Imaging of fungal pneumonia in the ICU

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Outline

• ICU patients and their susceptibility to fungal pneumonia
• Common fungal etiologies in ICUs
• Index Case
• Radiologic hallmarks of fungal pneumonias
• Summary
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Immuno-susceptibility and the ICU

• Changes in innate and adaptive immune function (1)
• Use of immunosuppressant drugs such as corticosteroids
• Many patients have secondary pre-disposing diseases such as neutropenia, malignancy (2), or late sepsis (3)
• Frequent ventilation introduces pathogens directly into lungs

Nseir S et al, 2011.
Boomer JS et al, 2011.
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Common fungal etiologies in ICUs

• Aspergillus
• Candida
• Fusarium
• Zygomycetes
Aspergillus

• Aerobic mold
• Fumigatus is most common species
• Causes invasive pulmonary aspergillosis (IPA)
• Also causes semi-invasive pulmonary aspergillosis, allergic bronchopulmonary aspergillosis (ABPA), as well as aspergillomas (asymptomatic fungus balls) in pre-existing lung cavitations
IPA

• Presents with symptoms of pneumonia including fever, dyspnea, and productive cough (4)
• Pleuritic chest pain is a common complaint (angio-invasive infection leads to infarction) (4)
• The most common fungal pneumonia in the ICU
• Sputum cultures only positive in 10% of affected patients (7) making imaging key to diagnosis

Miller, 1996.
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Index Patient: HPI

• Our index patient is a 75 year old man with a history of MDS/AML, Wegener’s (in remission), and CKD on HD

• At time of admission he had recently taken a course of Revlimid (thalidomide analogue) with resultant pancytopenia

• He presented with one week of anorexia, headache, fatigue, fevers, cough with brown sputum, and left-sided “rib” pain with coughing
Index Patient: Physical Exam

• Vitals: T 102.5, HR 80, BP 140/80, SpO2 92%
• Poor dentition noted in oropharynx
• On chest auscultation, musical rhonchi heard in inspiration. Tenderness over 5th ribs present in mid-axillary line
• Spleen tip was palpable
Index Patient: Pertinent labs

- WBC 3.1 (76% neutrophils)
- Creat 4.6
- ANCA negative
Index Patient: Chest radiograph at presentation

Left upper lobe consolidation
Index Patient: CT chest at presentation

Ground-glass opacity indicating likely site of hemorrhage with multiple consolidations in both lung fields
Index Patient: Differential diagnosis

- Recurrence of Wegener’s vasculitis
- Opportunistic infections such as fungal, viral, nocardia, PCP and mycobacterium
- Pyogenic infection
- Hemorrhage
Index Patient: Decompensation

• After admission, he de-saturated to mid 80’s on low-flow nasal cannula
• Out of concern for tenuous respiratory status he was transferred to the ICU.
Index Patient: Chest radiograph in the ICU

Almost complete opacification of the left lung field with right-sided shift of the mediastinum
Index Patient: Chest CT in the ICU

Expansile consolidative opacity in the left upper lobe. Density is 40 HU, indicating intermediate density, with central hypodensity which may be necrotic. There is evident mediastinal shift.
Index Patient: ICU course

• His respiratory status continued to decline and he was intubated and treated with broad spectrum antibiotics and anti-fungals
• Per the patient’s previous wishes care was withdrawn and he passed away
• Post-mortem bronchoscopy revealed aspergillus
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Companion Patient 1: The Halo Sign in IPA

The Halo Sign

Solid nodular core surrounded by ground glass opacity

The Halo sign

• Results from a necrotic nodule surrounded by a hemorrhagic/necrotic rim (6)
• Specific for invasive aspergillosis, allowing for early diagnosis and institution of therapy(7)
The Halo Sign: Clinical Implications

The halo sign is associated with decreased mortality in patients with IPA

Greene R E et al, 2007
Index patient: Halo Sign on initial presentation?

Nodule surrounded by ground glass opacities

Axial CT chest, C-PACS, BIDMC
Companion Patient 2: Initial Radiograph

Invasive aspergillosis in a 6-year-old girl with neutropenia and acute lymphocytic leukemia, revealing a lingular infiltrate.

Companion Patient 2: The Air Crescent Sign

One week later there are multiple crescentic lucencies surrounded by soft-tissue density opacities

The Air-Crescent Sign

• Specific for IPA (7)
• Crescentic lucency surrounded by soft-tissue density opacities (7)
• Results from air in between necrotic/hemorrhagic lung (7)
Companion Patient 2: Air Crescent sign on CT

Crescentic lucency surrounded by enhancing opacities (box)

Axial CT chest, C+
Candida Pneumonia

• Yeast
• Albicans is the most common species
• Candida was isolated from respiratory secretions in 26% of ICU patients in one series (8)
• This usually represents colonization rather than infection, except rarely in severely immunosuppressed patients (8)
Candida Pneumonia

- Radiographic appearance depends on route of spread (4)
- Hematogenous spread (99%[9]) from disseminated infection produces diffuse miliary, nodular (4) microabscesses (10)
- Primary pneumonia (1% [9] ) usually reveals non-specific alveolar consolidations from pharyngeal aspiration of overgrown candida in the oropharynx of immunosuppressed patients (4)

Companion Patient 4: Candida - Hematogenous Spread

Diffuse bilateral nodular opacities representing likely micro-abscesses
Companion Patient 5: Candida - Aspiration

Fluffy right-sided infiltrate (box) in a patient who aspirated and later developed candidemia

Fusarium sp.

• Filamentous mold
• Solani is the most common species
• Second most common mold infection in immunosuppressed patients after Aspergillus (12)
• Imaging reveals non-specific infiltrates and nodular or cavitary lesions (12)

Companion Patient 6: Primary Fusarium Pneumonia

Multiple small right apical nodules in an immunocompetent patient who cleaned bird droppings (box)

Axial CT chest, C-

Zygomycetes

• Spore-forming, commonly found on decaying vegetation and soil (13)
• Rhizopus and Mucor are most common species
• Inhalation of spores by immunocompromised patients leads to rapidly progressive pneumonia with infarction and necrosis, and can spread to nearby structures such as the mediastinum and heart (13)
• Characteristic finding is the reverse-halo sign: a focal ground glass opacity surrounded by a ring of consolidation – non-specific, as also seen in COP

Companion Patient 7: Zygomycosis

The Reverse Halo Sign
Ground glass opacity surrounded by a ring of consolidation in a stem cell transplant recipient

Axial CT chest, C-
Compare

Reverse halo sign vs. Halo sign

Ground glass opacity surrounded by consolidation

Consolidation surrounded by ground glass opacity

Axial CT chest, C-Busca A et al, 2011.

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• Fungal pneumonia is a relatively common concern in ICUs, especially in immunosuppressed patients

• Distinguishing invasive disease vs. colonization can be difficult, especially regarding candida sp.

• Radiographic hallmarks can aid in early diagnosis, such as the halo and air-crescent signs in Aspergillus and reverse-halo sign in Zygomycosis
References

8. Azoulay E et al. CHEST January 2006 vol. 129 no. 1:110-117
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