Pleural Effusion — Diagnoses, Treatment, Transudate and Exudate

Medical students often encounter patients with pleural effusion during internships and residency. These patients do not always suffer from dyspnea and an accurate clinical examination is crucial for the diagnosis. In oral and written exams, explaining the difference between transudate and exudate is a frequent task. In this article, you can find all the important information regarding pleural effusion - for clinical practice and your studies!

Definition of Pleural Effusion
Pleural effusion as an accumulation of fluid in the pleural cavity

Pleural effusion refers to a pathological accumulation of pleural fluid in the pleural cavity that has been caused by either an inflammation (pleuritis) or other diseases.

Pleural fluid is physiologically produced at the capillary bed of the parietal pleura and absorbed by the parietal pleural lymphatics and visceral pleura.

Pathology of Pleural Effusion

Pleural effusion: transudate and exudate

Depending on the overall protein concentration of the pleural effusion, a distinction is made between transudate (< 30 g/L) and exudate (> 30 g/L).

Transudate is a clear fluid containing few cells. It can emerge, e.g., as a consequence of stasis: due to the increased hydrostatic pressure, the fluid efflux from the capillaries increases. Or the colloid osmotic pressure in the vessels may be decreased (e.g., in the event of hypoalbuminemia), causing more fluid to leak.

Exudate, on the other hand, is rich in cells and is mostly a consequence of inflammation or tumor diseases. Here, the permeability of the capillary walls for tumor cells, plasma proteins, and other blood components increases (barrier dysfunction). These particles will then form part of the pleural effusion, which is why exudate has such high content of cells and proteins.

In both cases, an increase in lymph production can also be observed. This increased production then exceeds the maximum reabsorption capacity of the pleura and, thus, also contributes to the increased fluid accumulation.

At a glance: Study aid for the differentiating criteria of both forms of pleural effusion
Overall protein concentration | Quotient: protein effusion/protein serum | LDH | Quotient: LDH effusion/LDH serum
--- | --- | --- | ---
**Transudate** | < 30 g/L | < 0.5 | < 200 U/L | < 0.6
**Exudate** | > 30 g/L | > 0.5 | > 200 U/L | > 0.6

The most telling parameters are the protein and lactate dehydrogenase (LDH) quotients. Thus, the following applies: If 1 of these parameters is elevated (> 0.5 or > 0.6), the fluid is considered exudate.

**Special forms of pleural effusion**

Special forms of pleural effusion are the **chylothorax** and the **hematothorax**. The 1st 1 consists primarily of **lymphatic fluid**; the pleural effusion is milky and cloudy with a markedly elevated **triglyceride content** (> 110 mg/dL). A hematothorax is basically an accumulation of blood.

**Note**: A bloody pleural effusion has to be considered suspicious for a tumor until proven otherwise.

**Etiology of Pleural Effusion**

**Causes of pleural effusions**

The 3 most frequent causes of transudate are:

- Lung embolism
- Decompensated left cardiac insufficiency
- Liver cirrhosis

For exudate, **pneumonia, malignomas**, and also **lung embolism** should be mentioned. So the latter can cause both transudate and exudate. Additional causes are an increased rate of formation, a decreased rate of absorption, and direct extension from the peritoneum. **Tuberculosis** is the most frequent cause of pleural effusion in patients under the age of 40!

**Study aid: The most important causes of pleural effusion**

<table>
<thead>
<tr>
<th>Transudate</th>
<th>Causes</th>
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<tbody>
<tr>
<td>Increased hydrostatic pressure: decompensated cardiac insufficiency, lung embolism, and venous congestion</td>
<td></td>
</tr>
<tr>
<td>Decreased colloid osmotic pressure: liver cirrhosis, hypoalbuminemia, nephrotic syndrome, uremia, and exudative enteropathy</td>
<td></td>
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<table>
<thead>
<tr>
<th>Exudate</th>
<th>Causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malignant: bronchial carcinoma (40%), metastases (carcinoma of breast 25%, gastrointestinal 5%, and ovarian carcinoma 5%), malignant lymphomas (10%), and pleural mesotheliomas</td>
<td></td>
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<tr>
<td>Infectious: pneumonia and tuberculosis</td>
<td></td>
</tr>
<tr>
<td>Rheumatic: lupus erythematoses and rheumatoid arthritis</td>
<td></td>
</tr>
<tr>
<td>Others: lung embolism, pancreatitis, pericarditis, and endometriosis</td>
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<table>
<thead>
<tr>
<th>Chylothorax</th>
<th>Causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shifting or lesions of the thoracic duct by tumors/metastases, trauma, or iatrogenic causes</td>
<td></td>
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</tbody>
</table>
Symptoms of Pleural Effusion

**Dyspnea is the cardinal symptom of pleural effusion**

Besides symptoms that are due to accompanying or underlying diseases, dyspnea is the only direct symptom. This shortness of breath can be more or less pronounced, depending on the severity of the effusion.

Diagnostics of Pleural Effusion

**Anamnesis and clinical examination of pleural effusions**

As always, anamnesis is the 1st step in the diagnostic process for pleural effusion. The different possible etiologies have to be considered (tumor in medical history, risk factors for lung embolism, etc.).

In the clinical examination, an asymmetrical chest expansion, with delayed expansion on the side of the effusion, can be noticed. Auscultation presents decreased or inaudible breath sounds over the effusion. Sometimes, bronchial breath sounds can be heard over the lung parts directly above the effusion because the lung is consolidated, i.e. compressed, here.

Also, bronchophony can be absent over the pleural effusion since the vibration is being reflected at the line between lung tissue and pleural effusion (2 matters of different density) and is, thus, not conducted to the hand of the examiner. In the case of an effusion > 300 mL, chest examination will also be notable for dullness to percussion. The upper border of this dullness follows a laterally ascending curve (Ellis-Damoiseau line). Palpation of larger effusions is notable for a reduced fremitus over the affected side due to the same reasons that bronchophony is absent.

**Imaging of pleural effusion**

If the torso is erected, the effusion follows gravity and accumulates on the costophrenic angles of the pleural spaces (costodiaphragmatic recess). The most sensitive and gentle way to confirm a pleural effusion diagnosis is sonography while the patient is sitting down. This way, effusions with a volume of **20 mL** or more will be depicted as an anechoic (= dark) area. Sonographic imaging also allows for the assessment of the pleura (fibrosis? tumor?) and the organization of the effusion, as well as for identifying a suitable site for puncture.
Chest x-rays for diagnosing pleural effusions can be made in different positions and planes:

<table>
<thead>
<tr>
<th>Position and Plane</th>
<th>Limit of Detection</th>
<th>Example</th>
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| Lateral decubitus (with the affected side facing down) | 100 ml            | ![Chest X-ray in lateral decubitus position with evidence of pleural effusion](image)
| Erect (lateral projection)                     | 150 ml            | Especially the recesses are well visible since they reach down furthest on the dorsal side |
| Erect posterior-anterior (PA) projection        | 200 ml            | Pleural effusion left and right with bilateral shadowed costophrenic angles |

In X-ray images, the effusion is depicted as a homogenous shadow, which sometimes ascends laterally (crescent sign). When the patient is standing, this shadow is usually seen in the lowest costodiaphragmatic recesses. Furthermore, the diaphragm is usually difficult to identify. Extensive decrease in transparency of the entire lung is possible along with a mediastinal shift to the opposing side. In rare cases, atypical
localizations of the effusion may be found: for example, encapsulated and intralobular (DD: round lesion) or encapsulated in the area of pleural adhesions.

**Left pleural effusion with mediastinal shift to the opposing side:**

![Image](Mediastinal_shift_to_the_right_in_case_of_very_large_pleural_effusion_on_the_left.png)

Thoracic computed tomography (CT) scans will typically be performed as part of advanced diagnostic procedures when the etiology is unclear. It allows for the detection of the smallest amounts of effusion, which will be notable as sickle-shaped consolidations between the lung and thoracic wall.

*Thoracic CT with distinct pleural effusion, right*

![Image](Pleural_effusion_in_computer томography axial Soft tissue window right pleural cavity.png)

**Pleural puncture: diagnostics and treatment**

For the purposes of differential diagnosis, obtaining testing material through a puncture of the pleural effusion is an important step. This applies in particular to any case of a **first or etiologically unclear** pleural effusion.
For this procedure, the patient is sitting down, a local anesthetic is applied, and the puncture needle is inserted dorsally into the area of the effusion, but not below the 9th rib (to avoid sub-diaphragmatic injuries). It is crucial to insert the needle at the upper edge of the rib as to prevent any injuries to the nerves and vessels at the inferior edge of the rib. In cases of encapsulated effusions or atypical localizations, the finding of the puncture site should be assisted sonographically.

The material obtained from the puncture should be stored in 4 tubes:

1. The first tube is for microbiology. From this material, a bacterial culture is made in order to perform a Gram stain and, in case of suspected tuberculosis, a Ziehl-Neelsen stain. This tube has to be kept sterile at all times!
2. The second tube is for clinical chemistry. With this material, various parameters will be determined: cell count (e.g., lymphocytosis for cases of tuberculosis and sarcoidosis), pH level, glucose (diminished glucose levels and an acidic pH suggest an inflammatory or malignant genesis), triglyceride (elevated in case of a chylothorax), amylase and lipase (elevated in case of a pancreatic effusion caused by pancreatitis, pancreas carcinoma, or others), and specific tumor markers in case of a suspected tumor disease.
3. The third tube is for pathology. Here, a cytological smear is prepared for the evaluation of malignancy. Indications for malignancy would include, inter alia, a shift in the nucleus-plasma relation, many mitoses, and multinucleated cells.
4. A fourth tube is kept for other, not yet foreseeable examinations.

Macrosopically, a first assessment of the punctured effusion can be made:

<table>
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<tr>
<th>Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>Serous</td>
<td>Bright, clear, ‘amber’ fluid: mostly transudate with few cells</td>
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<tr>
<td>Hemorrhagic</td>
<td>Reddish: bloody transudate or exudate - trauma or malignoma?</td>
</tr>
<tr>
<td>Chylous</td>
<td>Milky and cloudy: chylothorax</td>
</tr>
<tr>
<td>Purulent</td>
<td>Yellowish and dull: exudate in cases of pleural empyema, tuberculosis, or abscesses</td>
</tr>
</tbody>
</table>

The puncture furthermore represents a relief for the patient and can thus be considered a part of symptomatic treatment, especially in cases of severe dyspnea due to lung compression and cardiopulmonary strains due to a mediastinal shift, i.e. in very severe cases of pleural effusions.

Note: Every pleural puncture should be followed by a chest X-ray to exclude an iatrogenic pneumothorax!

Treatment of Pleural Effusion

Pleural draining and pleurodesis

Treating the underlying disease should be the focus of any treatment approach. When this is followed through, transudates will most likely resolve completely.

As explained in the section on diagnostics, larger effusions with severe dyspnea are therapeutically punctured in order to relieve the patient from his/her shortness of breath. However, never extract more than 1.5 L in a single session since there is the risk of re-expansion edema or great losses of protein. Therefore, for larger effusions, treatment consists of suction drainage over the course of several days.

If the pleural effusion is recurrent (especially in cases of malignant genesis) and/or
cannot be controlled with medication, chemical pleurodesis can be performed. After the puncture of the effusion, a fibrosing substance (e.g., talcum) is introduced into the pleural cavity through the chest drain. The substance triggers an inflammatory reaction that causes the 2 pleural layers to adhere to each other and, thus, prevents any further accumulation of fluids in the pleural cavity.

For a well-aimed biopsy and the isolation of histological tissue samples in cases of malignant effusions, and also for further bacteriological diagnostics of non-controllable parapneumonic effusions and pleural empyema, an additional video-assisted thoracoscopy may be performed as well.

Complications of Pleural Effusion

Pleural fibrosis and pleural empyema

Sometimes, a pleural effusion is followed by the formation of pleural fibrosis. This manifests as cicatricial altered mostly thickened adhesions of the pleurae.

If the pleural effusion is the result of pneumonia, it is called a parapneumonic effusion. These particularly tend to become infected and are then further classified, using various parameters, as uncomplicated (= not infected), complicated (= infected), or pleural empyema (= purulently infected).

<table>
<thead>
<tr>
<th></th>
<th>Puncture specimen</th>
<th>Detection of bacteria</th>
<th>Leucocytes</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncomplicated</td>
<td>Clear</td>
<td>Sterile</td>
<td>+</td>
<td>&gt; 7.3</td>
</tr>
<tr>
<td>Complicated</td>
<td>Cloudy</td>
<td>(+)</td>
<td>++</td>
<td>7.1 – 7.2</td>
</tr>
<tr>
<td>Pleural empyema</td>
<td>Purulent</td>
<td>+</td>
<td>+++</td>
<td>&lt; 7.1</td>
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References


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