

2nd Lecture

Serous Fluid Analysis

Peritoneal fluid analysis



By

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All body cavities are lined by a thin membrane (**serous membranes**) which has 2 parts:

1. Visceral membrane: outer lining of the organ.
 2. Parietal membrane: lines the body cavity
- The **serous fluid** is in the space between the 2 membranes. Which provides lubrication as the surfaces move against each other.
 - **Serous fluid formation**: Is an ultra filtrate of plasma derived from the capillary network of the membrane. Normally the fluid is clear and slightly yellow, resembling serum.

Volume of serous fluids: Normally only a small amount of serous fluid is present because production and absorption take place at a constant rate.

Effusions are the accumulation of fluids in the tissue spaces or in serous cavities (of the pleural space, peritoneal cavity, or pericardial space).

- The principal function of physiologic fluid in cavities (pleural, peritoneal, or pericardial spaces) is to provide a frictionless surface between two membranes.
- Altered homeostasis, including increased production, fluid leakage from tissue, and lack of absorption of accumulated fluid into or from these spaces, leads to abnormal collection of fluid.
- Cytologic evaluation of effusion samples plays a key role in distinguishing reactive conditions from **malignancies**.

Primary causes of effusions include:

1. Increased capillary hydrostatic pressure in the systemic and/or pulmonary circulation (e.g. congestive heart failure, superior vena caval syndrome).
2. Decreased oncotic pressure (e.g., hypoalbuminemia, hepatic cirrhosis)
3. Increased capillary permeability (e.g., infection, inflammation, neoplastic disease, uremia, pancreatitis, pulmonary embolus)
4. Lymphatic obstruction (tumors).
5. Decreased lymphatic drainage or rupture of major lymphatic channels (e.g., chylosis, malignancy, trauma).

HYDROSTATIC PRESSURE

VERSUS

ONCOTIC PRESSURE

Hydrostatic pressure refers to the force that is exerted by the fluid inside the blood capillaries against the capillary wall

Pushes fluids out of the blood capillaries

Occurs as a result of the pressure of blood inside the capillaries

Pressure is around 30 mmHg

A type of fluid pressure

Occurs at the arterial end of blood capillaries

Increases filtration

Aids the supply of nutrients to the tissues of the body

Oncotic pressure refers to the force that is exerted by albumin and other proteins in the blood vessels

Pushes fluids into the blood capillaries

Occurs due to proteins such as albumin, globulins, and fibrinogens inside the blood capillaries

Pressure is around 20 mmHg

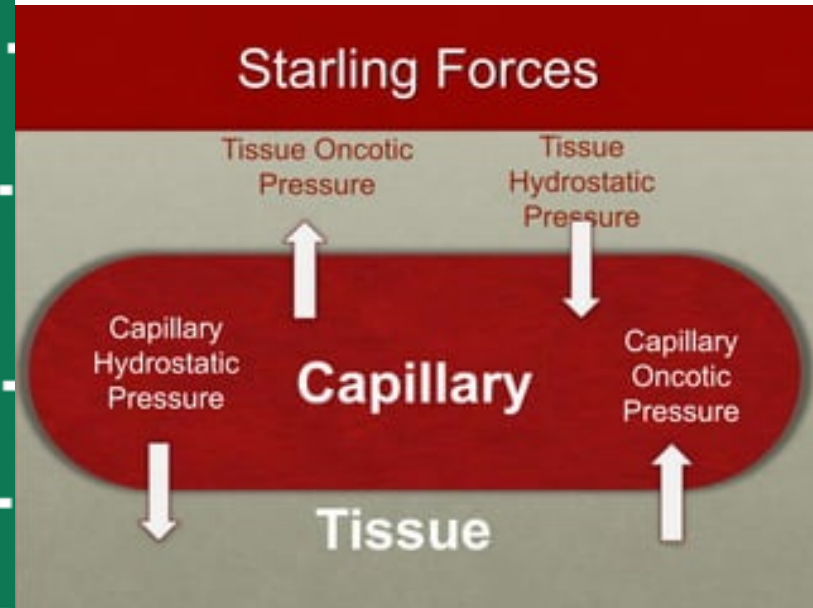
A type of colloid pressure

Occurs at the venular end of the blood capillaries

Prevents fluid from leaving blood capillaries

Helps to remove metabolic wastes from the tissues

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Categorization (Classification) of effusions:

1. Transudate is fluid pushed through the capillary due to **high pressure** within the capillary. disrupt fluid filtration, fluid reabsorption, or both. Usually results from increased hydrostatic pressure and decreased oncotic pressure.

- **Caused by either cirrhosis or congestive heart failure.**

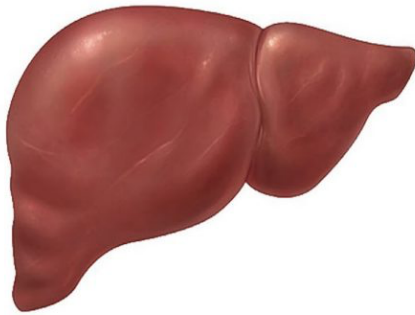
2. Exudate is fluid that leaks around the cells of the capillaries.

- Result in damage to blood vessel walls, body cavity membrane damage, or decreased reabsorption by the lymphatic system.
- **Caused by infections, inflammations, hemorrhages, malignancies, and Other conditions – cardiac bypass surgery, heart or lung transplantation, pancreatitis, or intra-abdominal abscesses.**

Thus, an **exudative fluid** more frequently parallels the plasma content. exudates are more frequently noted with malignancies and infectious/inflammatory processes.

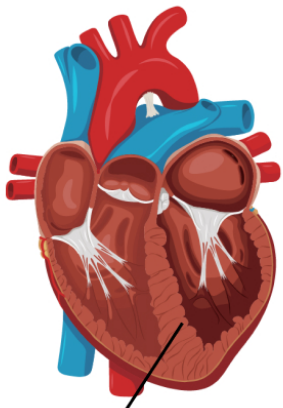
Normal Liver

Liver with Cirrhosis



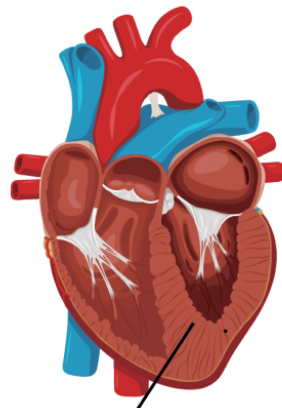
Normal vs. Congestive Heart

Normal heart

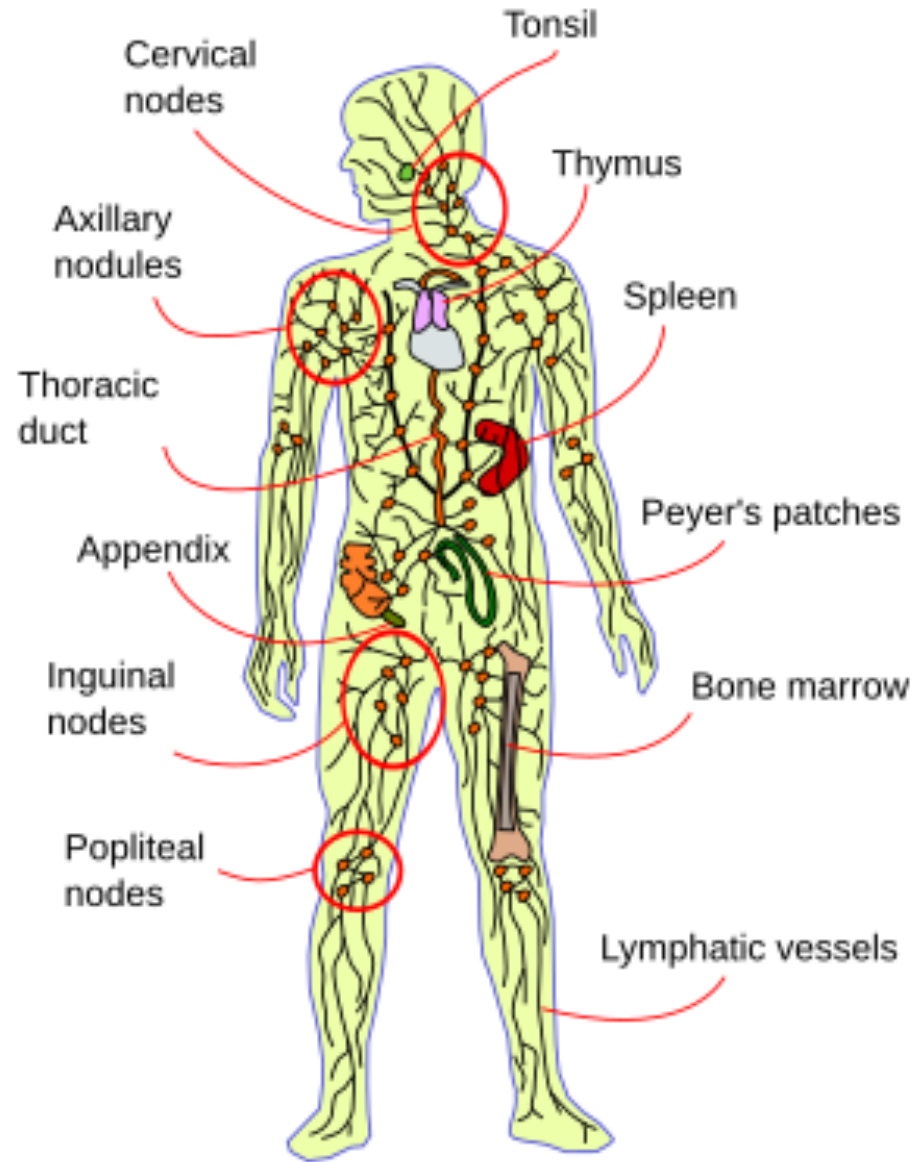


Normal ventricular chambers

Congestive heart



Thickening of the ventricular chambers and smaller filling capacity and ejection of blood



Laboratory Differentiation of Transudates and Exudate

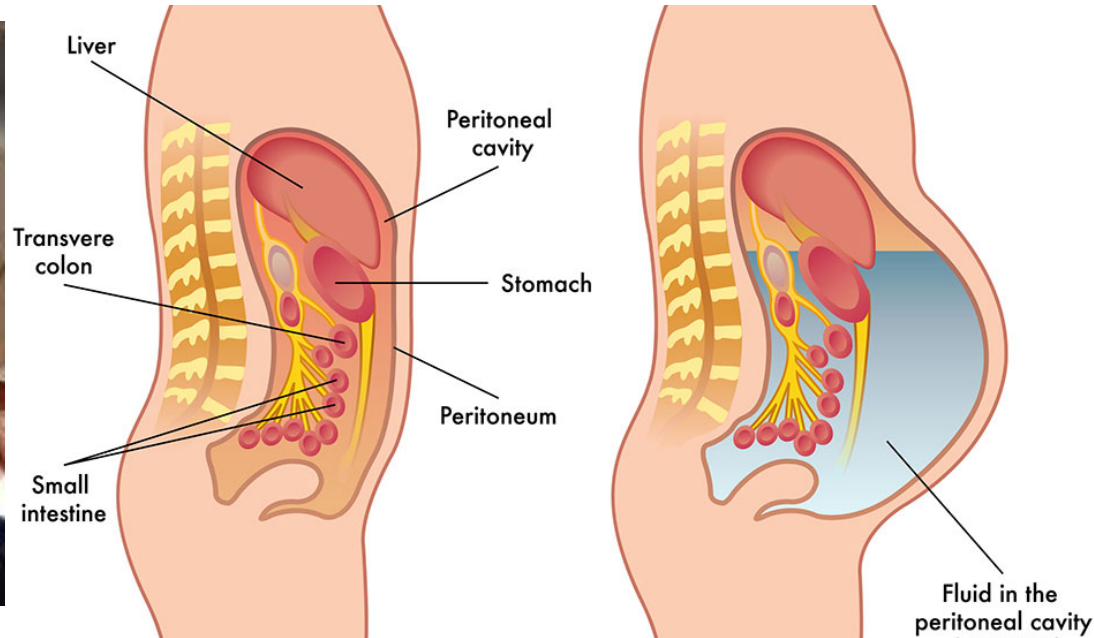
A variety of laboratory tests have been used to differentiate between **transudates** and **exudates**, including:

	Transudate	Exudate
Appearance	Clear	Cloudy
Specific gravity	< 1.015	> 1.015
Total protein	< 3.0 g/dl	> 3.0 g/dl
Lactic dehydrogenase	< 200 IU	> 200 IU
Cell count	< 1000/ μ l	> 1000/ μ l
Spontaneous clotting	No	Possible

Specific gravity, protein, and lactic dehydrogenase were considered to be the most valuable criteria for classification.

1. Peritoneal Effusion

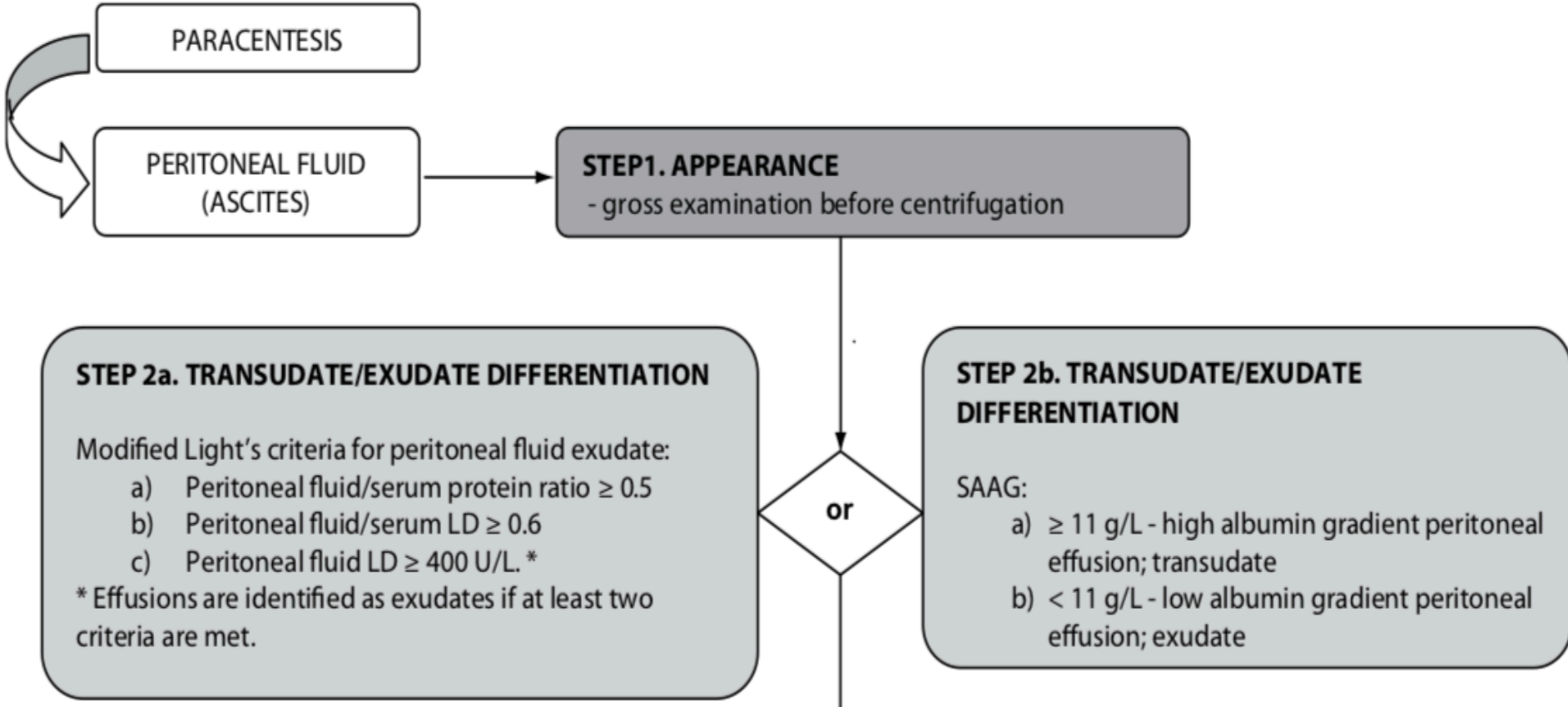
- Pathological accumulation of fluid in the peritoneal cavity is called Peritoneal effusion which is known as **Ascites**.

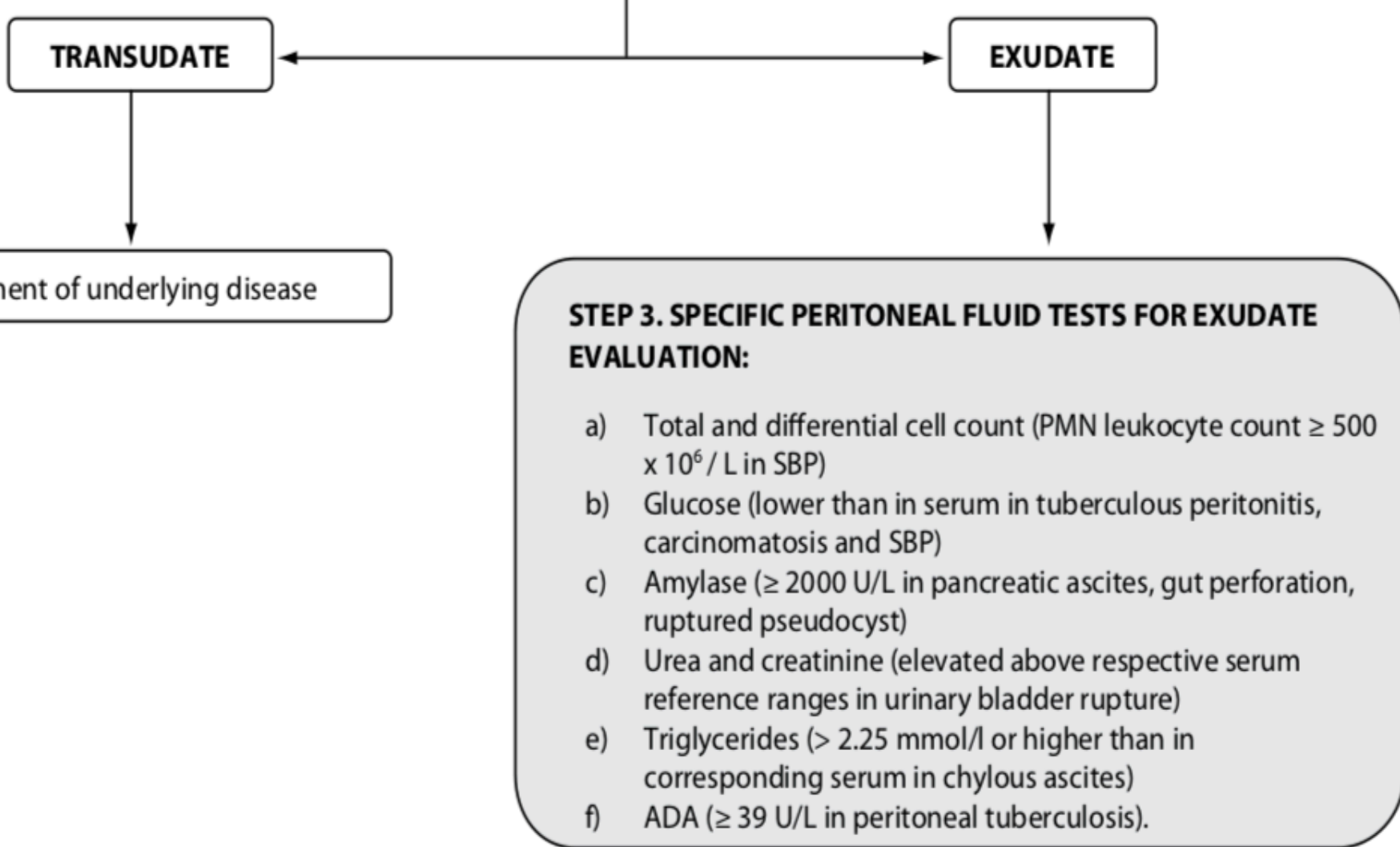


- The parietal peritoneum lines the wall of abdominal and pelvic cavities, and visceral peritoneum cover the organ.
- Up to 50 ml Fluid normally present in peritoneal cavity.

• **Common causes of Peritoneal effusions (or ascites) include:**

- 1. Liver cirrhosis
- 2. Malignancy
- 3. Congestive heart failure.
- 4. Tuberculosis.
- 5. Nephrotic syndrome.
- 6. Pancreatic disease and dialysis





Biochemical analysis of peritoneal effusions.

LD – lactate dehydrogenase; SAAG – serum ascites albumin gradient; SBP-spontaneous bacterial peritonitis; ADA - adenosine deaminase.

Table 2. Typical characteristics of ascites in patients with cirrhosis compared with other diseases

Test	Causes of ascites					
	Cirrhosis	Congestive cardiac failure	Malignancy	Tuberculosis	SBP	Pancreatitis
Gross appearance	clear straw or milky	clear to pale yellow	milky or bloody	milky or N	cloudy or turbid	milky or cloudy or turbid
TP	< 25 g/L	< 25 g/L	≥ 25 g/L	≥ 25 g/L	≥ 25 g/L	≥ 25 g/L
SAAG	≥ 1.1 g/dL	≥ 1.1 g/dL	< 1.1 g/dL	< 1.1 g/dL	< 1.1 g/dL	< 1.1 g/dL
LDH	↓	↓ or N	↑	↑ or N	↑ or N	↑ or N
Glucose	N	N	↓	↓	↓	↓
Amylase	N		↑ or N			↑
ADA	↓ or N		↓ or N	↑		
Cell counts	≥ 250/μL or N			≥ 250/uL or N	≥ 250/uL	
Bacterial culture	+ or -			+ or -	+	
Viscosity	< 1.03 cP	< 1.03 cP	≥ 1.03 cP	≥ 1.03 cP	≥ 1.03 cP	≥ 1.03 cP
¹ H NMR	↑ or ↓	↑ or ↓				
VEGF	↓	N	↑	↓	↓	↓
Tumor markers	↑ or N	N	↑	↑ or N		↑ or N

↑ -increase, ↓ - decrease, N -normal, + -positive, - - negative.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4521252/pdf/JCTH-2-058.pdf>

Vascular endothelial growth factor (VEGF), Proton nuclear magnetic resonance (1H NMR) spectroscopy, Ascitic fluid total protein and the serum-ascites albumin gradient (SAAG) adenosine deaminase activity (ADA)

Chylous ascites (CA) is an uncommon form of ascites, defined as the leakage of the lipid-rich lymph into the peritoneal cavity. Damage or obstruction to the lymphatic system with a turbid or milky appearance from the high triglyceride content.

The principal mechanisms for CA formation are related to disruption of the lymphatic system, from any cause.

1. Exudation of lymph through the walls of retroperitoneal megalymphatics into the peritoneal cavity.
2. Leakage of lymph from the dilated subserosal lymphatics on the bowel wall into the peritoneal cavity which is due to malignant infiltration of the lymph nodes obstructing the flow of lymph from the gut to the cisterna chili.
3. Direct leakage of lymph through a lymphoperitoneal fistula associated with retroperitoneal megalymphatics due to acquired lymphatic disruption as a result of trauma or surgery.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4890871/>

- This should be distinguished from pseudochyolous ascites, in which the turbid appearance is due to cellular degeneration from infection or malignancy without actually containing high levels of triglycerides.
- Depending on the clinical suspicion, ascitic fluid should be sent for cell count, culture, Gram stain, total protein, albumin, triglyceride levels, glucose, lactate dehydrogenase, amylase, and cytology.
- The serum to ascites albumin gradient (SAAG) should be calculated to determine if the ascites is related to portal hypertension or other causes.
- The triglyceride levels in ascitic fluid are very important in defining CA. Triglyceride values are typically above 200 mg/dL, although some authors use a cutoff value of 110 mg/dL.
- A tuberculosis smear and culture and adenosine deaminase activity (ADA) should be performed in selected cases when tuberculosis is suspected. ADA has high sensitivity and specificity in the diagnosis of tuberculous peritonitis.
- The diagnosis of tuberculous peritonitis usually requires a peritoneal biopsy via laparoscopy.
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4890871/>

Characteristics of ascitic fluids in chylous ascites (adapted from Cárdenas and Chopra) [1].

Color	Milky and cloudy
Triglyceride level	Above 200 mg/dL
Cell count	Above 500 (lymphocytic predominance)
Total protein	Between 2.5 and 7.0 g/dL
SAAG	Below 1.1 g/dL*
Cholesterol	Low (ascites/serum ratio < 1)
Lactate dehydrogenase	Between 110 and 200 IU/L
Culture	Positive in selected cases of tuberculosis
Cytology	Positive in malignancy
Amylase	Elevated in cases of pancreatitis
Glucose	Below 100 mg/dL

IU: international units; SAAG: serum-ascites albumin gradient.

*Is elevated above 1.1 g/dL in CA secondary to cirrhosis.