When Critical Care & Radiology Meet

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Goals and Objectives

1. Be able to recognize a variety of common pathologies in the ICU based on imaging
2. Know appropriate imagining modalities to identify specific pathology
3. Recognize the signs, symptoms and causes of these pathologies
4. Recognize other diagnostic tools
5. Understand general approach to treatment
Case 1

• 45yo male with progressive dyspnea, productive cough for 4 days.
45yo male with progressive dyspnea, productive cough for 4 days.
OH YOU KNOW WHAT IT IS?

PLEASE DO SHARE
45yo male with progressive dyspnea, productive cough for 4 days.

1. Pulmonary hemorrhage
2. Acute respiratory distress syndrome (ARDS)
3. Community acquired pneumonia (CAP)
4. Pulmonary embolism (PE)
ARDS

• The Berlin Definition\(^1\)
  • Acute onset
  • Chest imaging - bilateral opacities
  • Origin of edema
  • Oxygenation
    • Mild - PaO\(_2\):FiO\(_2\) 200-300 mm Hg with PEEP or CPAP >5 cm H\(_2\)O
    • Moderate - 100-200 with PEEP >5
    • Severe - <100
ARDS

Mortality (%)
ARDS

• Incidence
  – 10-15% of admitted patients
  – Up to 20% of mechanically ventilated patients

• Causes
  – **Sepsis**
  – Aspiration
  – Pneumonia
  – Trauma
  – Massive transfusion or TRALI
  – Many other causes...
ARDS

• What should you order?
  – CXR
  – CT (with or without contrast)
ARDS: Normal Chest
ARDS: CXR

- Bilateral opacities within 24 hours
ARDS: CXR

Pulmonary edema
ARDS

Multifocal pneumonia
ARDS - Seeing the trend?

Pulmonary hemorrhage
ARDS Treatment

• General
  – ABCs
  – Treatment of underlying cause
  – Sedation
  – Nutrition
  – Glucose control
  – Conservative fluid management\(^2\)
    • Improved lung mechanics, decreased days on vent. No 60-day mortality benefit.
    • Furosemide + albumin in hypoproteinemic pts\(^3\)
      – Improved oxygenation, hemodynamics. Mortality not outcome.
ARDS Treatment

• Lung protective/open lung ventilation\(^4\)
  – Low tidal volumes (6 ml/kg PBW)
  – \(P_{plt} < 30 \text{ cm H}_2\text{O}\)
• Prone positioning\(^5\)
• Neuromuscular blockade\(^6\)
Case 2

- 32yo female with dyspnea and chest pain
32yo female with dyspnea and chest pain
THINK YOU’VE GOT THIS ONE?

WE’RE ALL EARS
32yo female with dyspnea and chest pain

1. Pulmonary embolism
2. Constrictive bronchiolitis
3. Dissection
4. Cardiac tamponade
5. Airway obstruction
Submassive/Massive PE

- Obstruction of pulmonary artery by thrombus causing right ventricular dysfunction
- 112 cases per 100,000
  - 400,000 deaths in US and Europe annually
- Risk factors
  - Malignancy, pregnancy, stroke, hospitalized patients, nephrotic syndrome, spinal cord injury, joint arthroplasty, inherited thrombotic disorders
Submassive/Massive PE

• Diagnosis
  – Pre-test probability
  – D-dimer
  – Troponin I, BNP
  – Imaging
    • Venous dopplers
    • Echocardiogram
    • Radiograph
    • CTA chest
    • VQ scan
PE

- Signs on radiograph:
  - Hampton’s Hump: pleural based consolidation due to lung infarct
  - Westermark’s sign: lucency of lung field due to oligemia
  - Fleishner Sign: enlarged pulmonary artery
PE: Westermark
PE: Hampton’s Hump
PE: Fleishner Sign
WHAT DO I THINK ABOUT PE SIGNS?

GARBAGE!
PE: CTA

- Gold Standard!
Pulmonary infarct: wedged shaped and peripheral
PE: CTA

Right heart strain
PE Treatment

• General
  – ABCs
    • Respiratory support
    • Resuscitation
  – Anticoagulation
  – IVC filter
  – Thrombolysis
  – Emblectomy
Case 3

- 78yo male with sudden weakness, difficulty speaking
78yo male with sudden weakness, difficulty speaking
CLEARLY THERE IS ONLY ONE ANSWER

ALIENS
78yo male with sudden weakness, difficulty speaking

1. Seizure
2. Acute ischemic stroke
3. Encephalopathy
4. Multiple sclerosis
5. Aliens
Acute ischemic stroke

• Sudden loss of focal brain function due to decreased blood supply
• 4th leading cause of death in the US

• Causes
  – Thrombus
  – Embolism
  – Hypoperfusion
  – Cerebral venous sinus thrombosis

• Diagnosis
  – H&P
    • r/o seizures, syncope, hypoglycemia, migraine, drug toxicity
  – NIHSS
Acute ischemic stroke

• What to order?
  – CT: non contrast
  – CTA: +contrast
  – MRI: non contrast
  – CT or MRI perfusion? +contrast
Acute ischemic stroke: CT

- Immediate state: Normal
- Loss of gray white differentiation: 1-3 hours
  - Cytotoxic edema (intracellular damage)
  - Cytotoxic versus Vasogenic edema (break down of blood brain barrier)
Acute ischemic stroke: Normal
Stroke: CT (loss of gray white)
Stroke: CT

• Immediate neurosurgery consultation:
  – Herniations
  – Hemorrhagic conversion
Stroke: Complication
Stroke: Complication

3. Basal cisterns

- Frontal lobe
- Sylvian cistern
- Uncus
- Ambient cistern
- Interpeduncular fossa
- Quadrigeminal plate cistern
- Tentorium
- Cerebellar hemisphere
- Anterior interhemispheric fissure
- Suprasellar cistern
- Cerebral peduncle
- Inferior colliculus
Stroke: Complication

Subfalcine herniation

Uncal herniation
Stroke: MRI

- Diffusion weighted sequence: within minutes of ischemia.
- Ischemic core: over 100cc $\rightarrow$ not a candidate for reperfusion intervention.
- Diffusion (DWI) and ADC sequences: BFFs
  - Acute Ischemic Stroke = BRIGHT DWI and LOW ADC.
Stroke: MRI

Normal DWI
Stroke: MRI

• Cytotoxic edema!
CT or MRI perfusion

• If noncontrast MRI can be obtained, no need for either.
• CT perfusion: limited scanned area. Lots of radiation
  – 2-3 times more radiation than CT head noncon
CVA Treatment

- ABCs
- Thrombolytics within 4.5 hrs\textsuperscript{8}
- Mechanical thrombectomy within 6 hrs\textsuperscript{9}
  - Large artery in proximal anterior circulation
- Treat fever
- BP control
  - $< 185/110$ for thrombolytics
  - $< 220/120$ no thrombolytics
- Antithrombotic therapy within 48 hrs
- DVT prophylaxis
- Statins
Case 4

- 58yo male with abdominal pain
58yo male with abdominal pain
I DON'T KNOW WHAT THAT IS

BUT IT LOOKS AWFUL
58yo male with abdominal pain

1. Bowel perforation
2. Necrotizing fasciitis
3. Incarcerated hernia
4. Closed loop obstruction
5. Cecal volvulus
Necrotizing fasciitis (Fournier Gangrene)

• Rapidly progressive type I infection of deeper tissue resulting in progressive destruction of the muscle fascia and overlying fat

• Risk factors
  – Diabetes, PVD, immunosuppression, recent trauma

• Mortality 21%
  – 100% without debridement

• Diagnosis
  – Physical exam
  – Imaging
Necrotizing Infection

• What to order?
  – Depends on body part
    – Radiograph
    – CT
    – Ultrasound
    – MRI (rare)
Necrotizing Infection

• IV contrast if also worried about loculated collection.
Necrotizing Infection: radiograph or scout
Necrotizing Infection: CT
Necrotizing Infection: CT
Necrotizing Infection: US
Necrotizing Infection: US

- Same patient on CT
Necrotizing Infection
Necrotizing Fasciitis Treatment

• ABCs
• Surgical debridement
• Broad spectrum antibiotics
  – Carbapenem or beta-lactam-beta-lactamase inhibitor
  – Clindamycin
  – Anti-MRSA agent
Case 5

• 46yo female with abdominal pain
46yo female with abdominal pain
46yo female with abdominal pain

1. Bowel perforation
2. Necrotizing fasciitis
3. Acute appendicitis
4. Cecal volvulus
FREE AIR??

NAH, I'M GOOD
Bowel perforation

• Full-thickness injury of bowel wall
• Causes
  – Trauma, obstruction, ischemia, IBD, neoplasm, PUD, infection, caustic injury, spontaneous
• Diagnosis
  – H&P
  – Sepsis workup
  – Imaging
GI Perforation

• What to order?
  – Radiograph
  – CT: if possible +IV and PO contrast. PO not as important.
GI Perforation: Why Contrast?
GI Perforation

Normal abdominal radiograph
GI Perforation: Radiograph

- Views:
  - Upright or lateral decubitus
    - Does not matter. Whatever the patient can tolerate.
    - Upright: look for underneath right hemidiaphragm, but not always the case. Can be both!!
    - Non dependent
    - Lateral decubitus: non dependent portion
      - Do not mistake peritoneal fat for air.
GI Perforation: Radiograph
GI Perforation: Radiograph

• Other places air hides:
  • Falciform ligament
  • Right upper quadrant/upper abdomen
  • Anything that looks too lucent
GI Perforation: Radiograph (rigler)

Air also seen near falciform ligament and overall right abdomen is more lucent
Do not mistaken properitoneal fat for free air
Bowel Perforation Treatment

• ABCs
• NPO, IVF, +/- decompression
• Broad-spectrum antibiotics
• Surgical management
  – Sepsis, ischemia, high-grade obstruction
• Conservative management
  – Contained perf, GI fistula, limited contamination
  – Local drainage, stenting, nutrition
Case 6

• 67yo male with fever, chest pain
67yo male with fever, chest pain
THIS ONE’S TOUGH

BUT NOT AS TOUGH AS ME
67yo male with fever, chest pain

1. Pulmonary emboli
2. Cryptogenic organizing pneumonia (aka, BOOP)
3. Lung carcinoma
4. Septic emboli
5. Myocardial infarction
Septic emboli

- Wide range of presentations, considerations
  - IE, empyema, lung cavitation
  - septic arthritis, CNS infection, osteomyelitis, hepatic abscesses
- Mortality site-dependent
  - DVT pylephlebitis 32%
  - Cavernous sinus 30%
  - Sagittal sinus 78%
  - Lemierre 6.4%
- Risk factors
  - Burns, steroids, IVDU, hypercoagulable
- Causes site-dependent
  - Diverticulitis, appendicitis, endometritis, pharyngitis, meningitis, SSTI
- Diagnosis
  - H&P
  - Sepsis workup, LP
  - Imaging
Septic Emboli

• What to order?
  – CXR
  – CT: + contrast
  – Doppler
  – Echocardiogram
Septic Emboli

• Imaging:
  – Peripheral, lower lung zone predominant, poorly marginated nodular or wedge shaped opacities (often due to infarct or hemorrhage)
  – Rapid cavitation (within 24 hours), but varied stages through the lungs.
  – Along bronchovascular distribution: pulmonary arteries.
  – 1-3cm, but most often times small
Secundary lobules. The centrilobular artery (in blue: oxygen-poor blood) and the terminal bronchiole run in the center. Lymphatics and veins (in red: oxygen-rich blood) run within the interlobular septa.
Septic Emboli: Normal CT Chest
Septic Emboli: CXR
Septic Emboli: CT

- Peripherally located. Nodules will rapidly progress and cavitate.
Septic Emboli Treatment

• Treatment site-dependent
  – Central line-associated
    • Anticoagulation, thrombolytics, antibiotics prior to removal
    • Similar with abdominal/pelvic
  – Lemierre
    • Antibiotics, +/- anticoagulation, I&D
  – CNS
    • Antibiotics, +/- anticoagulation
GREAT JOB

OLD SPORT
References


* Images were anonymized from Veterans Affairs of Western New York patients, STATdx, MedScape, and Google searches.