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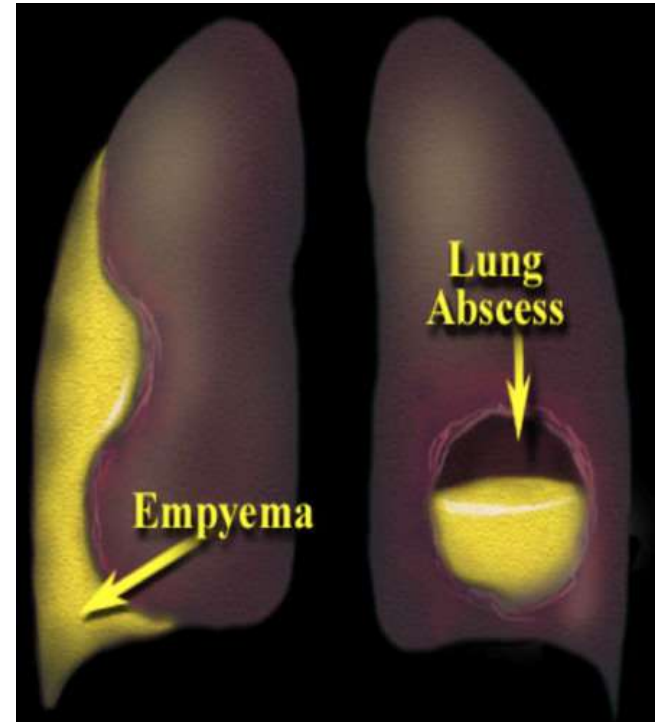
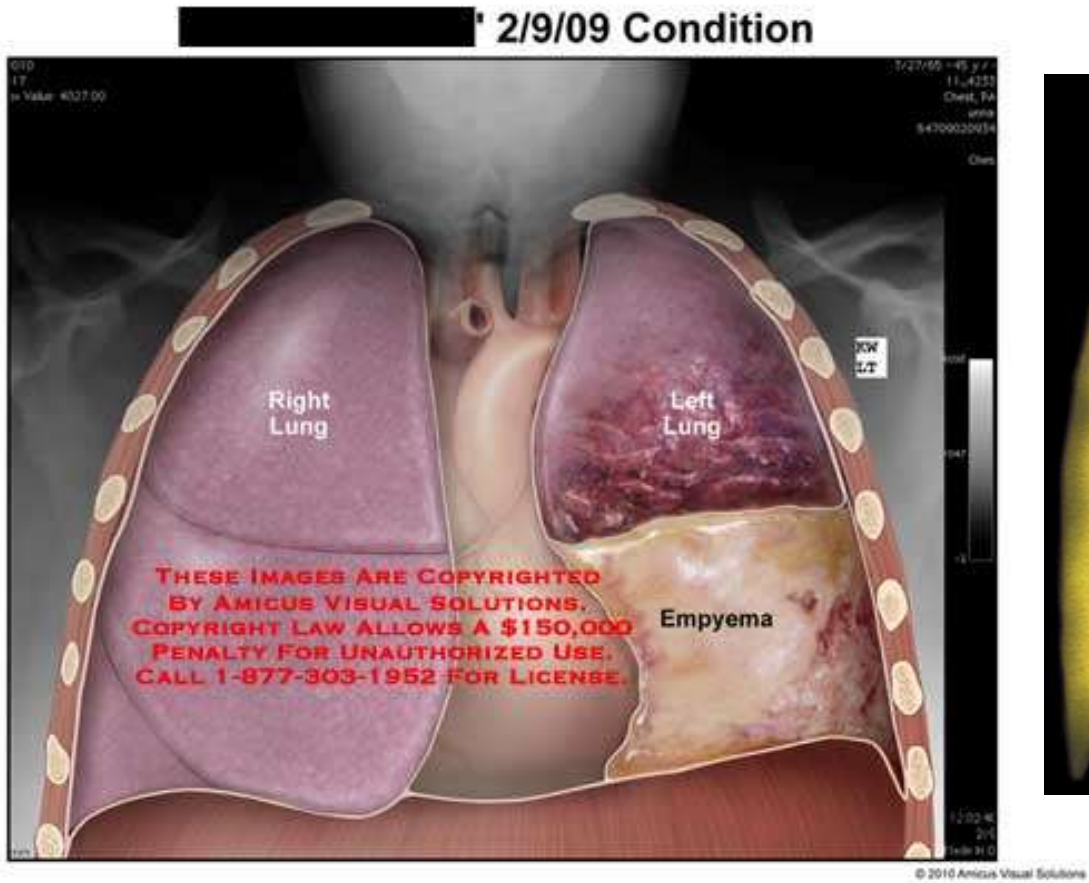
# **Pleural empyema**

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# Pleural empyema

- Pleural empyema is the presence of pus in the pleural space.
- It was first described in the 5th century B.C. by Hippocrates in his aphorisms: *“pleuritis that does not clear up in fourteen days results in empyema”*.

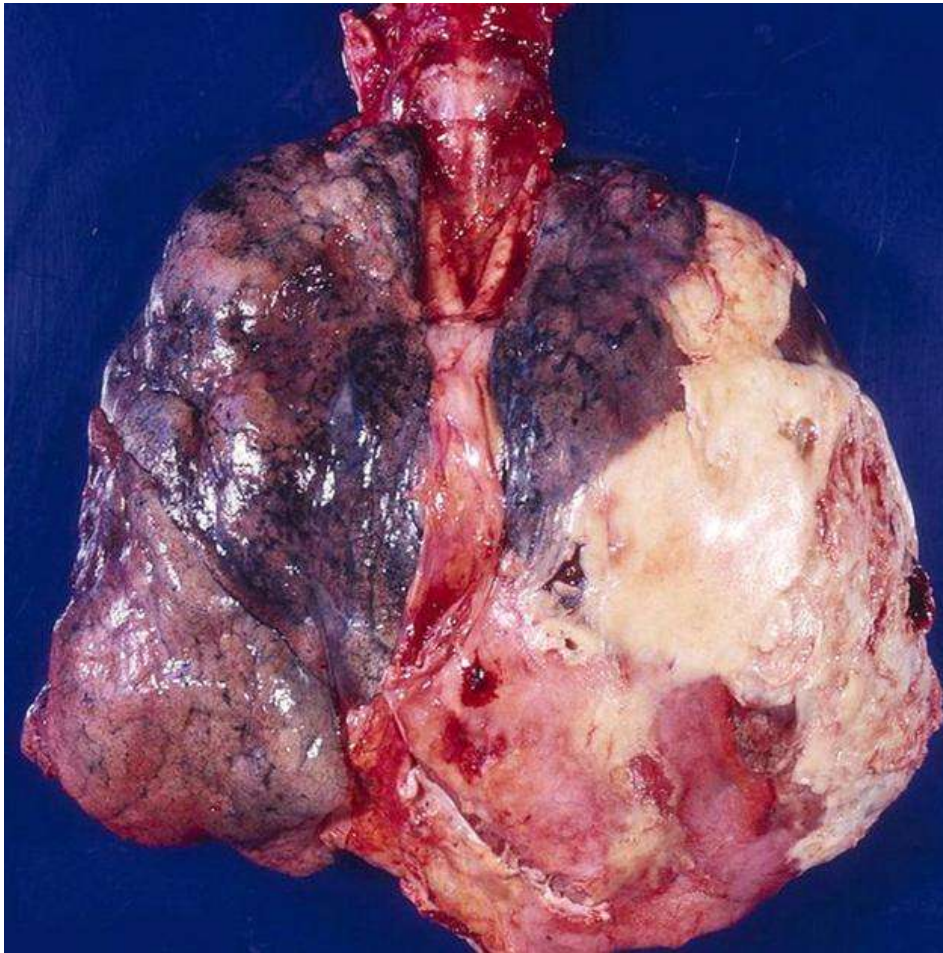
# Pleural empyema



[http://www.medicalexhibits.com/medical\\_exhibits\\_image.php?exhibit=10151\\_02X](http://www.medicalexhibits.com/medical_exhibits_image.php?exhibit=10151_02X)

<http://quizlet.com/3167733/pulmonary-pathology-flash-cards/>

Autopsy specimen of the contents of the chest viewed from behind demonstrates encasement of the left lung by thick purulent exudate which is characteristic of empyema.



<http://radiopaedia.org/cases/empyema-gross-pathology>

# Epidemiology of Empyema

- PPE develop in up to 57% of patients hospitalized with bacterial pneumonias.
- The presence of PPE increases mortality in these patients by about three- to six-fold.
- Among adults, the incidence of empyema increased significantly by 1.2-fold during a nine-year period between 1995 and 2003 in a North American study.<sup>13</sup> Another study, from Utah in the United States, showed a more than six-fold increase in death rate from empyema during a 4-year period between 2000 to 2004 when compared to death rate from empyema during 1950 to 1975.

# Risk factors for Empyema

- Empyema may develop as a complication of pneumonia, or may follow surgery, trauma, iatrogenic procedures, or, rarely, bronchial obstruction from a tumour or foreign body.
- Pleural infection may also occur as a “primary” infection, without evidence of lung parenchymal infection.
- Approximately one third of cases occur in the absence of any identifiable risk factors, suggesting that variation in bacterial virulence or host immune defence may also play important role in empyema development.

# Pathophysiologic classification of pleural effusion

- Pleural effusion secondary to pneumonia is termed *parapneumonic effusion*.
- *Most of these effusions* remain sterile and are resolved with antibiotic therapy - *uncomplicated parapneumonic effusion*, but
- infections of the pleural space develop in a small subset of patients and require drainage for full recovery - *complicated parapneumonic effusion*.
- Without effective drainage, complicated parapneumonic effusion progresses to frank intrapleural pus or empyema.



# Bacteriology

- All patients suspected of having a parapneumonic effusion should undergo a thoracentesis, unless the effusion is very small .
- Bacteriological studies should include a Gram stain and aerobic and anaerobic cultures.
- The majority of culture-positive effusions are due to Aerobic organisms, while up to 15% are caused exclusively by anaerobic bacteria, and the remainder are due to multiple, usually both aerobic and anaerobic, organisms.
- Streptococci (often *Streptococcus pneumoniae*) and Staphylococci (mostly *Staphylococcus aureus*) usually dominate aerobic Gram-positive isolates,
- whilst *Escherichia coli*, *Klebsiella* spp., *Pseudomonas* spp., and *Haemophilus influenzae* are the most common aerobic Gram-negative isolates.
- *E. coli* and anaerobic organisms are often found in combination with other organisms.
- The most frequent anaerobic isolates are *Bacteroides* spp. and *Peptostreptococcus*.
- Occasionally, *Actinomyces* spp., *Nocardia* spp., or fungi (most frequently *Aspergillus*) may be the cause of an empyema.

# Pathophysiology of empyema

- Parapneumonic effusions and empyema usually develop along the following stages:

## **1. The pleuritis sicca stage**

- The inflammatory process of the pulmonary parenchyma extends to the visceral pleura, causing a local pleuritic reaction. This leads to a pleural rub and the characteristic pleuritic chest pain, which originates from the sensitive innervation of the adjacent parietal pleura.
- A significant number of patients with pneumonia report pleuritic chest pain without developing a pleural effusion, suggesting that the involvement of the pleura may be limited to this stage in many cases of pneumonia.

## **2. The exudative stage**

- The ongoing inflammatory process leads to a mediator-induced increased permeability of local tissue and of regional capillaries.
- The subsequent accumulation of fluid in the pleural space is probably the combined result of the influx of pulmonary interstitial fluid and of a local microvascular exudate. The fluid is usually clear and sterile, cytological specimens show a predominance of neutrophils, the pH is normal and the lactate dehydrogenate (LDH) activity is <1,000 international units (IU).

# Pathophysiology of empyema

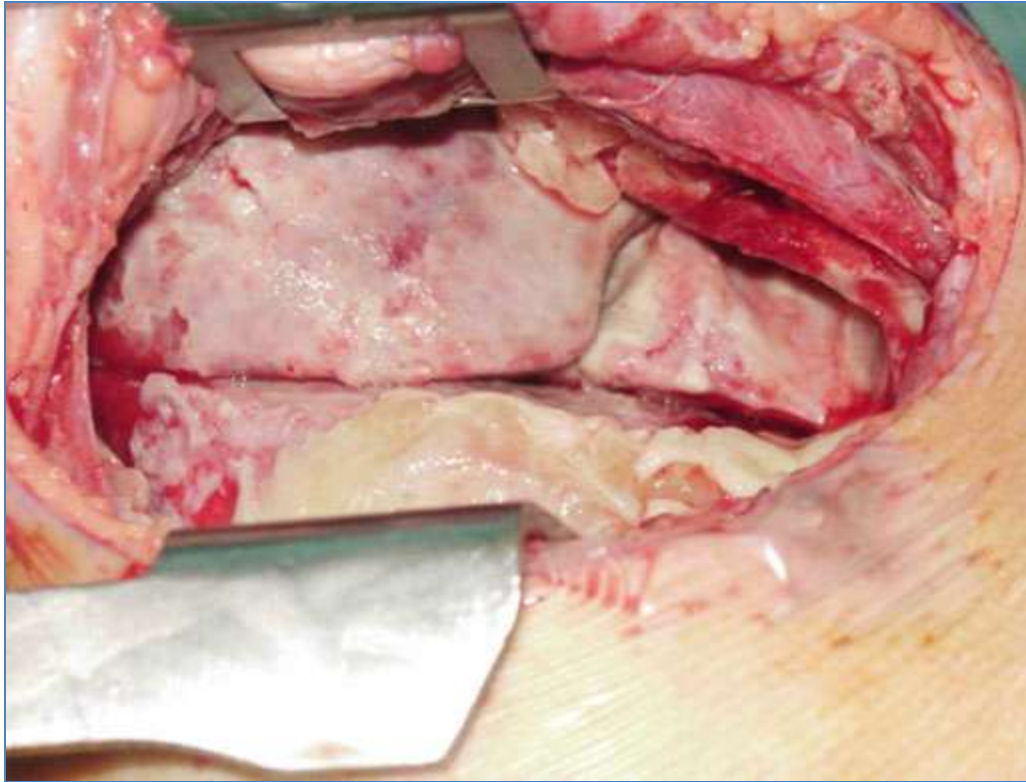
## 3. The fibropurulent stage

- This stage may develop quickly (within hours) in patients who are not receiving antibiotics, or who are treated with ineffective antibiotics.
- **It is characterized by the deposition of fibrin clots and fibrin membranes ("sails") in the pleural space, which lead to loculations with increasing numbers of isolated collections of fluid.**
- It is usually accompanied by (and caused by) bacterial invasion from the pulmonary parenchyma. The fluid is often turbid or frank pus. Cytology shows neutrophils and often degenerated cells, and Gram stains and bacterial cultures are usually positive.
- The metabolic and cytolytical activity in these effusions is high, as reflected by low pH values (<7.2), and high LDH activities (often >1,000 IU).

## 4. The organizational stage

- This final stage is characterized by the invasion of fibroblasts, leading to the transformation of interpleural fibrin membranes into a web of thick and nonelastic pleural peels.
- Functionally, gas exchange is often severely impaired on the side of the organizing empyema ("trapped lung").
- The further course may vary from spontaneous healing with persistent defects of lung function to chronic forms of empyema with high risks for further complications, such as bronchopleural fistula, lung abscess, or "empyema necessitatis" (spontaneous perforation through the chest wall).

# Empyema



Early organization phase

# Clinical presentations

- *Chills, fever, dyspnea, chest pain, or referred pain; recent pulmonary or contiguous infection in the oropharynx, mediastinum, or subdiaphragmatic area;*
- Symptoms suggesting adjacent tissue infection extending to the pleura, i.e., dysphagia, dyspepsia, hiccups, or pharyngeal, abdominal, back, or shoulder pain; recent instrumentation, surgery, or trauma of the chest, oropharynx, esophagus, or abdomen; delayed or incomplete response to appropriate medical therapy for an infection that could extend to the pleura;
- Patients with pneumonia due to infection with aerobic bacteria usually suffer from an acute febrile illness, whilst patients with anaerobic infections tend to present with a more subacute or chronic condition, with a longer duration of symptoms and frequent weight loss.

# Physical examination

- *Physical examination. Diminished breath sounds or basilar dullness to percussion; pleural friction rub; bronchophony or egophony above effusion or adjacent to pneumonia; tracheal or mediastinal shift; scoliosis following a respiratory infection (in children); focal chest wall heat, erythema, swelling, and/or pain (rare); draining dermal sinuses (rare); hyperpyrexia, shock, tachypnea (>30 respirations/min), and/or altered consciousness (all of which may be indicative of disproportionately severe infection).*
- *Clinical course. Rapid onset of clinical deterioration and sepsis with respiratory failure; persistent fever, sepsis, and/or organ failure despite appropriate antibiotic therapy (in a susceptible patient); worsening clinical and laboratory indicators of infection despite appropriate antibiotic therapy.*

# Diagnosis

# ***Pleural fluid***

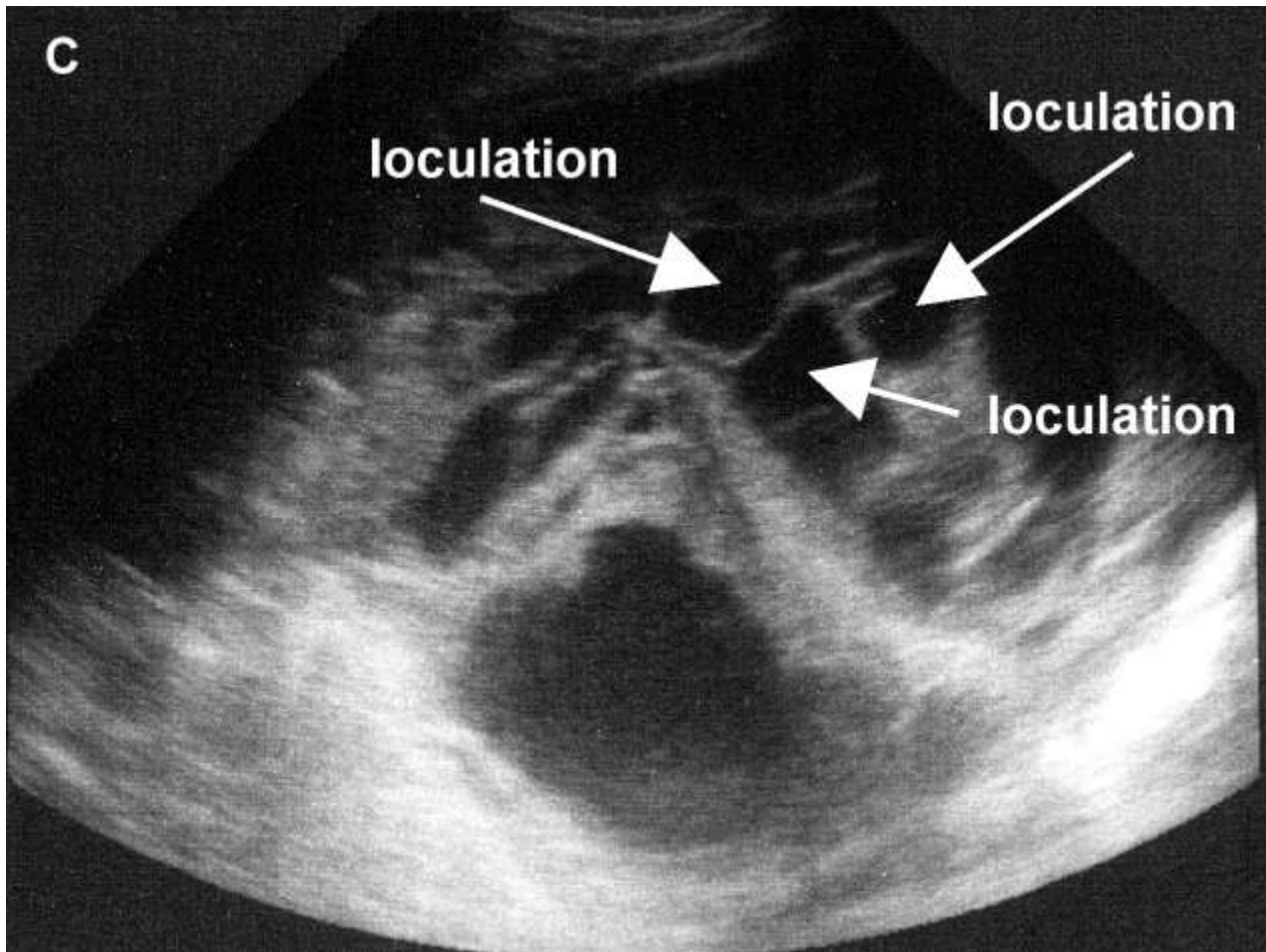
- *Pleural fluid. Cloudy, bloody, or purulent; WBC count  $>50,000 \times 10^9/L$  (usually); pH level  $<7.1$ , lactic dehydrogenase level  $>1,000$  IU/L; glucose level,  $<40$  mg/dL; positive smear stains or cultures; fetid ( 2/3 of anaerobic empyemas).*
- *Findings indicating severe infection. Neutropenia or neutrophilia with immature forms.*



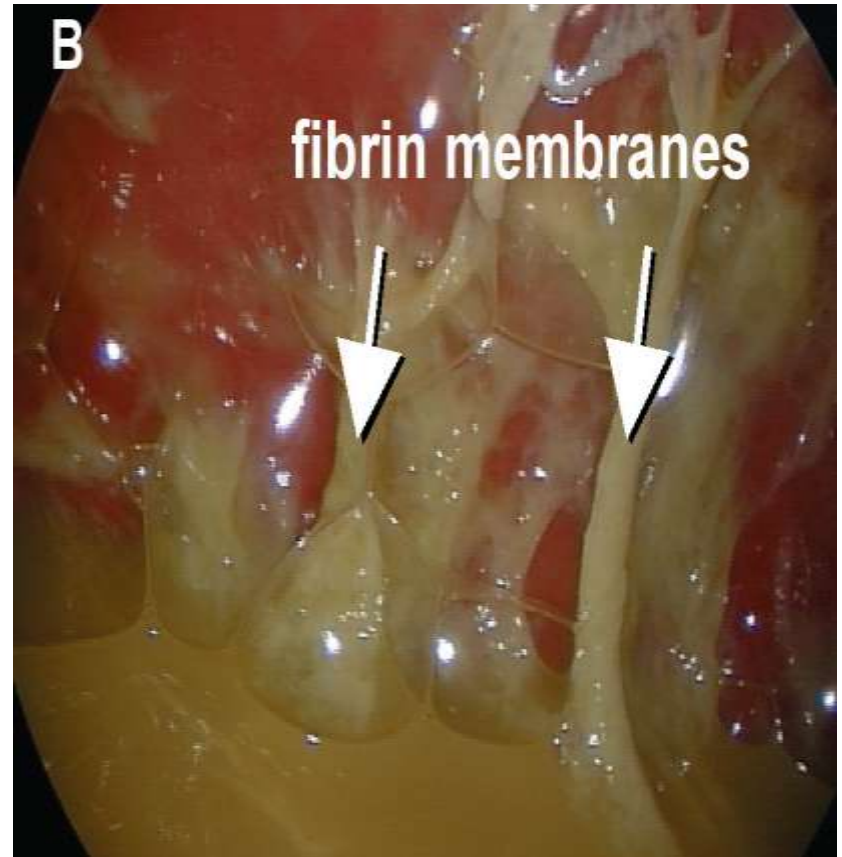
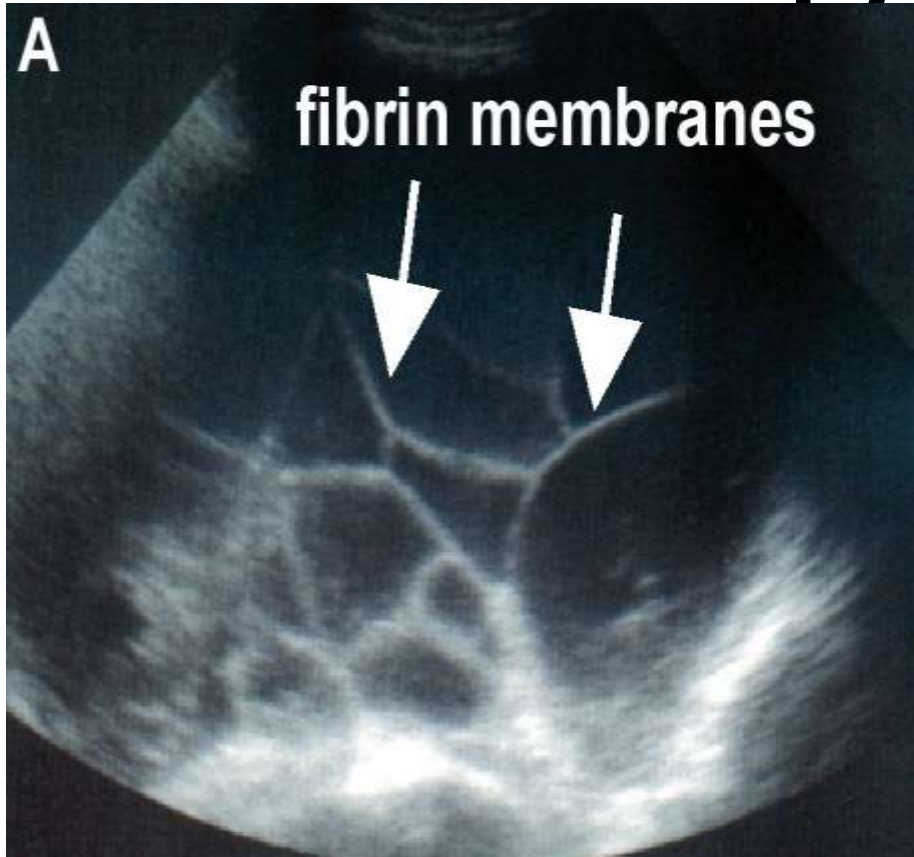
# Ultrasonography

- Ultrasonography is an easy, accessible, economical and helpful tool to identify and quantify pleural septation at an early stage

# Sonographic appearance of parapneumonic effusions: “Complex” effusion in which multiple loculations due to fibrin membranes are visible



# Sonographic appearance of empyema



Sonographic (A) and thoracoscopic appearance (B) of a complex septated parapneumonic effusion with fibrin membranes in the pleural cavity.

# Findings on CT

- **Features suggestive of an empyema include:**
- enhancing thickened pleura (split pleura sign) whereas pleural effusion have thin imperceptible pleural surfaces
- locules of gas absent unless recent thoracocentesis
- obvious septations
- associated consolidation
- associated adjacent infection (e.g. sub-diaphragmatic abscess)

# CT

- **The split pleura sign** is seen with pleural empyemas and is considered the most reliable CT sign helping to distinguish an empyema from a peripheral pulmonary abscess.
- The sign results from fibrin coating both the parietal and pleural surface of the pleura with resulting ingrowth of blood vessels with accompanying enhancement.
- Both layers of the pleura can then be visualised as linear regions of enhancement that come together at the margins of the collection.

# The Split Pleura Sign



Contrast-enhanced transverse CT scan shows empyema between thickened parietal (arrowheads) and visceral (arrow) pleural layers: the split pleura sign.

# Empyema



Coronal reformatted chest CT images show a lesion in the right upper lobe with internal air-filled cavity, thick irregular wall (green arrowheads) and another lesion in the left lower lung with internal fluid, thin wall (yellow arrowhead) and adjacent compression of the lung tissue (yellow arrows and box). The right upper lobe lesion is an abscess and the left lower lung lesion is an empyema

# Plain film

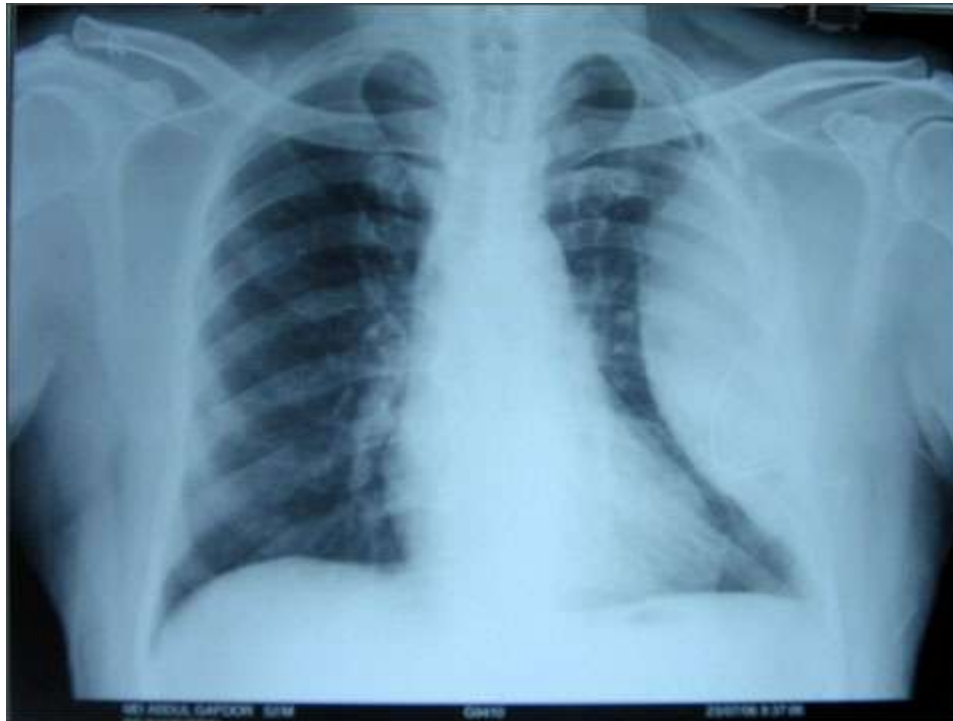
- Can resemble a pleural effusion and can mimic a peripheral pulmonary abscess, although a number of features usually enable distinction between the two empyema vs lung abscess.
- Pleural fluid is typically unilateral or markedly asymmetric.
- **Empyemas usually:**
- form an obtuse angle with the chest wall
- unilateral or markedly asymmetric whereas pleural effusions are (if of any significant size) usually bilateral and similar in size .
- lenticular in shape (bi-convex), whereas pleural effusions are crescentic in shape (i.e concave towards the lung)



# Meniscus sign indicative of a pleural effusion



# Chest X-Ray Empyema-pus in left side of Chest



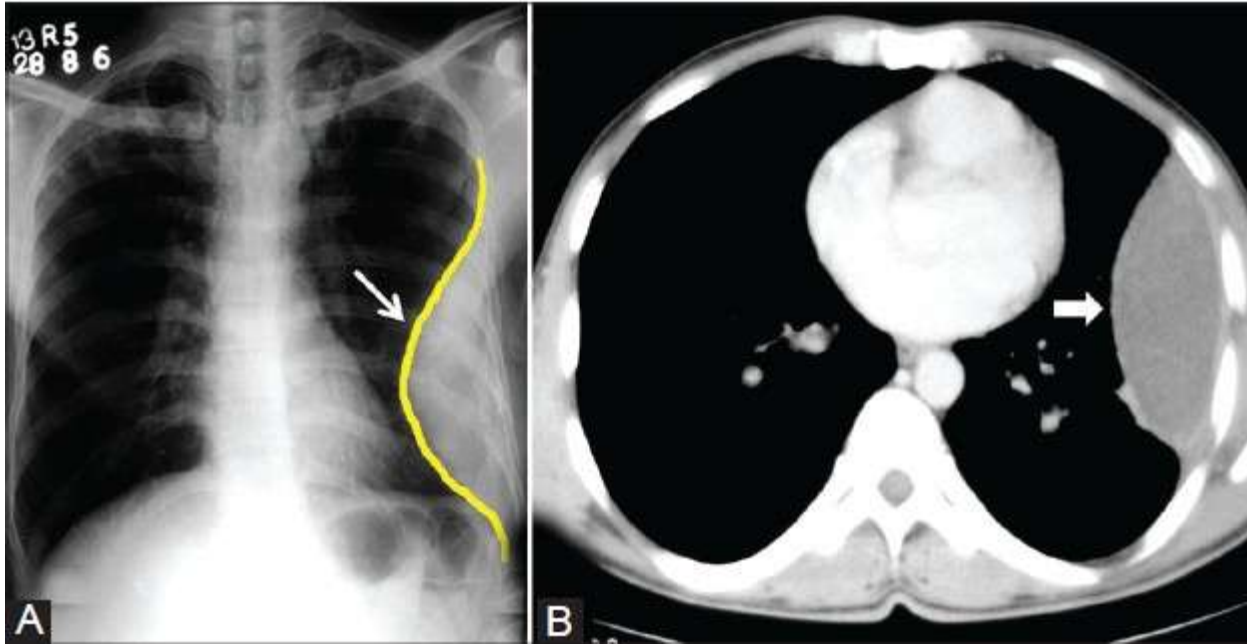
<http://www.drgokhale.com/img/gallery/Thoracic%20Surgery/img46.jpg>

# X-ray showing empyema on right side



<http://www.laparoscopyindia.com/chest-diseases/empyema>

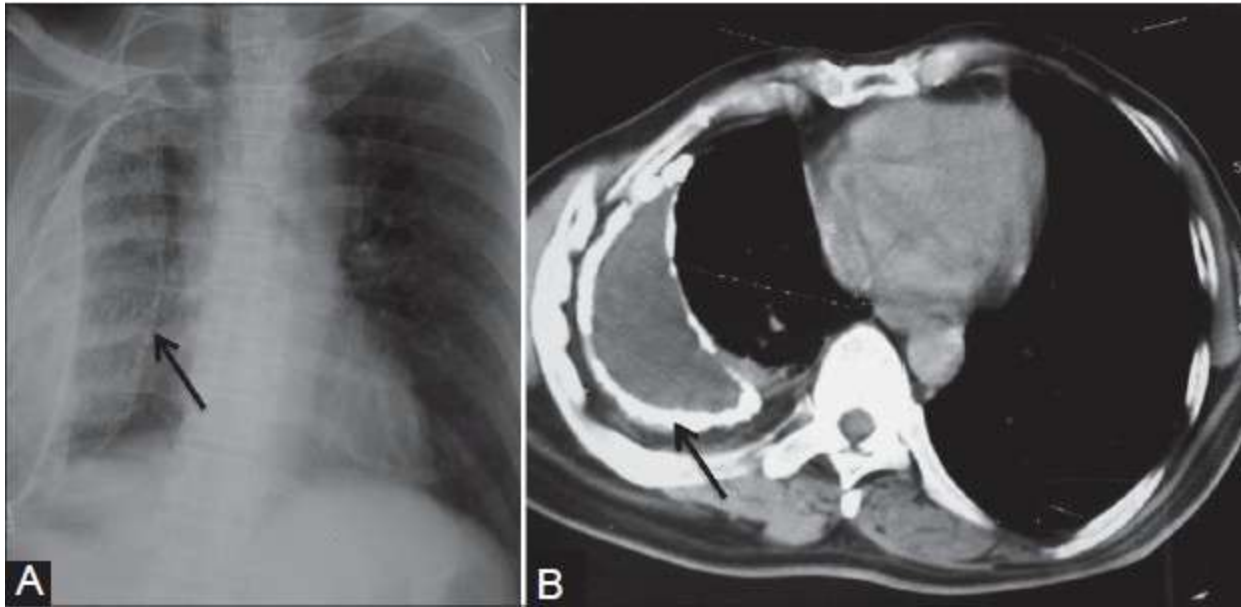
# Loculated empyema



(A) Chest radiograph showing pleural-based opacity (arrow) with tapering obtuse margins in left hemithorax; (B) axial contrast-enhanced CT scan showing loculated collection (arrowhead) with peripherally enhancing thick walls

[http://www.ijri.org/viewimage.asp?img=IndianJRadiolImaging\\_2013\\_23\\_4\\_313\\_125577\\_f3.jp](http://www.ijri.org/viewimage.asp?img=IndianJRadiolImaging_2013_23_4_313_125577_f3.jp)

# Calcified empyema



(A) Chest radiograph showing volume loss right hemithorax with veil-like calcified (arrow) pleural opacity; (B) axial contrast-enhanced CT scan showing evidence of calcified chronic empyema (arrow) with proliferation of extrapleural fat and crowding of ribs suggestive of volume loss in right hemithorax

[http://www.ijri.org/viewimage.asp?img=IndianJRadiolImaging\\_2013\\_23\\_4\\_313\\_125577\\_f4.jpg](http://www.ijri.org/viewimage.asp?img=IndianJRadiolImaging_2013_23_4_313_125577_f4.jpg)

# Treatment of empyema

Treatment, as a rule, is based on antibiotic therapy and complete drainage of the liquid to allow total lung re-expansion.

# Antibiotics

- The mainstay of all therapies in parapneumonic effusions and empyemas is systemic antibiotic therapy.
- Empirical antimicrobial therapy is initiated on the basis of its anticipated bactericidal activity against the suspected microbial pathogens and is changed when the susceptibilities of the infecting microorganism(s) are known.
- Aminopenicillins, penicillins combined with  $\beta$ -lactamase inhibitors (e.g. co-amoxiclav or piperacillin-tazobactam) and cephalosporins show good penetration of the pleural space.

# Antibiotics

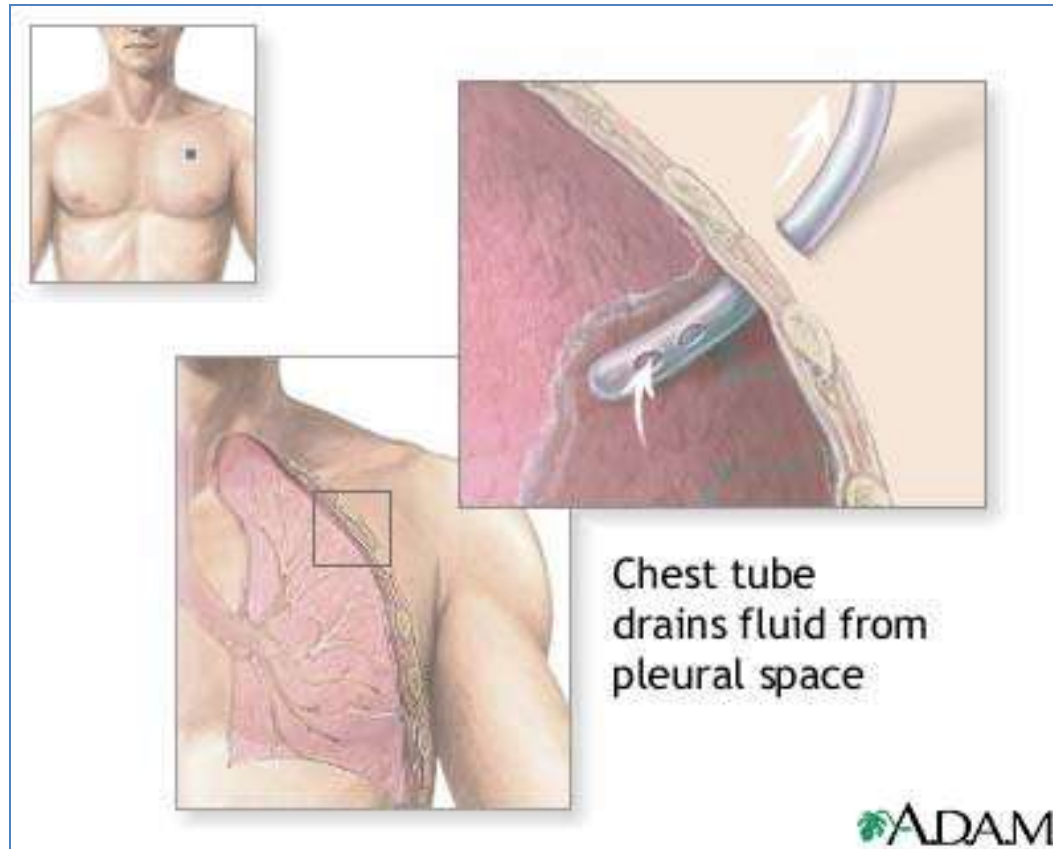
- Aminoglycosides should be avoided as they have poor penetration into the pleural space and may be inactive in the presence of pleural fluid acidosis.
- Macrolide antibiotics are not indicated unless there is objective evidence or high clinical index of atypical pathogens.
- Clindamycin achieves a good penetration of the infected pleural space and can be used either alone or in combination with a cephalosporin.
- Intravenous administration of antibiotics is often appropriate initially but can be changed to oral when objective clinical and biochemical improvement has been observed.
- The duration of treatment is often continued for at least 3 weeks.



# Chest tube drainage

- Lack of response to antibiotics, demonstrated by lack of clinical and radiological improvement, is a strong indication for chest tube drainage.
- The optimum size of chest tube and duration of drainage is still under discussion.
- Removal of the chest drain is appropriate depending on two factors: first, after radiological confirmation of successful pleural drainage, i.e. reduction in the size of pleural collection on the chest x-ray or thoracic ultrasound; and second, objective evidence of sepsis resolution, i.e. improvement in temperature and clinical condition and decreasing inflammatory markers.

# Chest tube



[http://lungcancer.ucla.edu/adm\\_proc\\_chest.html](http://lungcancer.ucla.edu/adm_proc_chest.html)

# Chest drain



[http://www.surgical-tutor.org.uk/default-home.htm?specialities/cardiothoracic/chest\\_drains.htm~right](http://www.surgical-tutor.org.uk/default-home.htm?specialities/cardiothoracic/chest_drains.htm~right)

# Fibrinolytic agents

- Fibrinolytics induce enzymatic lysis of adhesions and debridement.
- Today, fibrinolytic agents are recommended when chest tube drainage and a course of adequate antibiotics have failed to improve the situation, and when the effusion is loculated.
- Optimal dosage and timing of therapy are unknown.
- Most studies have used single doses of 250,000 IU streptokinase or 100,000 IU urokinase.
- Usually, the procedure is carried out as follows: the fibrinolytic substance is diluted in 100 mL saline and instilled *via the* chest tube. The tube is then clamped for 1–4 h. The instillation is usually repeated once daily, and is continued for several days, sometimes for periods of up to 2 weeks.

# Thoracoscopy

- Thoracoscopy has been used as an alternative to thoracotomy in pleural effusion due to lung infection, because it allows the mechanical removal of infected material and permits lung re-expansion.
- It is possible to open multiple loculations and aspirate the purulent liquid, removing the fibrinous adhesions, including the layer on visceral pleura.
- Most thoracoscopic empyema treatments are performed and described by surgeons using classical three-entry port intervention under general anaesthesia and double-lumen intubation (VATS).
- VATS can disrupt intrapleural adhesions and achieve complete drainage of loculated effusions refractory to intracavitary thrombolytic therapy

# Surgical decortication

- Decortication is a surgical procedure that removes a restrictive layer of fibrous tissue overlying the lung, chest wall, and diaphragm. The aim of decortication is to remove this layer and allow the lung to reexpand. When the peel is removed, compliance in the chest wall returns, the lung is able to expand and deflate, and patient symptoms improve rapidly

<http://emedicine.medscape.com/article/1970123-overview>

- It is still indicated in cases when, 6 months after the acute stage, the pleura is still thickened and the patient's pulmonary function is sufficiently reduced to limit normal activities.

[http://www.researchgate.net/profile/Valentina\\_Pinelli/publication/49736268\\_Practical\\_management\\_of\\_pleural\\_empyema/file/504635166b0a21eb33.pdf](http://www.researchgate.net/profile/Valentina_Pinelli/publication/49736268_Practical_management_of_pleural_empyema/file/504635166b0a21eb33.pdf)

# Complications of empyema

- Bronchopleural fistula
- Empyema necessitatis
- Empyema necessitatis occurs when an empyema extends through the parietal pleura into the surrounding tissues. EN has become less common with the routine drainage of empyema and antibiotic use. Most cases reported in the modern literature have been in immunocompromised patients.  
<http://journal.publications.chestnet.org/article.aspx?articleID=1086918>
- Inability to re-expand the trapped lung and difficulty in achieving therapeutic drug levels in pleural fluid