Complications of Acute Bacterial Endocarditis in an Injection Drug User: Radiologic Findings

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Agenda

- Patient Presentation
- Our patient’s initial CXR and CT scans
- Pulmonary septic emboli on CXR and CT
- Diagnostic criteria of endocarditis
- The role of TTE and TEE in diagnosis of IE
- Multi-organ system involvement on CT and U/S
- CNS complications on CT and MRI
- Treatment and follow-up
- Summary
- Acknowledgements
- References
Our patient:

History and clinical presentation

- HPI: BL, a 57yo male with known IVDU and prior episode of endocarditis (at BWH, tx with daptomycin), presents to ED with hip pain, fever, and 5 days of nausea/vomiting and malaise
- The pt could not remember the last time he had used IV heroin (possibly one week ago). Urine tox screen was positive for opiates in the ED.
- PMH:
  - Hepatitis B
  - Hepatitis C
  - Discoid cutaneous lupus, treated with topical cream
- Vitals in ED: T97.6, WBC 9.9 with 13% bands, 98%RA. Na+: 128, K+: 3.3, cr 2.2, platelets 21. On transfer to floor, WBC --> 17.1 and T100.8
- Physical exam: notable for II/VI systolic murmur
- Social history: sings in gospel band, lives in Roxbury. Admits to prior heroin and cocaine use. HIV negative.
Our patient’s CXRs: Initial and 4 hour follow-up

And four hours later...

Note: Tip of IJ line projecting over SVC

Increase in size and number of multiple patchy opacities, most of which are surrounded by small areas of consolidation

Ill-defined heterogeneous pulmonary opacities R>L
Our patient’s initial CT scan showing numerous cavitary lesions

Multiple cavitating nodules with both thick and thin walls, located at periphery with “feeding vessel sign”

Bilateral pleural effusions, possibly empyemas
Differential diagnosis of multiple cavitary lung lesions

- Cavitary pneumonia
  - Common pathogens: staphylococcus, strep, TB, klebsiella
- Septic emboli
- Metastases
- Acute presentation of Wegner’s granulomatosis
- Rheumatoid nodules
- AVMs
- Is patient immunocompromised? If yes, consider pulmonary aspergillosis, TB, *mycobacterium kansasii*, *Pseudomonas*, *Nocardia* and *Rhodococcus*. Also Kaposi’s sarcoma and non-Hodgkins lymphoma have been reported\(^1\)

\(^1\) Gallant and Ko 1996
Pulmonary septic emboli on CXR and CT

- The radiologist reading this CXR called the most likely pathogen from a comparison of two chest radiographs taken four hours apart.
- The notable aspect is the rapid progression of the cavitary lesions!

**STAPH AUREUS**

S. aureus is notable being particularly virulent and aggressive in the lungs as well as in other organs. Also known for cavitations, peripheral opacities, septic occlusion of smaller peripheral pulmonary arterial branches.¹

The initial chest radiograph can appear normal or only mildly prominent interstitial markings. Within 2-3 days, multiple patchy infiltrates may appear. They might rapidly cavitate and worsen in the first week. Complications include progression to ARDS, empyema, and effusion.²

¹ Kwon et al 2007; ² Alcantara et al 2002
Diagnostic criteria for endocarditis

- Usually a clinical diagnosis based on several positive blood cultures with a predisposing cardiac lesion.
- **Modified Duke’s criteria**: either pathologic diagnosis (confirmed by histology) or a clinical diagnosis: 2 major criteria OR 1 major and 3 minor criteria OR 5 minor criteria

**Major criteria**
- Positive blood cultures for IE (at least 2 separate blood cultures)
- Evidence of endocardial involvement
  
  Positive echocardiogram for IE
  - New valvular regurgitation
  - Abscess
  - Oscillating intracardiac mass
  - New partial dehiscence of a prosthetic valve

**Minor criteria**
- Fever (>100.4F)
- Predisposing heart condition or IVDU
- Vascular phenomena (Janeway lesions, conjunctival hemorrhages)
- Immunologic phenomena-glomerulonephritis, Osler's nodes, Roth spots, etc

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Our patient’s initial TTE showing large tricuspid valve vegetation.

**Bulky vegetation**, measuring 2.8cm by 1.7cm in largest dimension, on the atrial side of anterior leaflet of the valve.

Mildly thickened tricuspid leaflets.

Image courtesy of Dr. Warren Manning.
Our patient’s portable TTE showing severe tricuspid regurgitation

Abnormal septal motion of the RV was noted, consistent with pressure/volume overload

Note the severe tricuspid regurgitation [4+] seen on the Doppler
The role of TTE and TEE in infectious endocarditis

To TTE or TEE?

**TTE** can provide confirmatory diagnosis (e.g., vegetation seen)—BUT sensitivity for vegetations in IE varies (29-63%), although specificity approaches 100%. TTE underestimates the size and complexity of large vegetations and fails to detect small vegetations.\(^1\)

**TEE** has greater sensitivity and specificity for identifying IE (100 versus 63 percent and 94 versus 44 percent in two series).\(^2\)

Does the size of the vegetation matter?

Yes! **Vegetation size may be a predictor of outcome** in TV endocarditis in IVDU. In one series of 132 cases, there was a marked increase in mortality associated with vegetations greater than 2 cm.\(^3\)

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\(^1\) Gilbert et al, 1977; \(^2\) Shivley, et al 1991; \(^3\) Hecht et al 1991
Epidemiology and clinical presentation of endocarditis in IV drug users

- Estimated incidence of 1.5 to 3.3 cases/1000 drug users per year.
- The tricuspid valve is involved in 70% of cases in IVDU.\(^1\)
- **Clinical findings**: Patients with tricuspid valve IE often do not have a detectable heart murmur often lack the classically taught features such as splinter or conjunctival hemorrhages.\(^2\)
- Common pathogens: streptococcus, enterococci, and *P. aeruginosa*\(^1\)
- Patients often have simultaneous embolic and septic processes (infarctions and abscesses) in multiple organ systems:
  - Embolic (cerebral infarct)
  - Local spread of infection (heart valve destruction)
  - Metastatic infection (vertebral osteomyelitis)
  - Immune-mediated damage (glomerulonephritis)

\(^1\) Lowy and Gordon 2005; \(^2\) Sande et al 1992
Our patient: Follow-up chest CT showing new right pneumothorax

New right pneumothorax

SVC

Note the improvement in the bilateral pleural effusions; only a small effusion remains on R side
Our patient: Splenic lesions on follow-up abdominal CT and splenic U/S

Central hypoechoic lesion with hyperechoic rim, increased vascular flow on rim though no central flow

Thought to be either a hemangioma or an abscess. Given clinical correlate of spiking fevers in face of appropriate antibiotic therapy, this was presumed to be a splenic abscess.
Our patient: New RUE weakness

The requisition:
UNDERLYING MEDICAL CONDITION: 57 year old man with endocarditis and signal seen within the disc at C6-7 level on prev MRI w/o Gad. **New RUE weakness**. No focal neuro findings besides generalized weakness.
REASON FOR THIS EXAMINATION: r/o abscess or met

- We are suspicious for **vertebral osteomyelitis**... a well-known but relatively rare complication of IE—most often via hematogenous spread, but direct inoculation of skin flora can occur in patients who inject into the neck pocket.
- When the cervical spine is involved the most frequent symptoms are neck pain and upper extremity weakness.¹
- What would be the **best** imaging modality to evaluate this new complaint?

¹ Endress et al, 1990
Menu of Tests: Vertebral osteomyelitis/discitis

**PLAIN FILM**: Shows destruction of vertebral bodies and adjacent intervertebral disc, possibly soft-tissue mass or abscess.
**Disadvantages**: findings may not be present until 2 to 8 weeks after onset of infection

**CT**: Early CT findings include vertebral body endplate erosion and disc destruction
**Advantages**: CT scans are fairly sensitive; the soft tissues can be directly evaluated

**NUCLEAR STUDIES**: Radionuclide bone scan $^{99m}$ Technetium is fairly sensitive (greater than 90%) but even less specific than plain films because most bony abnormalities have positive tracer uptake
**Disadvantage**: Bone scan also may be negative during first week of infection in IVDU
**Gallium-67**—may be positive earlier than RN bone scan
**Disadvantage**: 24 hours are required to perform test

**MRI: TEST OF CHOICE** (sensitivity of 96% and specificity of 92% in diagnosing vertebral osteomyelitis)
**Advantages**: Allows for direct imaging of vertebral column, epidural space and spinal cord as well as tissue changes. Also identification of other complications (epidural abscess, cord impingement, infectious myelitis, cord abscess, or paraspinal soft tissue infections).
**Classic findings on MRI**: decreased signal intensity of the affected disc and vertebral bodies on T1 images, loss of separation of the disc and adjacent vertebral bodies. On T2-weighted images, increased signal intensity of the vertebral bodies and the disc with loss of the nuclear cleft

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Our patient: Involvement of C6/C7 on MRI

Marrow edema in vertebral bodies and intervening disc spaces as well as extensive edema in pre-vertebral soft tissue at C6-C7—clearly worsened in comparison to prior MRI.

Note the normal spinal cord caliber, no evidence of compression or epidural space involvement.

Enhancement at endplates: Suspicious for early abscess formation!
Our patient: Head CT showing bilateral frontal hypodensities

A non-contrast head CT obtained four days into ICU stay was obtained due to mental status changes (concern for possible ICH). No evidence of ICH was found.

The 3 most worrisome neurologic complications of IE:
1. Cerebral infarction/ischemia
2. Intracranial hemorrhage
3. Intracranial infection (septic emboli, abscesses, or cerebritis)

BUT the most common signs of neurologic involvement are headache and delirium

CNS involvement happens in ~30% of patients with infective endocarditis. Mortality rate and complications are greatly increased.1

1 Royden Jones and Siekert 1989
Our Patient: Septic emboli on MRI

INDICATION: 57-year-old male with endocarditis with concern for septic emboli to the brain? [Note: the neurologic examination performed at the time revealed frontal disinhibition and delirium]

What are these lesions? It is difficult to tell on FLAIR. Ddx is broad: infarcts, demyelinating disease, emboli, mets?

Look at these lesions that enhance after contrast
MRI sequences used to evaluate BL

1. **FLAIR**: an inversion-recovery pulse sequence (T2-weighted: fluid bright, fat dark) used to null signal from fluids (CSF). Good for pathology, but nonspecific

2. **Diffusion weighted imaging (DWI)**:
   - Bright on diffusion = signs of cytotoxic edema (swelling)
   - Can differentiate chronic versus acute infarcts
   - Used to identify ischemic strokes early (within 5-10 min)

3. **ADC (Apparent Diffusion Coefficient) map**:
   - Helps eliminate “T2 shine through”
   - In other words, do the suspected infarcts truly have restricted diffusion [areas of acute infarction]?
   - Areas of injured tissue show up as hypodensities on ADC

4. **T1 post contrast/MP-RAGE** (improved T1-weighted image—remember: on T1, fat is bright, CSF dark): Post-contrast sequences can show different levels of vascularity and brain perfusion.

BL: several lesions demonstrate restricted diffusion and corresponding ADC hypointensity

BL: posterior frontal lesions enhanced on T1 post contrast

All these findings highly suggestive of **SEPTIC EMBOLI**
Septic emboli in the brain on MRI

Septic emboli in the brain often appear as clusters of lesions in the distribution of the MCA (but can be any arterial distribution), often at the gray-white junction

- Higher rates of cerebral embolization, neurologic complications and mortality in patients with *S. aureus* endocarditis or in patients with large vegetations

- Once again, clinical course can be correlated with the organism involved
  - *S. aureus*: embolizes to brain within 2 weeks of presentation
  - Streptococci endocarditis: often embolizes later in illness

- Is the site of arterial conclusion related to the cause of the endocarditis?
  - Peripheral branches of the MCA seen with bacterial organisms
  - Fungal emboli occlude proximal carotids or basilar artery

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1 Azuma et al 2009  2 Johnson and Johnson 2010;  3 Royden Jones and Siekert 1989
BL’s treatment and follow-up

- BL was hospitalized for over 40 days and was in rehabilitation for several weeks after that. Given his numerous complications (as you have seen), BL had an extended IV antibiotic course (including vancomycin and daptomycin) for MRSA endocarditis.
- Given his recent drug use and multiple organ system involvement, as well as an episode of prior endocarditis, he was not deemed a surgical candidate for valve replacement.
- He missed all of his appointments with infectious disease and hepatology and cancelled his follow-up echocardiogram.
- At his new primary care follow-up, he felt well, complaining only of dyspnea on exertion when walking uphill and inability to procure food stamps and a stable place to live.
- He hopes to one day have a tricuspid valve replacement and is working on his music as a vocalist.
Take-home points

- Choosing the proper imaging modalities were crucial in helping diagnose and assess the pathology and extent of BL’s disease.
- Do not underestimate the value of the plain film! The comparison between two chest radiographs taken hours apart allowed the reading radiologist to identify the organism (S. aureus) and the presumed diagnosis of infectious endocarditis with septic emboli in the lungs.
- Diagnosing endocarditis and associated complications can be difficult due to diverse and nonspecific presentations (as in BL’s case, often the presentation in IV drug users is not textbook!)
- The role of imaging for diagnosis of endocarditis is crucial
  - TTE is relatively sensitive for revealing infectious endocarditis, although a TEE is preferable if possible and index of suspicion is high
- MRI is the test of choice for suspected vertebral osteomyelitis/discitis
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References

References