Syndrome of Diffuse and Focal Consolidation of the Lungs

SIGNS AND SYMPTOMS OF RESPIRATORY SYSTEM DISEASES

LECTURE IN INTERNAL MEDICINE PROPAEDEUTICS

M. Yabluchansky, L. Bogun, L.Martymianova, O. Bychkova, N. Lysenko, M. Brynza
V.N. Karazin National University Medical School' Internal Medicine Dept.

USMLE STEP 1

Myeloperoxidase (MPO) is a heme-containing molecule that is found in the azurophilic granules of neutrophils. Upon release, the enzyme catalyzes hypochlorous acid production during the phagocytic response. In the setting of pneumonia, which of the following is the end result and clinical significance of this reaction?

1. Green color of sputum, 2. Cough, 3. Rust-tinged sputum, 4. Fever, 5. Shortness of breath

http://www.justforhearts.org/2013/08/for-how-long-a-person-can-survive-without-oxygen-water-food/
http://assets-s3.mensjournal.com/img/article/you-re-breathing-all-wrong/298_298_you-re-breathing-all-wrong.jpg

USMLE STEP 1

Correct answer 1: The reaction catalyzed by myeloperoxidase results in the characteristic green-colored sputum that is often found in respiratory infections.

Incorrect answers: 2 & 4: Cough and fever are often the result of a systemic inflammatory response found when a patient is sick. It is often the result of leukotriene release., 3: Usually secondary to a pneumococcal pneumonia infection., 5: Tachypnea is a physiologic response secondary to increased hypercarbia or hypoxemia, and is often secondary to lung pathology.

http://www.justforhearts.org/2013/08/for-how-long-a-person-can-survive-without-oxygen-water-food/
http://assets-s3.mensjournal.com/img/article/you-re-breathing-all-wrong/298_298_you-re-breathing-all-wrong.jpg

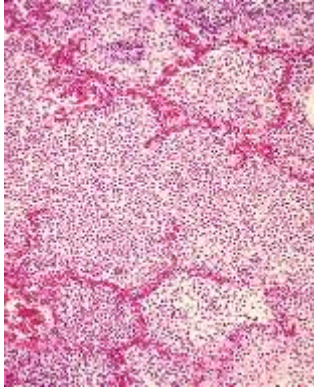
Preamble:
the importance of the respiratory system

- Since our childhood we all are aware that food, water and oxygen are the basic necessities of life and we cannot survive without them
- An average person can live without food for 3-4 weeks
- We cannot survive without water for more that 3-5 days
- Oxygen is crucial to sustain life, and 3 minutes is the maximum time where person can stay alive without breathing

http://www.justforhearts.org/2013/08/for-how-long-a-person-can-survive-without-oxygen-water-food/
http://assets-s3.mensjournal.com/img/article/you-re-breathing-all-wrong/298_298_you-re-breathing-all-wrong.jpg

Lung consolidation syndrome: definition 1

- A lung (pulmonary) consolidation is a region of (normally compressible) organ tissue that has filled with liquid, a condition marked by induration (swelling or hardening of normally soft tissue) of a normally aerated lung

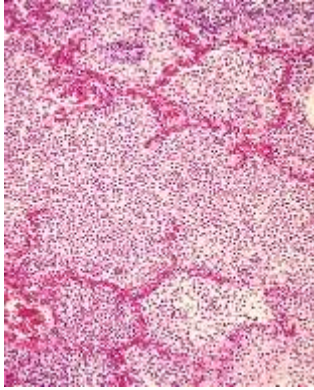


The photomicrograph shows many alveolar spaces filled with inflammatory infiltrate

http://www.stritch.luc.edu/lumen/MedEd/Radio/curriculum/IPM/consolidation_pg.htm https://en.wikipedia.org/wiki/Pulmonary_consolidation

Lung consolidation syndrome: definition 2

- Consolidation occurs through accumulation of liquid in the alveoli and adjoining ducts and is defined as alveolar space that contains liquid instead of gas

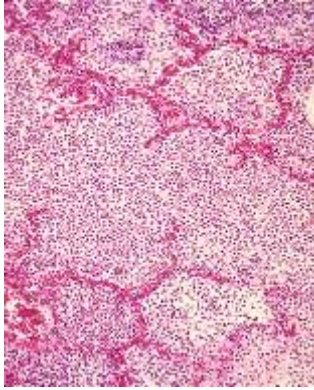


The photomicrograph shows many alveolar spaces filled with inflammatory infiltrate

http://www.stritch.luc.edu/lumen/MedEd/Radio/curriculum/IPM/consolidation_pg.htm https://en.wikipedia.org/wiki/Pulmonary_consolidation

Lung consolidation syndrome: definition 3

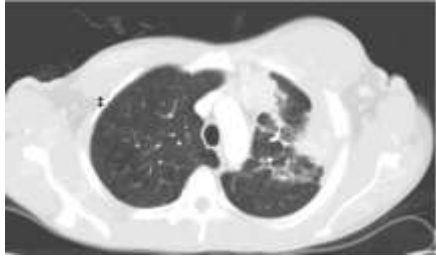
- The liquid can be pulmonary edema, inflammatory exudate, pus, inhaled water, or blood (from bronchial tree or hemorrhage from a pulmonary artery)



The photomicrograph shows many alveolar spaces filled with inflammatory infiltrate

http://www.stritch.luc.edu/lumen/MedEd/Radio/curriculum/IPM/consolidation_pg.htm https://en.wikipedia.org/wiki/Pulmonary_consolidation

Lung consolidation syndrome: diseases

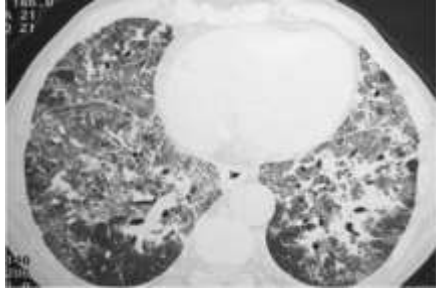


The mediastinal lymphadenopathy and lung consolidation

- Pneumonia
- Infections (lung): actinomycosis, ascariasis, aspergillosis (invasive/infection or allergic), blastomycosis, cryptococcosis, hydatid cyst, syphilis
- Pulmonary edema (fluid in lungs)
- Tumors of the lung
- Atelectasis (collapsed lung)

http://www.healthhype.com/consolidation-in-lung-signs-symptoms-and-causes.html

Lung consolidation syndrome: symptoms 1

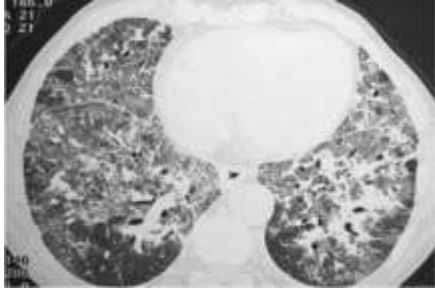


High-resolution CT scan at level of lower lung zones shows extensive "crazy-paving" pattern involving both lower lobes, lingula and middle lobe, in association with areas of air-space consolidation

- Dyspnea which is dependent on the extent of consolidation
- Abnormal (bronchial) breathing sounds
- Coughing
- Pallor acrocyanosis
- Percussion : dull note
- Palpation : tactile fremitus
- Vocal resonance
- Possible medium, late, or pan-inspiratory crackles

http://openi.nlm.nih.gov/imgs/512/176/2647177/2647177_kjr-10-21-g003.png http://www.healthhype.com/consolidation-in-lung-signs-symptoms-and-causes.html

Lung consolidation syndrome: symptoms 2



High-resolution CT scan at level of lower lung zones shows extensive "crazy-paving" pattern involving both lower lobes, lingula and middle lobe, in association with areas of air-space consolidation

- Egophony (it is said to occur when, during auscultation, a patient says the letter “E” and the examiner hears the letter “A”)
- Pleural friction rub (the sound made by treading on fresh snow)
- Unilateral reduction in chest expansion
- A lower expected Pa02 than calculated in the alveolar gas equation

http://openi.nlm.nih.gov/imgs/512/176/2647177/2647177_kjr-10-21-g003.png http://www.healthhype.com/consolidation-in-lung-signs-symptoms-and-causes.html

USMLE STEP 1

A 21-year-old college student with a history of hypertrophic cardiomyopathy and a systolic murmur heard best at the left sternal border presents to the emergency room with a temperature of 102.3 F, worsening shortness of breath, chest pain and productive cough. He states that two days ago upon returning from Spring Break in Australia he drank a significant amount of alcohol and had an episode of vomiting. He recalls little about the evening. His electrocardiogram displays a regular sinus rhythm and his chest x-ray is shown in Figure A. Which of the following is the most likely etiology of his illness?

1. Long-distance travel, 2. Impaired cough reflex,
3. Hypertrophic cardiomyopathy, 4. Valvular disease, 5. Close living quarters

http://www.justforhearts.org/2013/08/for-how-long-a-person-can-survive-without-oxygen-water-food/
http://assets-s3.mensjournal.com/img/article/you-re-breathing-all-wrong/298_298_you-re-breathing-all-wrong.jpg

USMLE STEP 1

Correct answer 2: Aspiration pneumonia is associated with a diminished cough reflex and dense opacities in the dependent lung fields. Impaired cough reflex, as seen with alcohol ingestion, is a risk factor for aspiration pneumonia.

Incorrect answers: 1: Long distance travel is often associated with the formation of pulmonary embolism., 3: Hypertrophic cardiomyopathy is often asymptomatic and diagnosed incidentally by EKG. It can be a cause of sudden death., 4: Valvular heart disease can be associated with IV drug use with the resulting formation of pulmonary embolism., 5: Close living quarters such as army barracks or college dorm rooms are often associated with infectious diseases such as tuberculosis or meningococcemia.

http://www.justforhearts.org/2013/08/for-how-long-a-person-can-survive-without-oxygen-water-food/
http://assets-s3.mensjournal.com/img/article/you-re-breathing-all-wrong/298_298_you-re-breathing-all-wrong.jpg

Lung consolidation syndrome: Examination

Left lower lobe consolidation

- On examination, decreased chest expansion may be noted on the affected side and dullness to percussion
- On auscultation, findings include bronchial breath sounds, inspiratory crackles or crepitations, increased vocal resonance and pleural rub

https://radiopaedia.org/articles/consolidation-basic

Lung consolidation syndrome: Pathology 1

Left lower lobe consolidation

- Pneumonia with pus filling the alveoli is the most common cause of acute consolidation
- Other acute causes include blood from hemorrhage or contusions and transudative fluid from pulmonary edema seen in heart failure

https://radiopaedia.org/articles/consolidation-basic

Lung consolidation syndrome: Pathology 2

Right upper lobe consolidation

- Chronic consolidation will be likely due to a malignant process
- Bronchoalveolar carcinoma, lymphoma and lung neoplasms with post-obstructive pneumonia result in malignant cells causing the consolidation seen on radiograph

https://radiopaedia.org/articles/consolidation-basic

Lung consolidation syndrome: Pathology 3

Right sided consolidation (multi-lobar)

- Chronic consolidation will be likely due to a malignant process
- Bronchoalveolar carcinoma, lymphoma and lung neoplasms with post-obstructive pneumonia result in malignant cells causing the consolidation seen on radiograph

https://radiopaedia.org/articles/consolidation-basic

Lung consolidation syndrome: Pathology 4

Right upper lobe consolidation

- Chronic post-infection diseases such as organising pneumonia or eosinophilic pneumonia as also causes, with alveolar proteinosis a rare cause resulting in alveoli filled with protein

https://radiopaedia.org/articles/consolidation-basic

Lung consolidation syndrome: Radiographic features

- Consolidated areas are radio opaque on chest radiograph and chest CT compared to normally air filled lung tissue
- The distribution pattern of consolidation can aid in narrowing the potential differential diagnosis

https://radiopaedia.org/articles/consolidation-basic

Lung consolidation syndrome: Lobar Consolidation

- Where increased density/opacity is seen in individual lung lobes
- Sharp delineation can be seen when consolidation reaches a fissure, since it does not cross
- Air bronchograms can also be seen due to bronchi becoming visible against the dense diseased tissue
- Volume loss is usually not seen

https://radiopaedia.org/articles/consolidation-basic

Lung consolidation syndrome: Diffuse Consolidation

- Most commonly due to heart failure, resulting in other signs such increased cardiac size, Kerley B-lines, redistribution on pulmonary blood flow and pleural fluid
- Other findings can include multiple ill defined opacities progressing to diffuse spread seen in bronchopneumonia and "white out" of a lung due to progressive consolidation from bronchoalveolar carcinoma

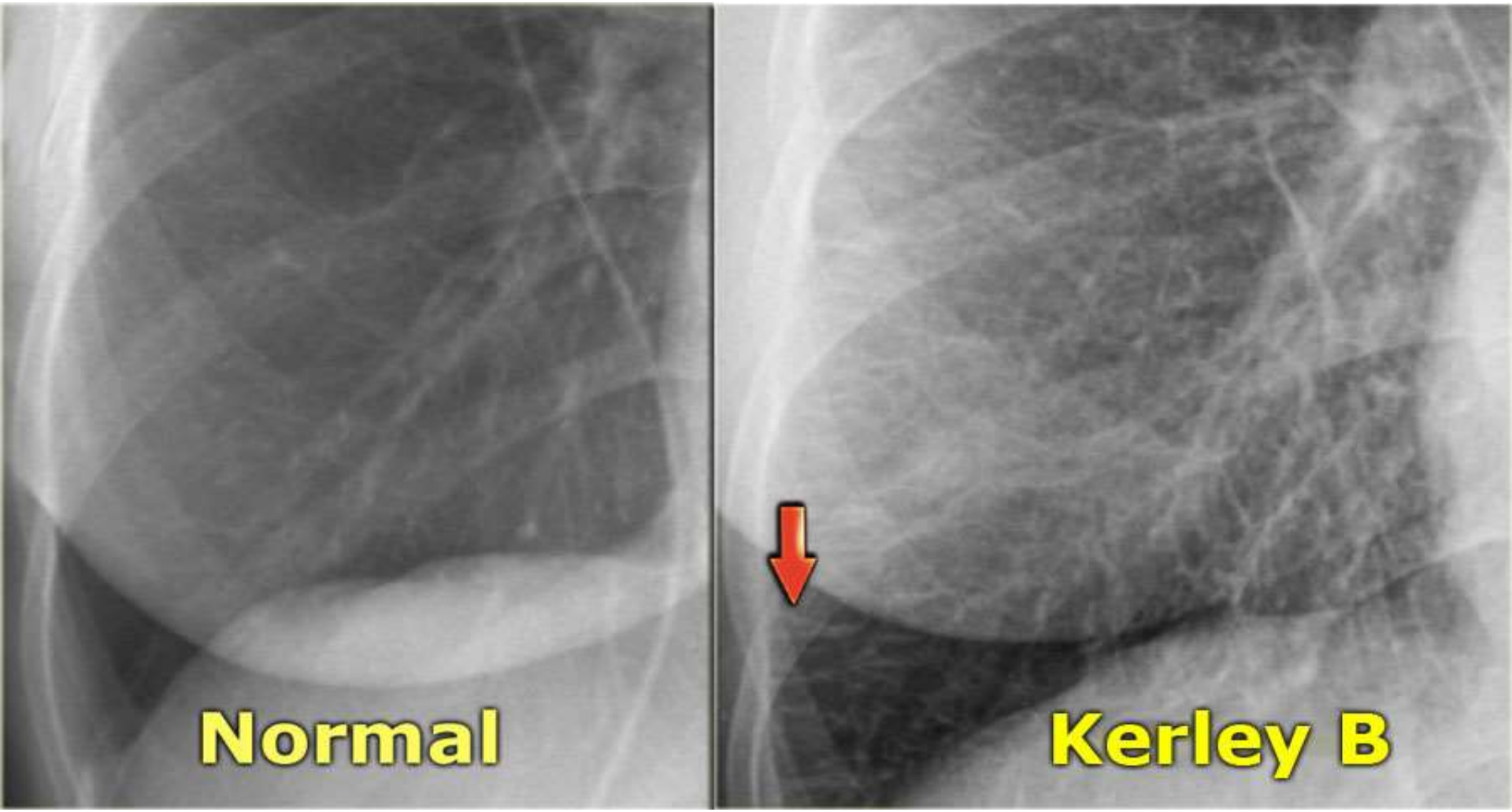
https://radiopaedia.org/articles/consolidation-basic

Lung consolidation syndrome: Kerley B-Lines

- These are short parallel lines at the lung periphery These lines represent interlobular septa, which are usually less than 1 cm in length and parallel to one another at right angles to the pleura
- They are located peripherally in contact with the pleura, but are generally absent along fissural surfaces

https://en.wikipedia.org/wiki/Kerley_lines

Lung consolidation syndrome: Kerley B-Lines



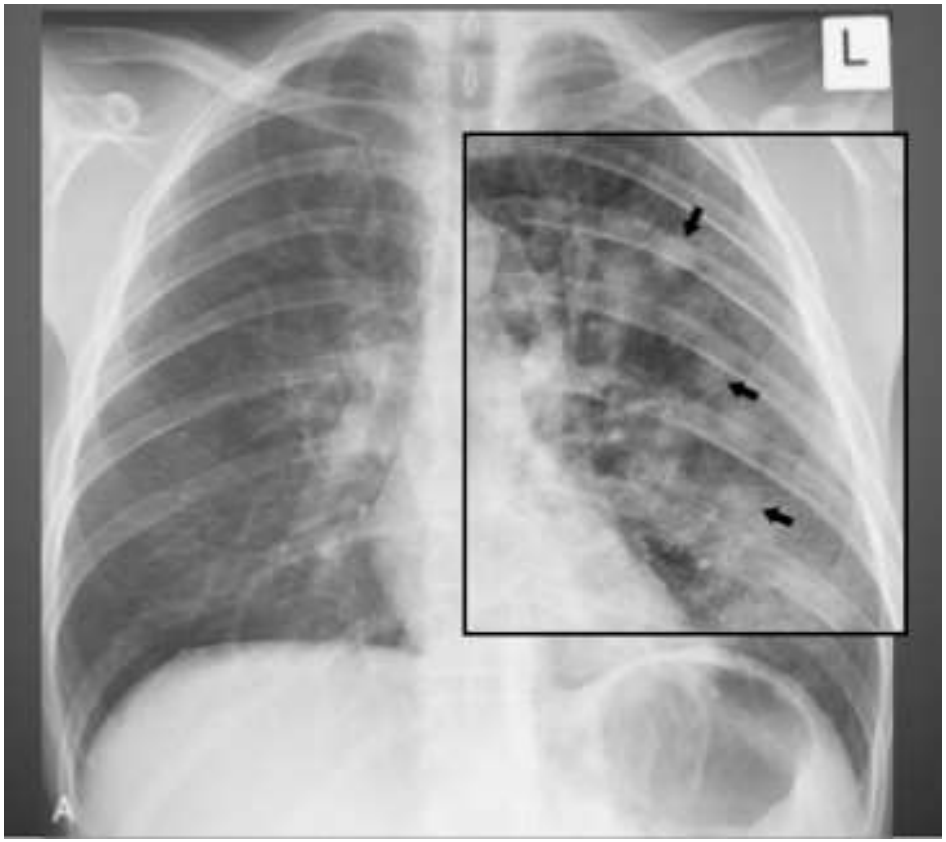
http://www.radiologyassistant.nl/data/bin/a509797a674d64_interstit-1.jpg

Lung consolidation syndrome: Multi-focal Consolidation

- Multiple areas of opacity seen throughout the lung most often is due to bronchopneumonia, starting from bronchi and spreading outwards
- Usually ill defined with peripheral distribution
- Neoplasms such as a primary malignancy or metastasis can also cause this picture

https://radiopaedia.org/articles/consolidation-basic

Lung consolidation syndrome: Multi-focal Consolidation



Bronchopneumonia

http://image.slidesharecdn.com/consolidation-150413132947-conversion-gate01/95/consolidation-16-638.jpg?cb=1428932167

Lung consolidation syndrome: X-ray patterns of consolidation

There is abnormal opacity on the right (arrowed). There is also loss of clarity of the right heart border known as silhouette sign

- Consolidation may be complete or incomplete
- The distribution of the consolidation can vary widely
- A consolidation could be described as “patchy”, “homogenous”, or “generalized”
- A consolidation may be described as focal or by the lobe or segment of lobe affected

http://www.wikiradiography.net/page/Patterns+of+Consolidation

Lung consolidation syndrome: X-ray features 1

The chest X-ray shows an area of lung inflammation indicating the presence of pneumonia

- Opacity of the affected area, lobule or lobe
- Loss of clarity of the heart border, diaphragm and or verterbal bodies (thoracic vertebrae)

http://www.mayoclinic.org/~/media/kcms/gbs/patient%20consumer/images/2013/08/26/10/01/ds00135_im00621_pnuesmal_gif.ashx http://www.healthhype.com/consolidation-in-lung-signs-symptoms-and-causes.html

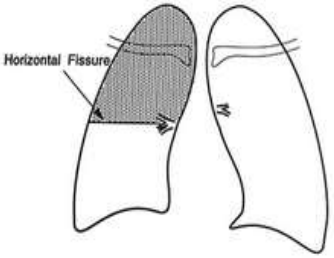
Lung consolidation syndrome: X-ray features 2

The chest X-ray shows an area of lung inflammation indicating the presence of pneumonia

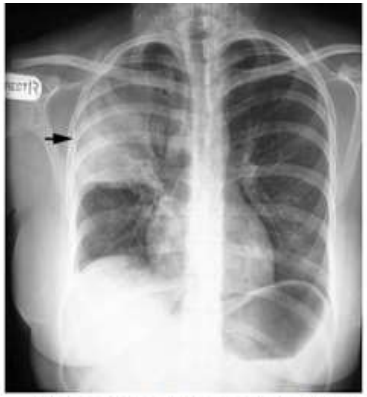
- Patchy consolidation may be seen with bronchopenumonia while confluent consolidation seen in lobar pneumonia
- Cavitation, bulging interlobular fissures and pleural effusion may also be evident

http://www.mayoclinic.org/~/media/kcms/gbs/patient%20consumer/images/2013/08/26/10/01/ds00135_im00621_pnuesmal_gif.ashx http://www.healthhype.com/consolidation-in-lung-signs-symptoms-and-causes.html

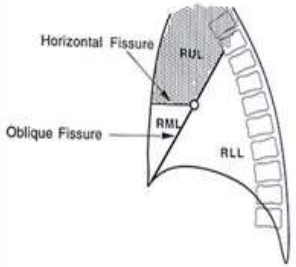
Lung consolidation syndrome:
Right Upper Lobe (RUL) consolidation



RUL consolidation will be seen as an increased opacity within the shaded area. Opacity may be sharply bordered by the horizontal fissure
Some loss of outline of the upper right heart border may be apparent



- Dense opacity seen above the horizontal fissure.
- Air-bronchogram line

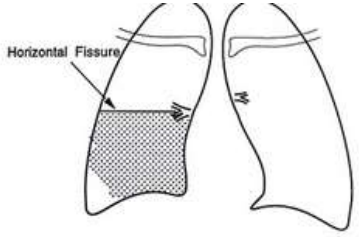


In the lateral view, there will be increased density in the RUL which may be sharply bordered by the horizontal and/or oblique fissure(s).

- Dense opacity in the RUL sharply bordered by the horizontal and oblique fissures

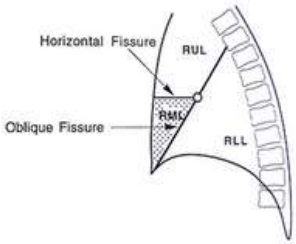
http://www.wikiradiography.net/page/Patterns+of+Consolidation

Lung consolidation syndrome:
Right Middle Lobe (RUL) consolidation

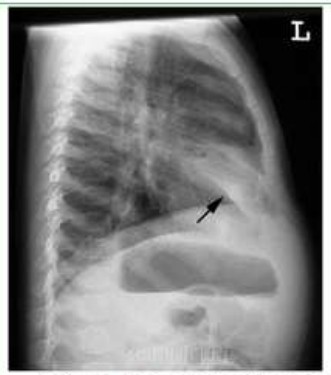


•Seen as an area of increased opacity in the shaded area
•Loss of the definition of the right heart border is often seen

- RML opacification
- Loss of adjacent right heart border



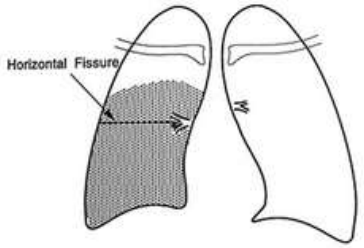
•RML consolidation is characteristically seen as a wedge opacity in the lateral view
•May be sharply bordered by the horizontal and oblique fissures
•(collapse of the lingula segment of the LUL has a similar appearance)



- Wedge shaped opacity characteristic of RML consolidation(black arrow)
- lingula segment consolidation can have a similar appearance on the lateral view
- some RML collapse also present

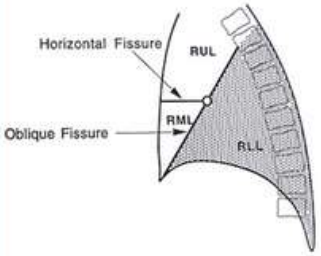
http://www.wikiradiography.net/page/Patterns+of+Consolidation

Lung consolidation syndrome: Right Lower Lobe (RUL) consolidation



•Appears as an area of increased opacity within the RLL
•Some loss of the hemi-diaphragm is commonly seen

•Loss of right hemi-diaphragm
•Dense opacity in RLL
•Some loss of right heart border

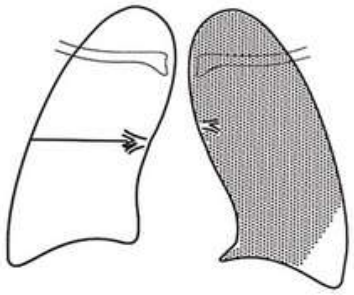


•Increased opacity within the RLL
•Commonly seen with loss of the right hemi-diaphragm

•Triangular opacity
•Loss of right hemi-diaphragm

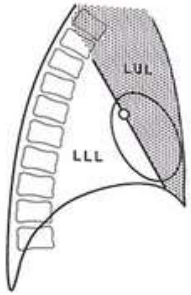
http://www.wikiradiography.net/page/Patterns+of+Consolidation

Lung consolidation syndrome:
Left Upper Lobe (RUL) consolidation



•Appears as an area of increased opacity within the LUL
•Characteristically not a dense opacity on the PA view
•Often loss of the upper mediastinal contour

•Opacity left hemi-thorax
•Air-bronchogram lines
•Some loss of left heart border

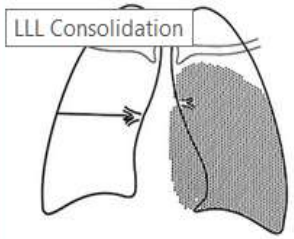


•Can be sharply bordered by the oblique fissure
•Does not involve the diaphragm

•Opacity seen anterior to the oblique fissure

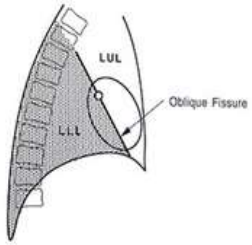
http://www.wikiradiography.net/page/Patterns+of+Consolidation

Lung consolidation syndrome:
Left Lower Lobe (RUL) consolidation



•Appears as an area of increased opacity within the LLL
•Some loss of the hemi-diaphragm is commonly seen
•May be increased density behind left heart shadow

•Appears as an area of increased opacity within the LLL
•Some loss of the hemi-diaphragm medially is seen
•increased density behind left heart shadow



•Increased opacity within the LLL
•Commonly seen with loss of the Left hemi-diaphragm
•May be sharply delineated by oblique fissure

•Increased opacity within the LLL
•Loss of the normal darkening of the t spine some loss of the left hemi-diaphragm posteriorly

http://www.wikiradiography.net/page/Patterns+of+Consolidation

Lung consolidation syndrome: lung ultrasound

- The consolidated lung is ‘hepatisised’ (looks similar to liver)
- Extensive consolidation (of a whole lobe) allows the opposite plural line to be seen (8-11cm deep) with mediastinum deeper and with the aorta or IVC still visible
- A fully consolidated lobe may be seen floating in a pleural effusion

http://www.icmteaching.com/ultrasound/lung%20ultrasound/alveolar%20syndrome/

USMLE STEP 1

A 48-year-old male dies in the intensive care unit following a severe Streptococcus pneumonia and septic shock. Autopsy of the lung reveals a red, firm left lower lobe. What would you most likely find on microscopic examination of the lung specimen?

1. Eosinophilia in the alveolar septa, 2. Vascular dilation and noncaseating granulomas,
3. Fragmented erythrocytes, 4. Alveolar exudate containing neutrophils, erythrocytes, and fibrin,
5. Collagen whorls

http://www.justforhearts.org/2013/08/for-how-long-a-person-can-survive-without-oxygen-water-food/
http://assets-s3.mensjournal.com/img/article/you-re-breathing-all-wrong/298_298_you-re-breathing-all-wrong.jpg

USMLE STEP 1

Correct answer 4: This patient died from lobar pneumonia. The red hepatization phase is grossly characterized by a red, firm lobe with a "liver-like" consistency, that corresponds microscopically to a massive confluent alveolar exudate containing neutrophils, RBCs, and fibrin.

Incorrect answers: 1: Acute eosinophilic PNA is characterized by respiratory distress, eosinophilic infiltration in the lung, acute onset, resolution of symptoms with corticosteroids and the absence of relapse., 2: Vascular dilation is not a common manifestation of PNA. Noncaseating granulomas are often seen in sarcoidosis, not PNA., 3: Invasive Streptococcus PNA is an uncommon cause of hemolytic uremic syndrome which can cause fragmented erythrocytes. This would not be expected in a typical case of PNA. Fragmented red blood cells are also seen in grey hepatization., 5: Whorls of collagen in histological examination are highly indicative of silicosis.

http://www.justforhearts.org/2013/08/for-how-long-a-person-can-survive-without-oxygen-water-food/
http://assets-s3.mensjournal.com/img/article/you-re-breathing-all-wrong/298_298_you-re-breathing-all-wrong.jpg

Lung consolidation syndrome: pulmonary consolidation with fever is not always pneumonia 1

- Microscopic polyangiitis (MPA) is defined as systemic necrotizing vasculitis with few or no immune deposits, affecting small vessels (capillaries, arterioles or venules)
- Although MPA can involve any organ, renal and pulmonary involvement predominate
- Pulmonary involvement can present from fleeting focal infiltrates to massive lung hemorrhage and hemoptysis secondary to alveolar capillaritis

http://www.sciencedirect.com/science/article/pii/S1755001708000328

Lung consolidation syndrome: pulmonary consolidation with fever is not always pneumonia 2

- This is a case of a 39-year-old male who was admitted to hospital due to fever of unknown origin
- He was an ex-smoker (stopped 3 years ago) and his medical history is unremarkable
- Ten days back he was examined by his doctor due to fever, fatigue and dry cough
- He was diagnosed as having pneumonia

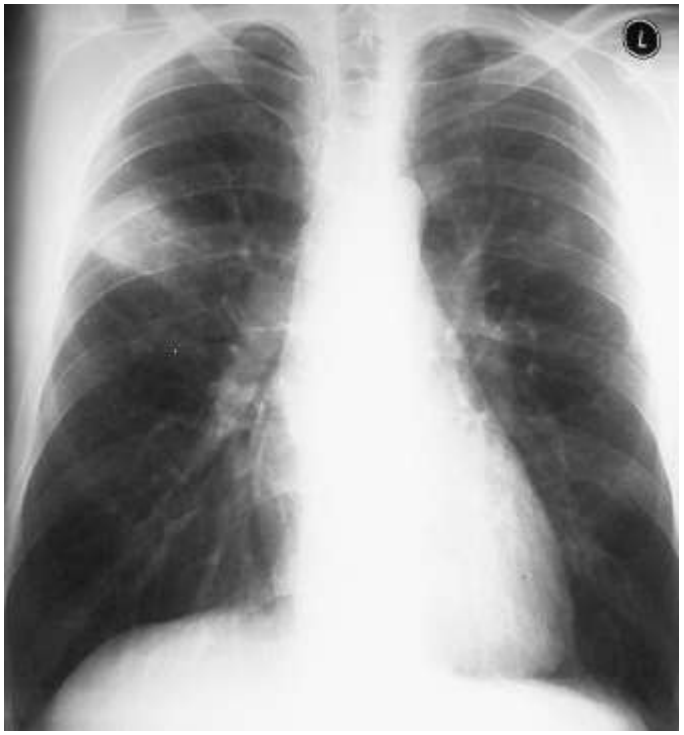
http://www.sciencedirect.com/science/article/pii/S1755001708000328

Lung consolidation syndrome: pulmonary consolidation with fever is not always pneumonia 3

- The patient had normal breath sounds with normal blood gases and his temperature was 38 °C
- Laboratory studies revealed white cell count: 13,9 (N:79, L:11.5, M:8.5, E:0.6) hemoglobulin 13.7 g/dl, the erythrocyte sedimentation rate 72 mm/h
- Renal, liver function and urinalysis were normal
- An arterial blood gas measurement while the patient was breathing room air demonstrated a PaO_2 of 88 mmHg, a $PaCO_2$ 41 mmHg and pH=7.39

http://www.sciencedirect.com/science/article/pii/S1755001708000328

Lung consolidation syndrome: pulmonary consolidation with fever is not always pneumonia 4



Chest radiograph revealed a consolidation in the right upper lobe

http://www.sciencedirect.com/science/article/pii/S1755001708000328

Lung consolidation syndrome: pulmonary consolidation with fever is not always pneumonia 5

- The patient was admitted in hospital and began treatment with moxifloxacin 400 mg once daily
- Sputum and blood cultures were obtained and serology tests were conducted to rule out bacterial or viral infection
- A new radiograph showed an increase of the consolidation
- Due to nonresolving of the shadowing on the X-ray, the treatment was switched to ticarcillin/ potassium plus teicoplanine

http://www.sciencedirect.com/science/article/pii/S1755001708000328

Lung consolidation syndrome: pulmonary consolidation with fever is not always pneumonia 6

Repeat chest radiograph a few days later shows worsening of consolidation

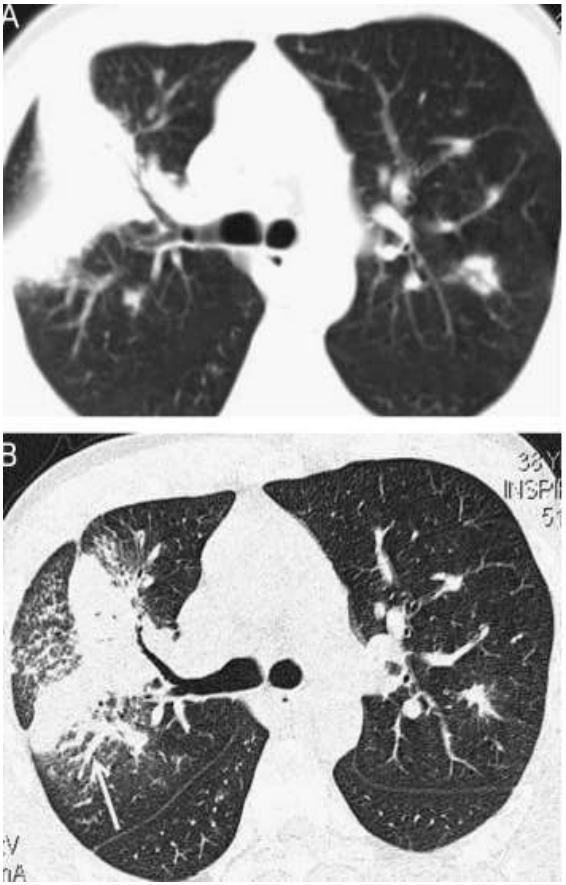
http://www.sciencedirect.com/science/article/pii/S1755001708000328

Lung consolidation syndrome: pulmonary consolidation with fever is not always pneumonia 7

- Chest spiral computed tomography showed a few enlarged lymph nodes in the paratracheal and carinal regions, up to 1.5 cm in the short axis
- Apart from the consolidation in the right upper lobe, CT revealed multiple nodular lesions, some with a central air-bronchogram, scattered in all lobes, more prevalent in the upper and middle lung fields
- Thickened bronchovascular bundles were seen, some connected to nodules

http://www.sciencedirect.com/science/article/pii/S1755001708000328

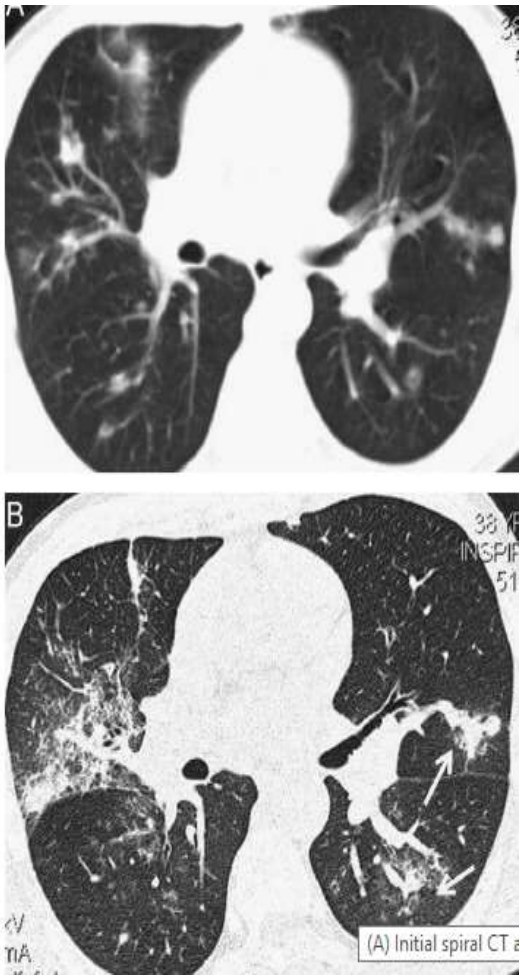
Lung consolidation syndrome: pulmonary consolidation with fever is not always pneumonia 8



- (A) CT obtained at presentation shows air-space consolidation in the right upper lobe and a nodule with air-bronchogram in the left upper lobe
- (B) HRCT reveals development of extensive areas of ground-glass attenuation as well as thickening of bronchovascular bundles (arrow)

http://www.sciencedirect.com/science/article/pii/S1755001708000328

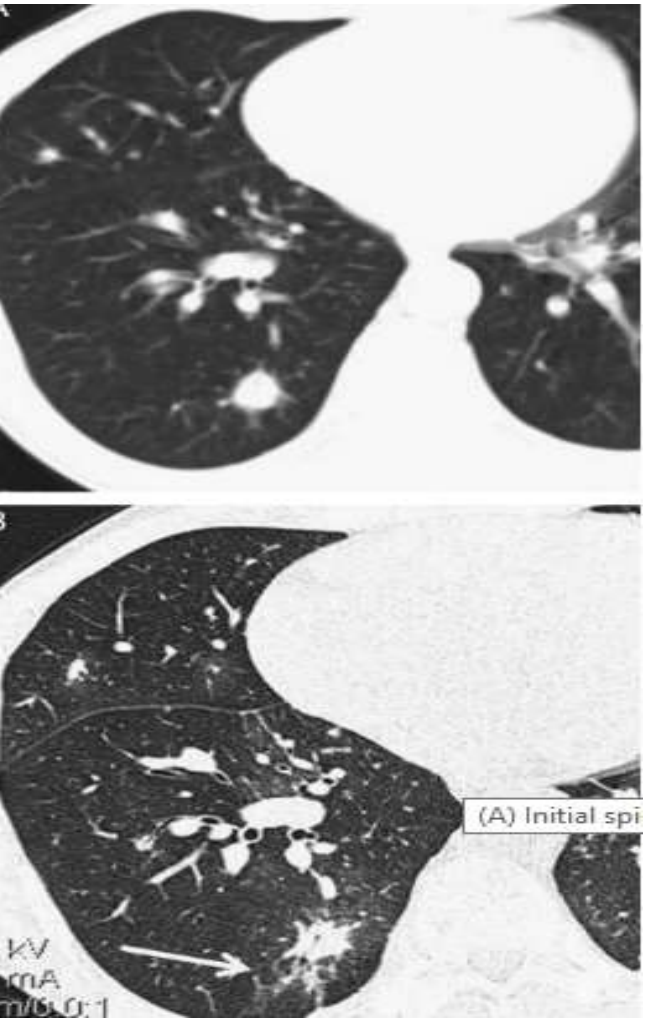
Lung consolidation syndrome: pulmonary consolidation with fever is not always pneumonia 9



- (A) CT: multiple nodules in both lungs connected to thickened bronchovascular bundles
- (B) HRCT: resolution of some nodular opacities in the right lung and patchy ground-glass opacities in both lung fields; newly developed ground-glass areas surround nodules in the left lung, a CT sign strongly indicative of hemorrhagic infiltration (arrows)

http://www.sciencedirect.com/science/article/pii/S1755001708000328

Lung consolidation syndrome: pulmonary consolidation with fever is not always pneumonia 10



- (A) Initial spiral CT at the level of basal segments of the lower lobes shows a rather smooth nodule in the right lower lobe
- (B) Follow-up HRCT shows a halo of ground-glass surrounding the nodule and neighboring peripheral bronchovascular bundle thickening (arrow)

http://www.sciencedirect.com/science/article/pii/S1755001708000328

Lung consolidation syndrome: pulmonary consolidation with fever is not always pneumonia 11

- Taking into account the febrile patient and nonresolving “pneumonia”, the differential diagnosis was broadened widespread infections, tuberculosis, whereas thickened bronchovascular bundles connected with nodules and lymphadenopathy indicated Wegener granulomatosis and lymphoma

http://www.sciencedirect.com/science/article/pii/S1755001708000328

Lung consolidation syndrome: pulmonary consolidation with fever is not always pneumonia 12

- Perinuclear anti-neutrophil cytoplasmic antibodies were positive and renal biopsy revealed focal pauci-immune necrotic glomerulonephritis
- The diagnosis of microscopic polyangiitis was established
- The patient began the treatment with methylprednisolone and
- Remission was achieved

http://www.sciencedirect.com/science/article/pii/S1755001708000328