Joel E. Fishman, M.D, Ph.D

- Professor of Radiology University of Miami School of Medicine
- Specialty: Chest Radiology
- Fields of interest: CTA, cardiac MRI, thoracic disease in AIDS
- Chief, Division of Thoracic Radiology, University of Miami Miller of School of Medicine
- Director of UM Satellite Imaging Services, University of Miami School of Medicine
- 2014-15- Fulbright Scholar Grant recipient for cardiopulmonary radiology education in Israel
- Author & co-author of multiple papers in peer-reviewed journals.
Chest Imaging in the ICU

Joel E. Fishman, MD, PhD
Department of Radiology
US-Israel Educational Foundation

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Objectives

1. Specific pleural & parenchymal diseases
2. Abnormal air & ventilator-related complications
3. Life support and other devices
4. Efficacy of ICU chest radiology
Lobar atelectasis

- Poor inspiratory effort, postoperative, post-extubation
- Propensity to affect the left lower lobe (Sheuland, Br J Radiol 1983)
  - left lower lobe 66%
  - right lower lobe 22%
  - right upper lobe 11%
Lobar Atelectasis

- small airway collapse
  - May show air bronchograms
  - May not respond to bronchoscopy
- mucus plugging
  - Often without air bronchograms
  - May respond to bronchoscopy
Nosocomial Pneumonia

- Pneumonia developing ≥48hr post admission
- Occurs in 8-12% of MICU/SICU patients
- CXR 52% accurate for dx pneumonia in ventilated patients
- Air bronchogram
- Doesn’t show rapid change (minutes or hours) vs. atelectasis, aspiration, edema
  - Antibiotics might not alter the CXR appearance for the first few days
Aspiration: CXR

- Multiple predisposing factors: post-anesthesia, obtunded, intubated, etc.
- CXR often changes over a few hours’ time
- More common on the right than left
- Dependent portions of lung
  - Upright patients: lung bases predominate
  - Supine ICU patients: posterior upper lobes and superior segments of the lower lobes
Pulmonary edema

Hydrostatic edema + Permeability edema

- heart failure
- overhydration
- renal failure

- Aspiration
- Sepsis
- drug reaction or allergy
- near drowning
- smoke or toxic fume inhalation
- neurogenic edema
- fat embolism
- heroin toxicity
- shock
- ARDS
Chest Radiography in Edema

• Scoring system for pulmonary edema (n=51)
  – Cardiogenic: sens 46%, spec 84%
  – Renal: sens 63%, spec 86%
  – ARDS: sens 89%, spec 33%
    • Rocker G, Br J Radiol 1989;62:582

• 2 observers, 277 patients with acute dyspnea
  – $\kappa = 0.63$ (distribution of blood flow); 0.89 (overall impression)
    • Studler U et al, Eur Radiol 2008;18:1644
Hydrostatic Edema

1. engorgement of the pulmonary vasculature (PCWP 12-17mm Hg)
   • comparison of daily CXR to assess
   • cephalization of the vasculature not very helpful in supine ICU CXR
Hydrostatic Edema

2. interstitial edema (PCWP 18-24 mm Hg)
   - indistinct vessel margins
   - thickening of bronchi
   - Kerley lines (A/B/C)
   - hazy or “ground-glass” opacities
   - gravity-dependent increase in density

• Pleural effusions
  - bilateral or right ≥ left
Hydrostatic Edema

3. Alveolar opacification (PCWP $\geq 25$ mm Hg)
   - usually bilateral and reasonably symmetric
   - may be indistinguishable from hemorrhage or diffuse pneumonia
Asymmetric edema

- gravity
- underlying lung disease altering blood flow
- underlying pulmonary vascular disease
- reexpansion
ARDS more likely than hydrostatic edema to show:

- Air bronchograms
- Patchy peripheral distribution
- Decreased lung volumes
- Lack of vascular engorgement
- No or small effusions
- Relatively little change day-to-day
Barotrauma & Abnormal Air

- 4-25% of patients on ventilators develop barotrauma
- Underlying lung disease raises the risk
  - pneumonia and especially ARDS
- Effects of barotrauma more severe in children and adults up to the age of 40
- Supine patient: PTX usually anteromedial or subpulmonic
- PTX suspected on supine CXR→upright or bilateral decubitus radiographs
PTX

• False-positive for PTX:
  – skin folds
  – overlying tubing/dressing/lines
  – prior chest tube tracks

• Size of PTX unrelated to its significance
  – Tension in 60-96% of ventilated PTX
  – Mediastinal shift not always observed
Pneumomediastinum

- Must be distinguished from PTX
- Mimics: PTX, pneumopericardium, Mach effect
- air streaking into neck
- ‘continuous diaphragm’
- retroperitoneal air
Life Support Devices: ET tube & Tracheostomy

- ET optimal position ~5cm above carina, or at level of aortic arch
- Cuff should fill but not expand the trachea
  - Cuff/lumen ratio >1.5 increases risk of damage
  - pressure erosion of the trachea, stenosis, fistula
Life Support Devices: Pacer/AICD

- RA tip deflects superiorly
- RV tip projects anteriorly on lateral xr
- LV lead (coronary sinus->cardiac vein) superior deviation on ant xr, posterior deviation on lateral xr
Intra-aortic Balloon Pump

Normal Appearance

P. Cascade, STR
Where’s the feeding tube?
Effectiveness of ICU CXR

• Prospective clinical value of 2,457 routine CXRs in a SICU/MICU (Graat ME, Crit Care 2006)
  – ~6% of daily routine CXRs showed new or unexpected findings
  – ~2% warranted a change in therapy

• Prospective trial: daily vs on-demand CXR in 851 ventilated patients:
  No change in pt outcome
Compromised respiratory function. Patient with endotracheal tube.

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>RRL*</th>
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<tbody>
<tr>
<td>X-ray chest portable after catheter/tube insertion</td>
<td>9</td>
<td>☢</td>
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<tr>
<td>X-ray chest portable clinical indications only</td>
<td>9</td>
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<tr>
<td>X-ray chest portable follow-up</td>
<td>1</td>
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Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate