visualized, with CT being more sensitive for accurate assessment.

Molecular biology: PCR-RFLP with specific restriction enzymes can confirm *A. fumigatus* isolates.

Treatment:

Dogs: Topical treatment with clotrimazole is often the first-line approach. Systemic infections may require fluconazole, itraconazole, ketoconazole, or voriconazole.

Horses: Surgical exposure, curettage, topical natamycin, and oral potassium iodide have shown effectiveness.

Bovine mastitis: Combined intra-arterial and intramammary injection with miconazole has been successful.



Conclusion:

Aspergillosis is a fungal infection that can affect various species, including birds, ruminants, horses, dogs, and cats. Understanding the different types, clinical findings, and diagnostic methods is essential for effective management. Treatments primarily involve topical and systemic antifungal medications tailored to the specific case, while preventative measures play a critical role in reducing the risk of infection, particularly for vulnerable populations.

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