Uses, limitations and interpretation of CT in pulmonary infections: A practical approach

Daria Manos
Canadian Association of Radiologists 2013
DISCLOSURES

Speakers honorarium, Siemens Canada
Objectives

1. Recognize and differentiate the HCRT patterns of specific pulmonary infections, including those involving the immunocompromised host.

2. Identify non-infectious mimics of pulmonary infections and recognize the role of the radiologist in directing appropriate clinical work up and treatment.

3. Identify infectious mimics of neoplastic processes.
CASE 1:
Which is most likely to represent PCP?

A. 50 yo male: chronic steroids
B. 24 yo male: IVDU, HIV+ living on street
C. 38 yo female: cachexia, 6 weeks of cough
D. 60 yo female: 7 days post SCT
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CASE 1: Answer
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Pneumocystis jiroveci pneumonia

PCP no longer the most common respiratory infection in AIDS. Now with Septra prophylaxis – changing demographic.

- HIV with poor health care (IVDU)
- HIV not yet diagnosed
- Non-HIV immunocompromised – high dose corticosteroids, chemotherapy, transplant, hematologic malignancies

30% will have normal CXR

Diagnosis:
- Induced sputum and PCR
- May need BAL
HISTORY: Few days of cough and fever.
TRIAGE NOTE: often hypoxic

PCP in 75 yo with CLL - Abnormal CXR in ED
Progression over 3 days
Early – bilateral perihilar ggo, interstitial thickening, hazy vessels.
No effusion.
Patchy, often geographic

Can see crazy paving.

Why is this not alveolar proteinosis or HP?
Look for cysts or cavitation within ground glass

Cysts/pneumatoceles in 10-38%
Can be nodular
but not pure tree in bud
Dense air space consolidation possible
Lobar consolidation rare
PCP and Respiratory infections in HIV

Bacterial

Primary Tb

Post primary Tb

PCP

Fungal Toxoplasmosis

MAC

CMV

CD4

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<th>50</th>
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Respiratory Infection post Stem cell transplant

Course of events and risks associated with allogeneic transplantation.
Léger C S , and Nevill T J CMAJ 2004;170:1569-1577
CT often adds little compared to CXR and clinical history.

Weigh the risks of CT. Consider low dose.

Indications for CT:
- normal CXR but high suspicion
- non-specific CXR pattern
- guiding invasive procedures
- assessing complications (eg effusion)
Diffuse ggo in immunocompromised
Infection clinically: PCP
Viral (CMV, herpes, RSV)

CMV case courtesy Geoff Marshall
Diffuse ggo in immunocompromised

Infection clinically: PCP
Viral (CMV, herpes, RSV)

Specifically mention possibility of PCP and CMV.
Induced sputum not very sensitive.
Made need bronchoscopy to diagnose.
Diffuse ggo in immunocompromised

If alternate clinical presentation:
Consider other causes of ground glass opacity
Case 2: What is the most likely diagnosis?

History: 65 yo man with productive cough

10 months earlier
Case 2: What is the most likely diagnosis?

History: 65 yo man with productive cough
Case 2:
What is the most likely diagnosis?

A. Tuberculosis.
B. Central obstructing tumor.
C. Mucinous adenocarcinoma.
D. Organizing pneumonia.

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“Non-resolving pneumonia”

- **Infectious**
  - Pathogen factors
  - Host factors

- **Inflammatory**
  - Lipoid Pneumonia
  - Organizing Pneumonia
  - Eosinophilic Pneumonia
  - Scar/radiation
  - 20%

- **Neoplastic**
  - Consolidative adenocarcinoma
  - Lymphoma
  - Kaposi Sarcoma
Non resolving pneumonia

Pathogen factors:
severe – up to 10 wks
complex, abscess
resistant
penicillin – 50% strep
levofloxacin – 5% strep
misdiagnosed
tb, fungal, nocardia,
actino

Host factors:
DM, COPD, EtOh, age
Tuberculosis

Dx may be difficult
↑SNTB
Altered in HIV
Consider risk factors
HIV
endemic areas
institutionalization

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Lipoid Pneumonia

Aspiration of oil/fat

Consolidation may be fatty density

Fibrosis

Courtesy Geoff Marshall
Scar / radiation

Radiation fibrosis
6 to 12 months post
> 20Gy
Stereotactic radiation: not as obvious
Chronic Eosinophilic pneumonia

3+ months

Peripheral and upper
Patchy
Neg of pulm edema
Chronic Eosinophilic pneumonia

3+ months

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Chronic Eosinophilic pneumonia

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Peripheral and upper
Patchy
Neg of pulm edema
Cryptogenic organizing pneumonia

Pattern of lung reaction
Idiopathic (COP) or 2°

Patchy peripheral and peribronchovascular consolidation and ggo
Lower predominant

Can recur
Can migrate
CEP and OP

Reverse halo, atoll sign, perilobular consolidation, lobular sparing

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Lymphoma

Extranodal – NHL > HL

In lung:

- consolidation
- masses
- nodules
- interstitial thickening

Progressive mass-like consolidation.

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Adenocarcinoma- mucinous subtype

“mucinous BAC”
“pneumonic BAC”
endobronchial spread

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Progressive consolidation over months
  especially if mass-like – consider lymphoma.
  middle aged, older – consider mucinous adeno ca.

Progressive consolidation over days/weeks
  consider Tb, resistant organism

Peripheral consolidation in patient with unusual
  clinical story and otherwise healthy
  consider OP and EP

Recurrent consolidation in same region
  abnormal underlying lung (obstruction, congenital)

Migratory consolidation
  consider OP, EP, aspiration, vasculitis

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Case 3: Question
What is your recommendation?

65 yo smoker: “abnormality on CXR”
Case 3:
What is your recommendation?

A. Follow up CT
B. PET CT
C. FNA or core
D. Resection
When should the radiologist raise the possibility of infection as a cause of SPN?
Consider infection as cause of SPN when:

1. Infectious history on original requisition.

81 yo one week of dyspnea
Round pneumonia

Typical and atypical bugs
Slowly fades away

CT
delayed resolution
lobular pattern
often satellite nodules
Consider infection when:

2. Demographic clues:

- Risk of infection
- Immunocompromise
- Smoker
- Exposure
- < 50 years
- > 60 years
34 year old
40 year old woman with fever and malaise

Blastomycosis

Serology
core biopsy
bronch
VATS wedge.

Fungal infection
Endemic in Ohio and Mississippi River valleys
First 30 days post SCT – angioinvasive aspergillosis

Halo sign very specific but only in appropriate clinical context (severe neutropenia)
35 yo male HIV + : tuberculosis
Consider infection when:

3. Infectious CT features
   - ground glass margin
   - subsolid nodule/mass that has not been proven persistent
   - multifocal
   - satellite nodules
   - air bronchograms in a solid lesion
   Not present on recent CT

CT features alone only raise the possibility of infection. Neoplasm can not be excluded.
Value of short interval follow up CT
Role of FNA and PET?

When infection is more likely, the yield of FNA is lower.
When infection is a possibility, the specificity of PETCT is reduced.
Textbook list of infectious causes of SPN

- Round pneumonia
- Lung abscess
- Tb, NTMB
- Fungal
  - Coccidiomycosis
  - Histoplasmosis
  - Blastomycosis
- Cryptococcus
- Mycetoma
- Angioinvasive aspergillosis
- Dog heartworm
- Echinococcus
- Nocardia
- Echinococcus
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**Echinococcus**

**Nocardia**
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Ruling out infectious cause of SPN

Step 1 – Is there infectious history?
Step 2 – If no infectious history but infectious CT features, do short interval follow up CT
Step 3 – If there is growth but still reasonable likelihood of infection, consider bronchoscopy or biopsy. Serology depending on risk factors (travel).
Case 4:

Which micronodular pattern most likely represents infection?
Case 4: Answer

Which micronodular pattern most likely represents infection?

A

B

C

D
Tree in bud

Bronchiolar dilation and impaction

Mucus, fluid, pus
Secondary pulmonary lobule
Centilobular core

Pulmonary artery

Airway

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Textbook causes of Tree in bud

Tree-in-Bud Pattern at Thin-Section CT of the Lungs: Radiologic-Pathologic Overview

Causes of the Tree-in-Bud Pattern

- Peripheral airway disease
- Infection
  - Bacterial
    - Mycobacterium tuberculosis
    - M. avium-intracellulare complex
    - Staphylococcus aureus
    - Haemophilus influenzae
  - Fungal
    - Aspergillus
  - Viral
    - Cytomegalovirus
    - Respiratory syncytial virus
- Congenital disorders
- Cystic fibrosis
- Kartagener syndrome
- Idiopathic disorders
- Obliterative bronchiolitis
- Diffuse panbronchiolitis
- Aspiration
- Inhalation
- Toxic fumes and gases
- Immunologic disorders
  - Allergic bronchopulmonary aspergillosis
- Connective tissue disorders
- Rheumatoid arthritis
- Sjögren syndrome
- Peripheral pulmonary vascular disease
- Neoplasms
  - Gastric cancer
  - Breast cancer
  - Ewing sarcoma
  - Renal cancer
Acute bronchiolitis and Bronchopneumonia

Majority of tree in bud is endobronchial infection. Bacterial, viral or fungal bronchopneumonia.
Practical causes of tree-in-bud

Aspiration

Inpatient
- Elderly
- Post operative
- Vomiting or bowel obstruction
- New NG tube

At risk ED patient
- Overdose
- Friday night trauma
- Vomiting or bowel obstruction
Practical causes of tree in bud

Non-tuberculosis Mycobacterial

Elderly women otherwise healthy
Bronchiectasis – especially RML and lingula
TIB - may be infection or bland mucous plugs
Small nodules
Waxes and wanes

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Non-tuberculosis Mycobacterial

Practical causes of tree in bud

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Bronchiectasis – especially RML and lingula
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When does Tree in bud = TB??

If clinical suspicion of Tb: tree-in-bud is an early and strong marker of active disease.

Consider Tb:
- If cavitating focus.
- If evidence of prior disease.
- If risk factor.
- Appropriate clinical setting.

→ Precautions and Induced sputum.

Practical causes of tree in bud

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Does HIV + TIB = TB

TIB in HIV often bacterial bronchiolitis / bronchopneumonia. Viral and bacterial TIB often basal predominant.

TIB in TB often asymmetric and more often both upper and lower lung involved.
Beware isolated TIB

Possible obstructing tumor
Look for subtle central mass
If no infectious symptoms/high risk - do bronch
If unclear – follow up

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Practical causes of tree in bud

? Active disease. Don’t overcall

Tree in bud can simply represent mucus impaction in bronchiectasis.

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Radiologic pattern of disease

Lobar pneumonia
  Bacteria, bacteria, bacteria.
  If immunocompromise – consider TB.
  If organ transplant – consider Nocardia.

Multifocal airspace
  Type and level of immunocompromise become more important than radiologic pattern.

Nodular – fungal, mycobacteria, nocardia more likely.

Interstitial or GGO – PCP + viral more likely (especially in no effusion, no nodes)
If you are just waking up:

- History (type of immunocompromise and timing) may better predict specific infectious agent than CT appearance.
- A dominant pattern of GGO in an immunocompromised patient is worrisome for opportunistic infection, including PCP.
- Consider adenocarcinoma or lymphoma in air space consolidation progressing over months.
- Tree-in-bud nodularity is often infection or aspiration.
- When reporting a CT always review indication for the original CXR.

*Heussel et al. AJR 1997;169:1347-1353.*
Thank you.

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