CHEST PATTERN RECOGNITION

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Why is pattern recognition for radiographers ‘in fashion’?

• It is a form of Role extension
• Assist referring doctor in the right direction—esp community service radiographers
• Adds to the professional standing of the radiographer
Background

- What is pattern recognition?
  It is a form of communication-in the form of a report to describe the findings of a radiograph

- Since 1987-Red dot system used; various opinions about this form of role extension(Hughes, Hughes& Hamill; In 1996, the college of radiographers proposed that it should be included in the radiography curriculum

- The opinions in 2013??
- The starting point - A person needs to be able to recognise normal anatomy on a radiograph as well as abnormal appearances on a radiograph which may be indicative of pathology (Munro 2001)
Requirements of a report

• The report should be tailored to satisfy the need for timeliness.
• It should be relative and concise
• Minimize the risk of communication errors.
How to communicate findings

1. **Final report**
   - the definitive documentation
   - should be proofread to minimize typographical errors etc.
   - should be transmitted to the referring physician
   - should accompany the transmittal of relevant images
   - final report should be archived by the imaging facility as part of the patient’s medical record and be retrievable for future reference.

2. **Preliminary report**
   - A preliminary report precedes the final report. It may be rendered for the purpose of directing immediate patient management or to meet the needs of a particular practice environment. It very likely will contain
   - limited information or incomplete information. It should not be expected to contain all the information
   - subsequently found in the final report.

(Resolution 11)*
How to communicate findings

3. Non-routine communications

Situations that may require non-routine communication

- Findings that suggest a need for immediate or urgent intervention:
  - eg pneumothorax, pneumoperitoneum, or a significantly misplaced line or tube.

(http://www.acr.org/guidelines) Revised 2010 (Resolution 11)*
Our Expectations

Instead of remembering nothing about a lot of things, remember a little about a few things

Overview

This presentation will therefore only include:-

• The normal chest
• Findings that may require immediate or urgent intervention:
  - Identification of Misplaced lines or tubes
  - Some Chest trauma
  - Lobar collapse/consolidation
anatomy
How to start?

• Analyse the radiograph by looking at the technical aspects. WHY??

  Name, age, gender

  Quality of the radiograph

  anatomy

  It will assist with identifying potential pathology

(Wong & Curtis 2012)
Technical aspects

• **Orientation**-PA/AP-heart; Erect- lower zone vessels are larger than those in the upper zone, due to gravity.

• **Respiration**- poor inspiration may be a sign of underlying pathology/ lack of patient understanding; reduces the size between upper and lower zone vessels; heart may be squashed.

• **Rotation**- may cause unequal radio-opacity of left and right lung; lordotic/kyphotic projection which may distort mediastinal structures.

( Eyres & Thomas 2005).
PROJECTIONS/VIEWS

WHY PA?
• Accurate assessment of cardiac size
• Scapulae able to be rotated out of the way.

WHY LATERAL?
• To see areas that are difficult to see on PA (areas behind the hilar)
• Anatomical localization of lesions (Wong & Curtis 2012)
Systematic approach to review the radiograph

• An approach was developed by a chest radiologist Benjamin Felson.

• He advises to target the least interesting areas of the radiograph first, before proceeding to analyse the more “important” areas—the lungs and heart.

• There is no gold standard system for reviewing a chest radiograph however.

(Wong & Curtis 2012)
Benjamin Felson’s System

• Abdomen
• Thorax
• Mediastinum
• Lungs (one side at a time)
• Lungs (compare one against the other)
• Aide memoire: Are There Many Lung Lesions?
  (Wong & Curtis 2012)
Alternative Method to review the chest

• **A** - Airway (midline, no obvious deformities, no paratracheal masses).
• **B** - Bones and soft tissue (no fractures, subcutaneous emphysema).
• **C** - Cardiac size, silhouette and retrocardiac density normal.
• **D** - Diaphragms (right above left by 1 cm to 3 cm, costophrenic angles sharp, diaphragmatic contrast with lung sharp).
• **E** - Equal volume (count ribs, look for mediastinal shift).
• **F** - Fine detail (pleura and lung parenchyma).
• **G** - Gastric Bubble (above the air bubble one shouldn't see an opacity of any more than 0.5 cm width).
• **H** - Hilum (left normally above right by up to 3 cm, no larger than a thumb), hardware (in the intensive care unit: endotracheal tube, central venous catheters).

(Talley & Connor, 2006)
Saiga’s approach

- Name, date, anatomical marker
- Area of interest
- Exposure
- Respiration
- Positioning technique?
- Soft tissue structures
- Bony structures
- Film faults
- Pathology (pattern recognition)
Easy way-film evaluation criteria (Technical)

1. **Area of interest**
   - First ribs?
   - Costophrenic angles?
   - Lateral edges of ribs?
   - Lungs

2. **Exposure**
   - Vertebrae should be seen faintly through the Heart shadow
   - Lung markings-visible
Easy way-film evaluation criteria (Technical)

3. Rotation

Medial ends of the clavicles should be equidistant to the spinous processes of the thoracic spine.

Cowen 2009

http://www.radiologymasterclass.co.uk/tutorials/chest/chest_pathology/chest_pathology_page8.html#top_first_img
Easy way-film evaluation criteria (Technical)

4. Respiration

- Inspiration
- Good inspiration – when one is able to count 10-11 posterior ribs above the diaphragm. If more ribs are visible then the lungs are hyperinflated(?)

(how do we know it is posterior ribs?)

- How many anterior ribs should be visible?

5. Bones

- Sternal ends
- Scapulæ?
- Ribs-10 posterior ribs visible above D
Easy way-film evaluation criteria (diagnostic assessment)

6. Soft tissue
   • 2cm of lung apex above the clavicles
   • Trachea should be in midline
   • Heart shadow
   • chest wall for swelling
   • breast shadows
   • the diaphragm (phrenic nerve)
How to assess a chest radiograph

• Three convexities visible on the left
  1. Aortic knuckle
  2. Main pulmonary artery (just below Aortic knuckle)
  3. Left heart border.

• Right
  1. Azygos is seen end on to enter the SVC
  2. SVC-seen as a straight line continuous inferiorly with the right heart border.
  3. Right hilum-midway between the Diaphragm and the lung apex

(Wong & Curtis 2012)
Trachea

tracheostomy  
Calcified trachea
Thyroid mass

http://www.meddean.luc.edu/lumen/meded/medicine/pulmonar/cxr/atlas/cxratlas_f.htm
Pre op-MASS of rt upper lobe

http://www.meddean.luc.edu/lumen/meded/medicine/pulmonar/cxr/atlas/cxratlas_f.htm
Crossing the midline

When a mediastinal density crosses mid-line, most of the time it is a bowel.
This is a case of a hiatal hernia.

http://www.meddean.luc.edu/lumen/meded/medicine/pulmonar/cxr/atlas/cxratlas_f.htm
Aortopulmonary Window

local concavity or notch between the aortic arch and the pulmonary artery

http://www.slideshare.net/crisbertc/basic-radiology,2009
Soft tissue-hila

Contents:
- Pulmonary arteries
- Pulmonary veins
- Bronchi

Not seen on normal xray:
- Lymph nodes
- Nerves

Note:
Left hilum is normally higher than right hilum

Pulmonary arteries
Pulmonary veins

Cowen 2009
Cardio thoracic ratio (CTR)

Heart size measurement

(Cowen 2009)

http://www.slideshare.net/mahayousif/basics-of-chest-x-ray-interpretation
Cardiomyopathy

- Globe shaped

Cowen 2009
Pericardial effusion

• The water bottle sign or configuration refers to the shape of the cardiac silhouette on erect frontal chest x-rays in patients who have a very large pericardial effusion.

• The pericardium has gradually stretched. (The fluid, often measuring a litre or more)

Dr Frank Gaillard et al.
http://radiopaedia.org/articles/water-bottle-sign
Evaluation criteria (lateral)

- Long axis of the lung fields should be vertical (NO forward/backward leaning)
- Area of interest - costophrenic angles and apices included
  - **Motion** - minimal amount of unsharpness: heart, lung and D should show sharp outlines
- No shadow of upper arm overlying upper the lung fields

http://lifeinthefastlane.com/education/investigations-tests/cxr-normal
Bones of lateral chest

(Cowen 2009)
Fissures

(Cowen 2009)
Fluid-filled fissures

(Cowen 2009)
Lung Size Proportion

- Right lung proportion is approximately 55%, and left lung proportion is approximately 45%.
- Whenever this relationship changes it indicates an abnormality.

http://www.meddean.luc.edu/lumen/meded/medicine/pulmonar/cxr/atlas/cxratlas_f.htm
Pattern Recognition

pathology

• Where is it?
• Single/multiple
• Radiopaque/radiolucent?
• Shape-round/elliptical
Position of tubes and lines

- **Central lines** should pass to the lower superior vena cava, and should not enter the right atrium.
- **Endotracheal tubes** should have the tip at least 3 cm above the carina, optimally midway between the carina and thoracic inlet.
- **Gastric tubes** should pass below the diaphragm and into the stomach.
- **Chest drains**—check the position. The tip of the tube should lie in an effective position, and not be misplaced or displaced into lung tissue.
Position of LINES

All lines

Eg CVP

http://www.meddean.luc.edu/lumen/meded/medicine/pulmonary/cxr/atlas/cxratlas_f.htm
Central line position

http://www.meddean.luc.edu/lumen/meded/medicine/pulmonary/cxr/atlas/cxratlas_f.htm
What To Look For in chest trauma

1. Rib fractures (Fractures can be single/multiple; one sided or bilateral; fragments-which may be displaced)
2. Abnormal collections of air
3. Abnormal collections of fluid
4. Pulmonary contusions
5. Pulmonary/diaphragmatic lacerations

1. Rib Fractures

- Only important for what they are associated with or produce
- Rib 1 only — facial fractures
- Ribs 1, 2 and 3 — Serious Trauma — ruptured bronchus
- Ribs 4 – 9 — pneumothorax, contusion
- Ribs 10 – 12 — lacerations of liver/spleen

Injuries associated with rib trauma

1. **Pneumothorax**: lacerations of the pleura
2. **Haemothorax**: Bleeding into the pleural space from lacerations of the intercostal vessels (thorocotomy)
3. **Traumatic emphysema**: Air enters the chest wall through a break in the pleura and distends the subcutaneous tissue
4. **Flail chest**: this happens when there are several adjacent ribs that are fractured in 2 places or bilaterally.
FLAIL CHEST

- A flail segment is formed which is sucked in during inspiration and pushed out during expiration.
- A segment of the chest wall that is flail is unable to contribute to lung expansion.
Ribs

http://www.slideshare.net/mahayousif/basics-of-chest-x-ray-interpretation
Old rib fracture

Cowen 2009
2. Abnormal Collections Of Air

a. Pneumothorax
b. Pneumomediastinum
c. Pneumopericardium
d. Subcutaneous emphysema

2a. Pneumothorax

- Must see visceral pleural white line
- Absence of lung markings peripheral to pleural line
- Beware of skin folds
- Beware of bullae

Pneumothorax

- No vascular markings on right
- No shift of mediastinum to left
- Atelectatic right lung
- Increased haziness on left: Diversion of entire cardiac output
- Small fluid level near costophrenic angle: Hydro pneumothorax

http://www.meddean.luc.edu/lumen/meded/medicine/pulmonar/cxr/atlas/cxratlas_f.htm
Tension Pneumo

Tension Pneumothorax

- No vascular markings on right
- Shift of mediastinum to left
- Atelectatic right lung
- Increased haziness on left: Diversion of entire cardiac output

http://www.meddean.luc.edu/lumen/meded/medicine/pulmonar/cxr/atlas/cxratlas_f.htm
Chest drain

http://www.meddean.luc.edu/lumen/meded/medicine/pulmonar/cxr/atlas/cxratlas_f.htm
Cardiac

2b. Pneumomediastinum
- May develop after blunt trauma due to pulmonary interstitial emphysema
- Mediastinal pleura is displaced from heart border
- Visualization of central part of diaphragm — continuous diaphragm sign

http://www.learningradiology.com/lectures/chestlecture\ss/chesttraumappt_files/frame.htm [13 August 2013]

2c. Pneumopericardium
- Requires direct penetration of the pericardium
- Air appears around heart but does not extend above great vessels
- Very difficult to differentiate from pneumomediastinum

3. Abnormal collections of fluid

Signs Of Mediastinal Haemorrhage

• Widening of the mediastinum
  Subjective, influenced by position
• Apical pleural cap on left
• Displacement of left paraspinal stripe
• Deviation of trachea to right
• Deviation of NG tube
Widened mediastinum

If dissecting aorta:-

• Irregularity of the aortic knuckle

• Haziness around the knuckle-due to bleeding

(Cowen 2009)

http://www.ajronline.org/doi/full/10.2214/AJR.07.3324
Dissection or leaking aortic aneurysm

Cowen 2009)
Aortic dissection

Cowen 2009)
Dissecting aorta (CT/ANGIO)

Dissecting Aorta

Compare!

Normal

Aortic dissection

What are the radiological criteria for pleural effusion?

- Homogenous density
- Density in dependent portion
  - Upright: Costophrenic angle in PA view
  - Lateral view: Anterior and posterior portions of gutter
  - Lateral decubitus position: Along sides
  - Supine position: Along posteriorly, giving diffuse haziness on the side of effusion

http://www.stritch.luc.edu/lumen/MedEd/Radio/curriculum/Medicine/Pleural_effusion1.htm
Pleural effusion
Pleural Effusion (?WHY difference in appearance)

Pleural effusion (supine)  
Pleural effusion (erect)

http://www.meddean.luc.edu/lumen/meded/medicine/pulmonar/cxr/atlas/cxratlas_f.htm
Subpulmonic effusion

The costophrenic angle (black arrow head) is blunted and displaced medially.
The distance between the stomach bubble and diaphragm has increased (Black arrow). Do a lateral decubitus film to confirm

http://www.stritch.luc.edu/lumen/MedEd/Radio/curriculum/Medicine/Pleural_effusion1.htm
5. Pulmonary/diaphragmatic lacerations

Rupture of the Diaphragm

- Left hemidiaphragm affected almost always
- May not occur for weeks after trauma
- Hernia may contain omentum, stomach, large and small bowel, spleen, kidney
- X-ray shows bowel, soft tissue at left lung base
- Differentiation from eventration (no constricted loops) or hernia (no stomach) may be difficult
Ruptured Diaphragm

Cowen 2009
Pneumo peritoneum

The most common cause is a **perforation** of the abdominal viscus—most commonly, a perforated ulcer,

The most common cause of a **spontaneous** pneumoperitoneum is the introduction of air through the female genital tract ¹⁴

http://student.bmj.com/student/view-article.html?id=sbmj.e988
Two major pathological processes give rise to many of the appearances of airspace disease on the chest x-ray:

- **Consolidation**
  - Airspace **consolidation** can be defined as a replacement of the normal airspace gas by either fluid or solid material.

<table>
<thead>
<tr>
<th>Substance within airspace</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pus</td>
<td>Infection (pneumonia)</td>
</tr>
<tr>
<td>Blood</td>
<td>Pulmonary haemorrhage</td>
</tr>
<tr>
<td>Fluid</td>
<td>Pulmonary oedema</td>
</tr>
<tr>
<td>Cells</td>
<td>Lung cancer</td>
</tr>
<tr>
<td>Protein</td>
<td>Alveolar proteinosis</td>
</tr>
</tbody>
</table>

- **Collapse, (atelectasis)**
  - is defined as reduction in inflation of all or part of the lung, with corresponding diminution of volume. It refers to collapse of the airspaces.

**How to identify atelectasis on a chest x-ray:**

- **Volume loss**
- **Diaphragmatic**, mediastinal or hilar displacement
- **Local increased density** (due to lack of air in collapsed lung). Silhouette sign may locate the affected part of the lung!
- **Crowding of vessels and bronchi**
Atelectasis or lung-collapse is the result of loss of air in a lung or part of the lung with subsequent volume loss due to airway obstruction or compression of the lung by pleural fluid or a pneumothorax.

The key-findings on the X-ray are:

- Sharply-defined opacity obscuring vessels without air-bronchogram
- Volume loss resulting in displacement of diafragm, fissures, hili or mediastinum

http://www.radiologyassistant.nl/en/p50d95b0ab4b90/chest-x-ray-patterns-of-lung-disease.html
Key points (Chris Dennison)

• Key Points
• Understanding the lobar anatomy of the chest is essential in localising airspace pathology
• Consolidation on a chest x-ray does not automatically equal 'pneumonia'. The causes of consolidation are: debris, pus, blood, protein and fluid
• Remember to stand back from the film when looking for lobar collapse, especially left upper lobe!
Silhouette Sign\textsuperscript{9} Chandekhar, A.J

Cardiac margins are clearly seen because there is contrast between the fluid density of the heart and the adjacent air filled alveoli. Both being of fluid density, you cannot visualize the partition of the right and left ventricle because there is no contrast between them. If the adjacent lung is devoid of air, the clarity of the silhouette will be lost. The silhouette sign is extremely useful in localizing lung lesions.

<table>
<thead>
<tr>
<th>Silhouette</th>
<th>Adjacent Lobe/Segment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right diaphragm</td>
<td>RLL/Basal segments</td>
</tr>
<tr>
<td>Right heart margin</td>
<td>RML/Medial segment</td>
</tr>
<tr>
<td>Ascending aorta</td>
<td>RUL/Anterior segment</td>
</tr>
<tr>
<td>Aortic knob</td>
<td>LUL/Posterior segment</td>
</tr>
<tr>
<td>Left heart margin</td>
<td>Lingula/Inferior segment</td>
</tr>
<tr>
<td>Descending aorta</td>
<td>LLL/Superior and medial segments</td>
</tr>
<tr>
<td>Left diaphragm</td>
<td>LLL/Basal segments</td>
</tr>
</tbody>
</table>
Lobes

http://student.bmj.com/student/view-article.html?id=sbmj.e988
Fissure/hilum

http://www.meddean.luc.edu/lumen/meded/medicine/pulmonar/cxr/atlas/cxratlas_f.htm
Horizontal fissure displacement

- Displacement of the horizontal fissure may be an indicator of the location of pathology.
- If displaced upwards, this may be because of volume loss of the right upper lobe, for example due to collapse, or fibrosis.
- If it is displaced downwards, there may be a process which has caused volume loss of the right lower lobe.
Ressected rt lung

Right Upper Lobe Resection

- Surgical clips
- Right hilum pulled up
- Right diaphragm higher
- Right lung proportion decreased (normal 55%)

http://www.meddean.luc.edu/lumen/meded/medicine/pulmonar/cxr/atlas/cxratlas_f.htm
Pre-op radiograph (mass upper lobe)

http://www.meddean.luc.edu/lumen/meded/medicine/pulmonar/cxr/atlas/cxratlas_f.htm
Resected lung

http://www.meddean.luc.edu/lumen/meded/medicine/pulmonar/cxr/atlas/cxratlas_f.htm
Bowing sign

- Bowing Sign
- In LUL atelectasis or following resection, as in this case, the oblique fissure bows forwards (lateral view). Bowing sign refers to this feature. The arrow points to the forward movement of the left oblique fissure.
Lt upper lobe Pneumnia

Lt upper lobe pneumonia

http://www.meddean.luc.edu/lumen/meded/medicine/pulmonar/cxr/atlas/cxratlas_f.htm
Lobar pneumonia

Consolidation Right Upper Lobe
Air Bronchogram

- Density in right upper lung field
- Lobar density
- Loss of ascending aorta silhouette
- No shift of mediastinum
- Transverse fissure not significantly shifted
- Air bronchogram

http://www.meddean.luc.edu/lumen/meded/medicine/pulmonar/cxr/atlas/cxratlas_f.htm
Rt upper lobe collapse

• With right upper lobe collapse. There is reduction in volume of the right lung, with elevation of the right hemidiaphragm due to the volume loss in the upper lobe

• The horizontal fissure, no longer horizontal.
Rt middle lobe pneumonia

Where is the rt heart border?

Horizotal fissure

http://www.radiologymasterclass.co.uk/tutorials/ chest/ chest_pathology/chest_pathology_page5.html#top_first_img
? Collapse/consolidation?

Lt lingula

http://www.meddean.luc.edu/lumen/meded/medicine/pulmonar/cxr/atlas/cxratlas_f.htm
Pneumonia/collapse?

http://www.meddean.luc.edu/lumen/meded/medicine/pulmonar/cxr/atlas/cxratlas_f.htm
Pneumonia/collapse?

Rt upper lobe

http://www.meddean.luc.edu/lumen/meded/medicine/pulmonar/cxr/atlas/cxratlas_f.htm
Projection to show this better?

Rt middle lobe

http://www.meddean.luc.edu/lumen/meded/medicine/pulmonar/cxr/atlas/cxratlas_f.htm
Silhouette sign

- If the airspace adjacent to one of the normal mediastinal or diaphragmatic contours is filled with dense material i.e. consolidated, then the normal air-soft tissue interface is lost and the normally seen edge of the silhouette disappears.

http://cs1.e-learningforhealthcare.org.uk/public/Image%20Interpretation/eXI_05_04/d/ELFH_Session/7/session.html?lms=n
• demonstrate an abnormality posterior to the heart, but not in contact with it. When viewed on a PA chest x-ray the normal heart border is preserved.

http://cs1.e-learningforhealthcare.org.uk/public/Image%20Interpretation/eXI_05_04/d/ELFH_Session/7/session.html?lms=n

S - spine
T - trachea
H - heart
- abnormal density
Way forward

• Look at as many normal radiographs as possible! Be aware of anomalies
• If unsure of a finding, ask for advice! - radiologist for expert interpretation
• Scope of practice?
• Medical legal issues?
• How do radiographers feel about role extension?
• Still produce beautiful xrays-to make it easy for YOU and Your colleagues to interpret!
Thank you for your attention
References

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PRACTICE GUIDELINE Communications Diagnostic Radiology / 1:
(http://www.acr.org/guidelines) Revised 2010 (Resolution 11)*
http://www.acr.org/~media/C5D1443C9EA4424AA12477D1AD1D927D.pdf [13 August 2013]


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