PLEURAL EFFUSION

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The accumulation of serous fluid within the pleural space is termed pleural **effusion**. The accumulation of frank pus is termed **empyema** , that of blood is **haemothorax**, and that of chyle is a **chylothorax**. In general, pleural fluid accumulates as a result of either increased hydrostatic pressure or decreased osmotic pressure (‘transudative’ effusion, as seen in cardiac, liver or renal failure), or from increased microvascular pressure due to disease of the pleura or injury in the adjacent lung (‘exudative effusion). The causes of the majority of pleural effusions are identified by a thorough history, examination and relevant investigations

Normal pleural fluid

Normal pleural fluid has the following characteristics:

- Clear ultrafiltrate of plasma that originates from the parietal pleura
- A pH of 7.60–7.64
- Protein content of less than 2% (1–2 g/dL)
- Fewer than 1000 white blood cells (WBCs) per cubic millimeter
- Glucose content similar to that of plasma
- Lactate dehydrogenase (LDH) less than 50% of plasma

TABLE 99-3 MECHANISMS PROMOTING PLEURAL FLUID ACCUMULATION

MICROVASCULAR CIRCULATION
Increased hydrostatic pressure (heart failure) Decreased oncotic pressure (severe hypoalbuminemia) Increased permeability (pneumonia)
PLEURAL SPACE
Decreased pressure (lung collapse)
LYMPHATICS
Impaired lymphatic drainage (malignant effusion)
DIAPHRAGM
Movement of fluid from the peritoneal space (hepatic hydrothorax)

19.14 Causes of pleural effusion

Common causes

- Pneumonia ('para-pneumonic effusion')
- Tuberculosis
- Pulmonary infarction*
- Malignant disease
- Cardiac failure*
- Subdiaphragmatic disorders (subphrenic abscess, pancreatitis etc.)

Uncommon causes

- Hypoproteinaemia* (nephrotic syndrome, liver failure, malnutrition)
- Connective tissue diseases* (particularly systemic lupus erythematosus (SLE) and rheumatoid arthritis)
- Post-myocardial infarction syndrome
- Acute rheumatic fever
- Meigs' syndrome (ovarian tumour plus pleural effusion)
- Myxoedema*
- Uraemia*
- Asbestos-related benign pleural effusion

*May cause bilateral effusions.

- Frankly purulent fluid indicates an empyema
- A putrid odor suggests an anaerobic empyema
- A milky, opalescent fluid suggests a chylothorax, resulting most often from lymphatic obstruction by malignancy or thoracic duct injury by trauma or surgical procedure
- Grossly bloody fluid may result from trauma, malignancy, postpericardiotomy syndrome, or asbestos-related effusion and indicates the need for a spun hematocrit test of the sample. A pleural fluid hematocrit level of more than 50% of the peripheral hematocrit level defines a hemothorax, which often requires tube thoracostomy
- Black pleural fluid suggests a limited number of diseases, including infection with *Aspergillus niger* or *Rizopus oryzae*, malignant melanoma, non-small cell lung cancer or ruptured pancreatic pseudocyst, or charcoal-containing empyema[21]

Clinical assessment Symptoms (pain on inspiration and coughing) and signs of pleurisy (a pleural rub) often precede the development of an effusion, especially in patients with underlying pneumonia, pulmonary infarction or connective tissue disease. When breathlessness is the only symptom, however, the onset may be insidious, depending on the size and rate of accumulation .

On examination diminished chest expansion, stony dull percussion notes and decrease air entry on auscultation.

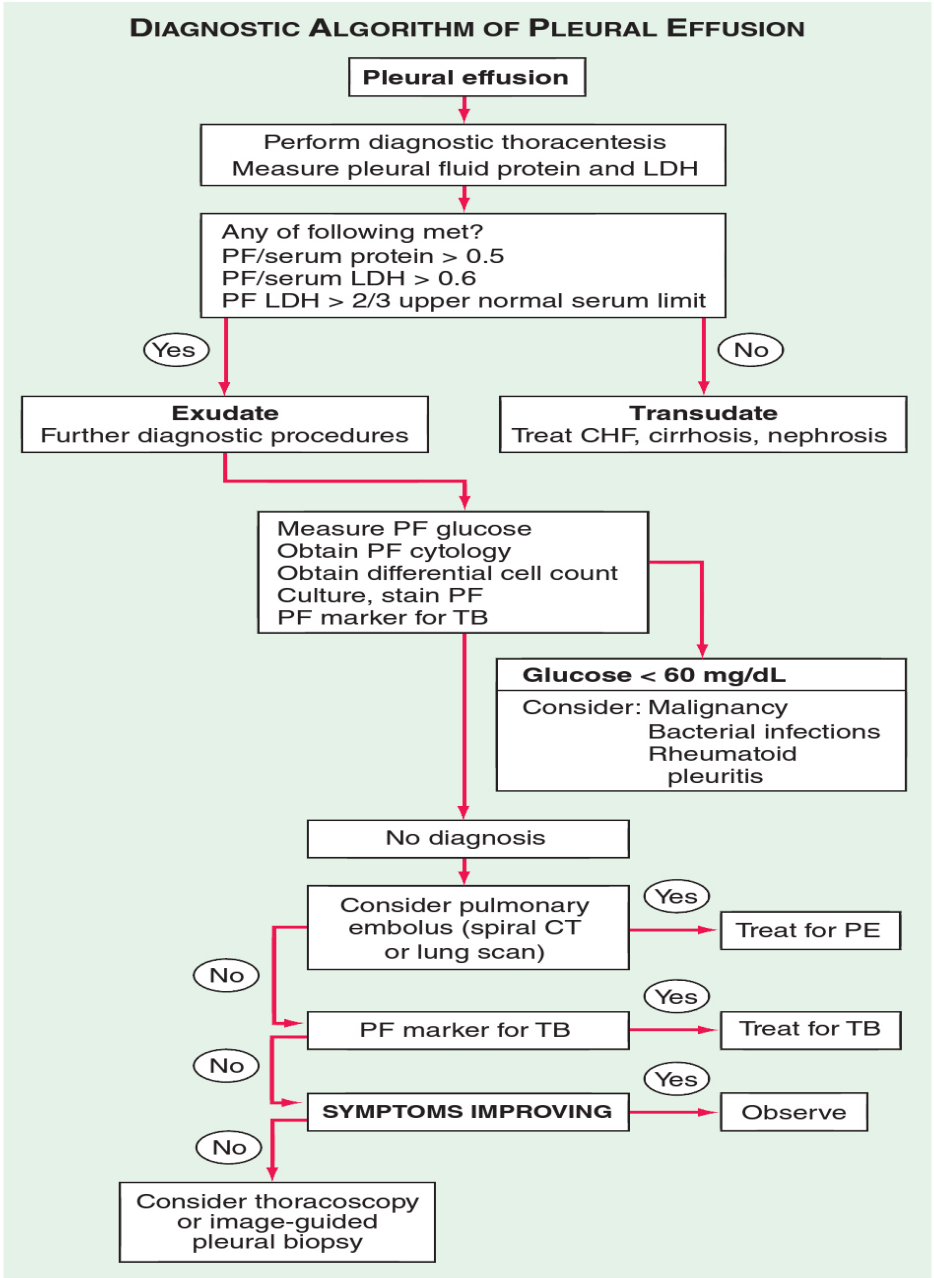
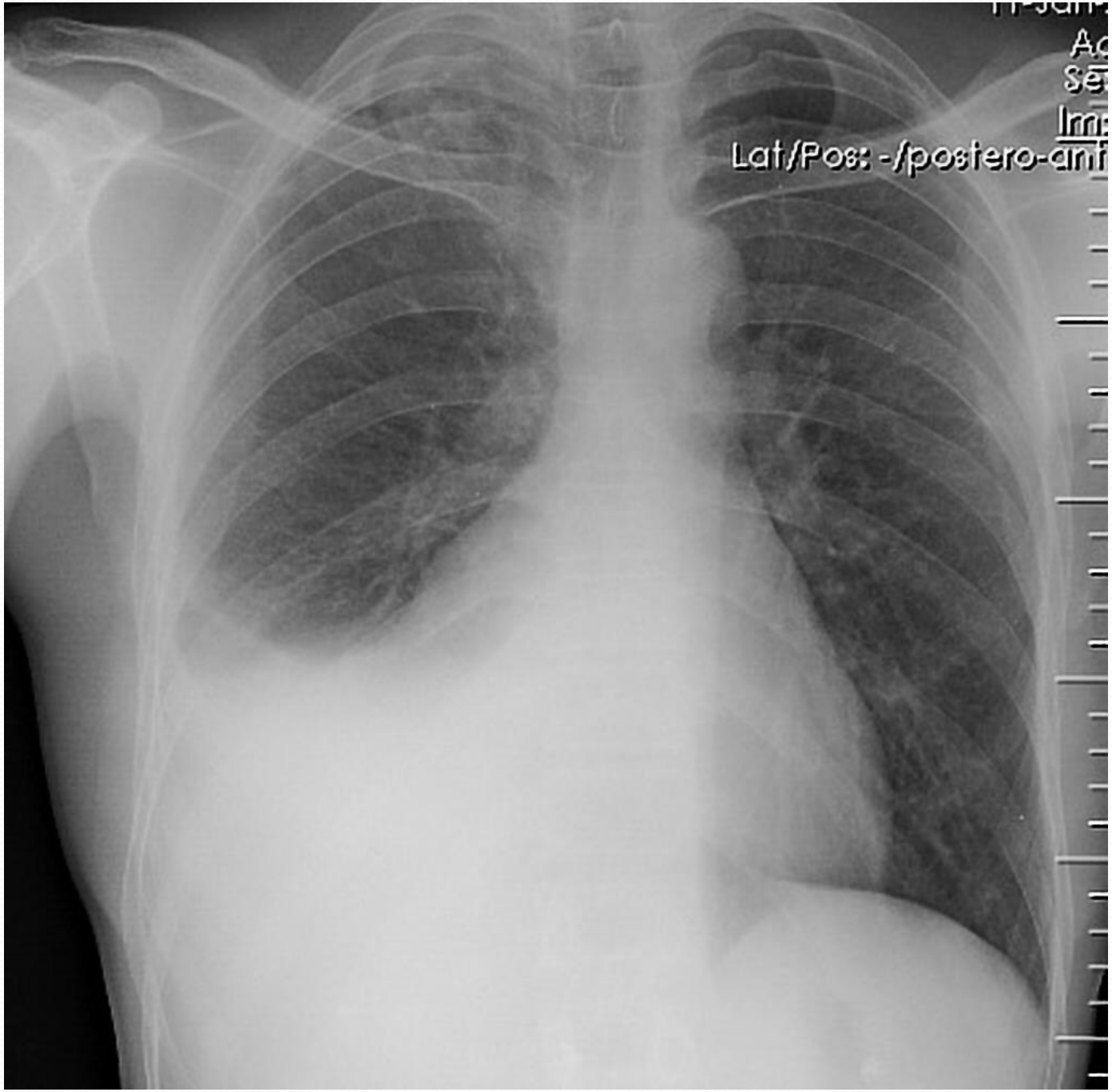


FIGURE 316-1 Approach to the diagnosis of pleural effusions. CHF, congestive heart failure; CT, computed tomography; LDH, lactate dehydrogenase; PE, pulmonary embolism; PF, pleural fluid; TB, tuberculosis.

Investigations

Radiological investigations The classical appearance of pleural fluid on the erect PA chest film is of a curved shadow at the lung base, blunting the costophrenic angle and ascending towards the axilla . Fluid appears to track up the lateral chest wall. In fact, fluid surrounds the whole lung at this level but casts a radiological shadow only where the X-ray beam passes tangentially across the fluid against the lateral chest wall. **Around 200 mL of fluid is required in order for it to be detectable on a PA chest X-ray**. Previous scarring or adhesions in the pleural space can cause localized effusions. Pleural fluid localized below the lower lobe ('subpulmonary effusion') simulates an elevated hemidiaphragm. Pleural fluid localised within an oblique fissure may produce a rounded opacity that may be mistaken for a tumour. Ultrasound is more accurate than plain chest X-ray for determining the presence of fluid. A clear hypoechoic space is consistent with a transudate and the presence of moving, floating densities suggests an exudate. The presence of septation most likely indicates an evolving empyema or resolving haemothorax. CT scanning is indicated where malignant disease is suspected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19.15 Pleural effusion: main causes and features

Cause	Appearance of fluid	Type of fluid	Predominant cells in fluid	Other diagnostic features
Tuberculosis	Serous, usually amber-coloured	Exudate	Lymphocytes (occasionally polymorphs)	Positive tuberculin test Isolation of *M. tuberculosis* from pleural fluid (20%) Positive pleural biopsy (80%) Raised adenosine deaminase
Malignant disease	Serous, often blood-stained	Exudate	Serosal cells and lymphocytes Often clumps of malignant cells	Positive pleural biopsy (40%) Evidence of malignancy elsewhere
Cardiac failure	Serous, straw-coloured	Transudate	Few serosal cells	Other signs of cardiac failure Response to diuretics
Pulmonary infarction	Serous or blood-stained	Exudate (rarely transudate)	Red blood cells Eosinophils	Evidence of pulmonary infarction Obvious source of embolism Factors predisposing to venous thrombosis
Rheumatoid disease	Serous Turbid if chronic	Exudate	Lymphocytes (occasionally polymorphs)	Rheumatoid arthritis: rheumatoid factor and anti-CCP antibodies Cholesterol in chronic effusion; very low glucose in pleural fluid
SLE	Serous	Exudate	Lymphocytes and serosal cells	Other signs of SLE Antinuclear factor or anti-DNA positive
Acute pancreatitis	Serous or blood-stained	Exudate	No cells predominate	Higher amylase in pleural fluid than in serum
Obstruction of thoracic duct	Milky	Chyle	None	Chylomicrons

(anti-CCP = anti-cyclic citrullinated peptide; SLE = systemic lupus erythematosus)

TABLE 76-1 Rules to Classified Pleural Fluid as Exudate Versus Transudate

Rule	Criteria
Light's criteria	PF/serum protein ratio >0.5, or PF/serum LDH ratio >0.6, or PF LDH > two-thirds upper limits of the laboratory's normal serum LDH
Rule that does not require serum tests	PF protein >2.9 g/dL, or PF cholesterol >45 mg/dL, or PF LDH >0.45 times upper limit of the laboratory's normal serum LDH

LDH, lactate dehydrogenase; PF, pleural fluid; S, serum.

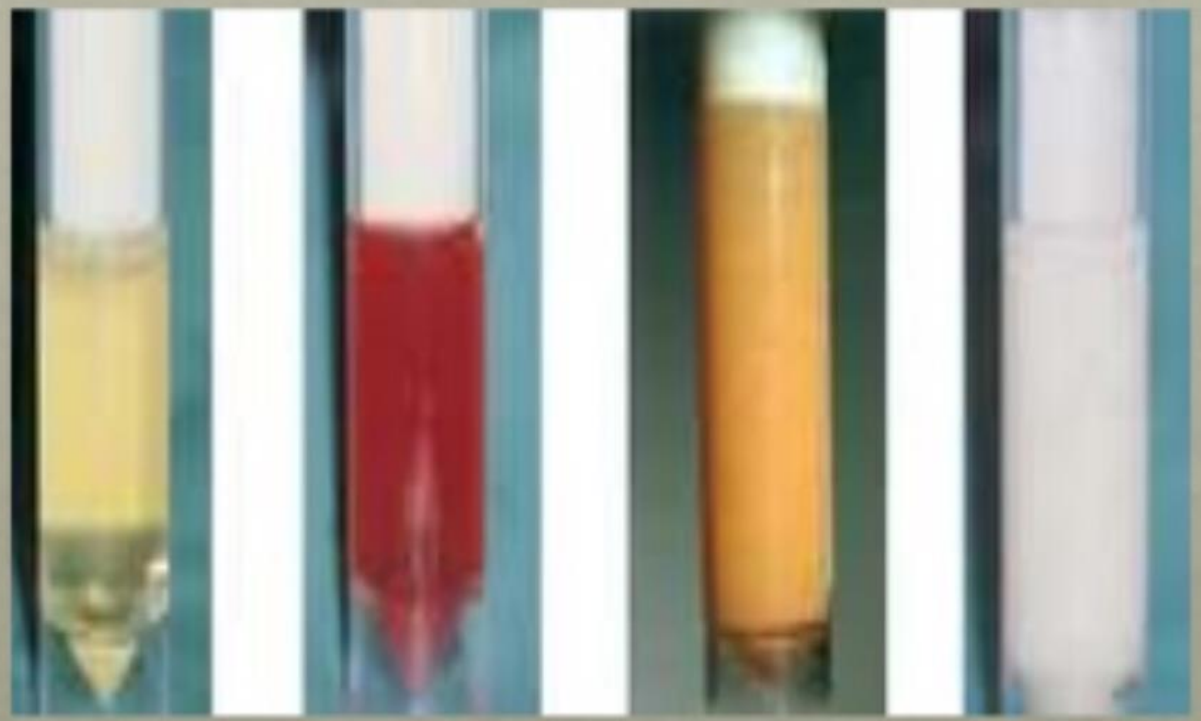
Pleural aspiration and biopsy In some conditions (e.g. **left ventricular failure), it should not be necessary to sample fluid unless atypical features are present; appropriate treatment should be administered and the effusion re-evaluated**. In most other circumstances, however, diagnostic sampling is required. Simple aspiration provides information on the colour and texture of fluid and these alone may immediately suggest an empyema or chylothorax. The presence of blood is consistent with pulmonary infarction or malignancy but may result from a traumatic tap. Biochemical analysis allows classification into transudate and exudate and Gram stain may suggest parapneumonic effusion. The predominant cell type provides useful information and cytological examination is essential. **A low pH suggests infection but may also be seen in rheumatoid arthritis, ruptured oesophagus or advanced malignancy**. Ultrasound- or CT-guided pleural biopsy provides tissue for pathological and microbiological analysis. Where necessary, video-assisted thoracoscopy allows visualisation of the pleura and direct guidance of a biopsy.

TABLE 99-6 CORRELATION OF THE CHARACTERISTICS OF PLEURAL EXUDATES WITH SPECIFIC DISEASE

TEST	DISEASE
pH < 7.2	Empyema, malignancy, esophageal rupture; rheumatoid, lupus, and tuberculous pleuritis
Glucose (<60 mg/dL)	Infection, rheumatoid pleurisy, tuberculous and lupus effusions, esophageal rupture
Amylase (>200 μg/dL)	Pancreatic disease, esophageal rupture, malignancy, ruptured ectopic pregnancy
RF, ANA, LE cells	Collagen vascular disease
↓ Complement	SLE, RA
RBCs (>5000/μL)	Trauma, malignancy, pulmonary embolus
Chylous effusion (triglycerides > 110 mg/dL)	Tuberculosis, disruption of thoracic duct (trauma, malignancy)
Cytology or biopsy (+)	Malignancy
ADA (>50 μg/L)	Tuberculosis

ADA = adenosine deaminase; ANA = antinuclear antibody; RA = rheumatoid arthritis; RBC = red blood cell; RF, rheumatoid factor; SLE = systemic lupus erythematosus.

- Straw-coloured
- Blood stained
- Purulent
- Chylous



Abram's needle, mainly for TB

Management **Therapeutic aspiration may be required to palliate breathlessness but removing more than 1.5 L at a time is associated with a small risk of re-expansion pulmonary oedema.** An effusion should never be drained to dryness before establishing a diagnosis, as biopsy may be precluded until further fluid accumulates. Treatment of the underlying cause – e.g. heart failure, pneumonia, pulmonary embolism or subphrenic abscess – will often be followed by resolution of the effusion.

EMPYEMA this is a collection of pus in the pleural space, which may be as thin as serous fluid or so thick that it is impossible to aspirate, even through a wide-bore needle. **Microscopically, neutrophil leucocytes are present in large numbers**. An empyema may involve the whole pleural space or only part of it ('loculated' or 'encysted' empyema) and is usually unilateral. It is always secondary to infection in a neighboring structure, usually the lung, **most commonly due to the bacterial pneumonias and tuberculosis**. Over 40% of patients with community-acquired pneumonia develop an associated pleural effusion ('parapneumonic' effusion) and about 15% of these become secondarily infected. **Other causes are infection of a haemothorax following trauma or surgery, oesophageal rupture, and rupture of a subphrenic abscess through the diaphragm.** Both pleural surfaces are covered with a thick, shaggy, inflammatory exudate. The pus in the pleural space is often under considerable pressure, and if the condition is not adequately treated, pus may rupture into a bronchus, causing a bronchopleural fistula and pyopneumothorax, or **track through the chest wall with the formation of a subcutaneous abscess or sinus, so-called empyema necessitans**

Clinical assessment An empyema should be suspected in patients with pulmonary infection if there is **severe pleuritic chest pain or persisting or recurrent pyrexia, despite appropriate antibiotic treatment**. In other cases, the primary infection may be so mild that it passes unrecognized and the first definite clinical features are due to the empyema itself.

19.17 Clinical features of empyema

Systemic features

- Pyrexia, usually high and remittent
- Rigors, sweating, malaise and weight loss
- Polymorphonuclear leucocytosis, high CRP

Local features

- Pleural pain; breathlessness; cough and sputum, usually because of underlying lung disease; copious purulent sputum if empyema ruptures into a bronchus (bronchopleural fistula)
- Clinical signs of pleural effusion

Investigations Chest X-ray appearances may be indistinguishable from those of pleural effusion, although pleural adhesions may confine the empyema to form a **'D'-shaped shadow** against the inside of the chest wall . **When air is present as well as pus (pyopneumothorax), a horizontal 'fluid level' marks the air/liquid interface.** Ultrasound shows the position of the fluid, the extent of pleural thickening and whether fluid is in a single collection or multiloculated, containing fibrin and debris . **CT provides information on the pleura, underlying lung parenchyma and patency of the major bronchi.** Ultrasound or CT is used to identify the optimal site for aspiration, which is best performed using a wide-bore needle.

If the fluid is thick and turbid pus, empyema is confirmed. Other features suggesting empyema are a fluid glucose of less than 3.3 mmol/L (60 mg/dL), lactate dehydrogenase (LDH) of more than 1000 IU/L, or a fluid pH of less than 7.0 (H+ > 100 nmol/L) and positive gram stain; these are indications for DRAINAGE. However, pH measurement should be avoided if pus is thick, as it damages blood gas machines. The pus is frequently sterile on culture if antibiotics have already been given. **The distinction between tuberculous and non-tuberculous disease can be difficult and may require pleural biopsy, histology, culture and/or a NAAT**.

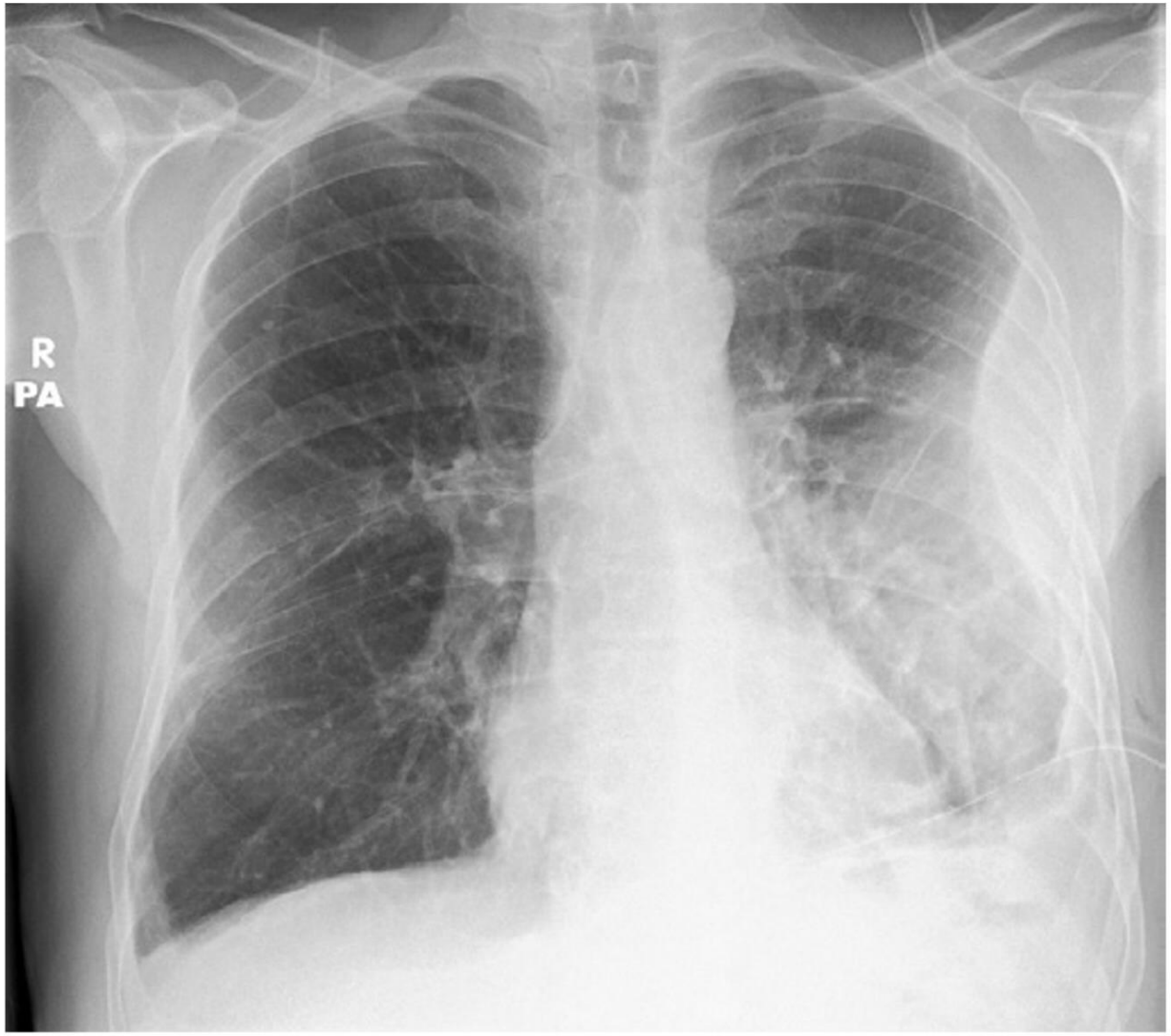


Fig. 19.14 Chest X-ray showing a 'D'-shaped shadow in the left mid-zone, consistent with an empyema. In this case, an intercostal chest drain has been inserted but the loculated collection of pus remains.

Management **An empyema will heal only if infection is eradicated and the empyema space is obliterated, allowing apposition of the visceral and parietal pleural layers.** This can only occur if re-expansion of the compressed lung is secured at an early stage by removal of all the pus from the pleural space. When the pus is sufficiently thin, this is most easily achieved by **the insertion of a wide-bore intercostal tube into the most dependent part of the empyema space**. If the initial aspirate reveals turbid fluid or frank pus, or if loculations are seen on ultrasound, the tube should be put on suction (−5 to −10 cmH2O) and flushed regularly with 20 mL normal saline. If the organism causing the empyema can be identified, the appropriate antibiotic should be given for 2–4 weeks. Empirical antibiotic treatment (e.g. **intravenous Clindamycin, co-amoxiclav or cefuroxime with metronidazole)** should be used if the organism is unknown. Intrapleural fibrinolytic therapy is of no benefit.

An empyema can often be aborted if these measures are started early, but if the intercostal tube is not providing adequate drainage – e.g. **when the pus is thick or loculated – surgical intervention is required to clear the empyema cavity of pus and break down any adhesions. Surgical 'decortication' of the lung may also be required if gross thickening of the visceral pleura is preventing re-expansion of the lung.** Surgery is also necessary if a bronchopleural fistula develops . **Despite the widespread availability of antibiotics that are effective against pneumonia, empyema remains a significant cause of morbidity and mortality.**