ISSN- O: 2458 - 868X, ISSN–P: 2458 – 8687
National Library of Medicine - ID: 101731606

International Journal of Medical Science and Innovative Research (IJMSIR)
IJMSIR : A Medical Publication Hub
Available Online at: www.ijmsir.com
Volume – 10, Issue – 4, August – 2025, Page No. : 22 – 25

Pleural Fluid and Its Interpretation

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Citation this Article: Dr. Mansi Raj, Dr. Jagdish Dalsania, Dr Bhoomika Dabhania, Dr. Gauravi Dhruva, "Pleural Fluid and Its Interpretation", IJMSIR - August – 2025, Vol – 10, Issue - 4, P. No. 22 – 25.
Type of Publication: Original Research Article
Conflicts of Interest: Nil

Abstract

Interpreting pleural fluid results correctly requires an awareness of the possible aetiologies of a pleural effusion and an understanding of the reliability of the outcome of each investigation. All results must be interpreted within each different clinical context and knowledge of the pitfalls for each test is necessary when the diagnosis is unclear. This review aims to discuss the common aetiologies of a pleural effusion and some of the pitfalls in interpretation that can occur when the diagnosis is unclear.

Keywords: Pleural effusion, pleural effusion cytology pleural infection, malignant pleural effusion, biomarkers, Light's Criteria

Introduction

Pleural fluid (PF) occurs when there is an imbalance between fluid production and removal from pleural space. PF is generates primarily by the parietal pleura and pleural lymphatics are responsible for reabsorbing it. In healthy individuals, the pleural cavity contains approximately 0.3 mL/kg of fluid. An effusion occurs when there is disturbance in production and reabsorption.

Clinical Approach to Pleural Effusion: Understanding the patient's clinical context is essential for identifying the underlying cause of a pleural effusion. For example, in a patient with congestive heart failure (CHF) who presents with bilateral pleural effusions, heart failure is the most likely etiology.

Imaging in Diagnosis

- Ultrasound findings of echogenic, loculated fluid with gas bubbles may suggest a pleural infection or empyema.
- CT scans can help distinguish malignant causes of pleural effusion by revealing features such as pleural thickening, nodularity, or involvement of the mediastinal pleura. Such findings raise suspicion for malignant pleural effusion (MPE). Many pleural effusions require radiological and clinical correlation because many pleural fluids do not have any clear etiology.

A standard panel includes such test like PF protein, PF glucose, PF pH, PF lactate dehydrogenase (LDH), PF cytology and microbiology.

Aims and Objective

To evaluate pleural fluid cytology with clinical correlation.

Methodology

Thepresentworkisretrospectivestudyundertakenatthedepartmentofpathologyof P.D.U MEDICAL COLLEGE, RAJKOT over a period of 08 months from August 2024 to March 2025. Pleural fluid samples were processed according to standard protocol and then studied. They were analyzed for cell count and cell features. Malignancy features, if found, were also noted.

Total 225 samples were collected & included for this study during this time period.

Light's criteria

- In 1972, Dr Richard Light published a study producing criteria that have a high sensitivity and specificity for differentiating transudative from exudative effusions using their biochemical results.
- The original criteria to diagnose a biochemically exudative effusion was one or more of

(1) PF to serum protein ratio greater than 0.5,

(2) PF LDH of greater than 200 IU and

(3) PF to LDH ratio greater than 0.6.

- The PF LDH level was later modified to more than two-thirds of the upper limit of the normal LDH level.
- Any one of these criteria being present, predicts an exudative effusion with a 94.7% accuracy, although the criteria have a lower specificity, so it is more comm on to misclassify a transudate as an exudate rather than vice versa. This is important, so causes of exudative effusions, such as MPE, are less likely to be missed. Serum to PF albumin levels, or the total protein gradient may be calculated and potentially used to reclassify apparently exudative effusions which are clinically more likely to have a transudative etiology.

Results

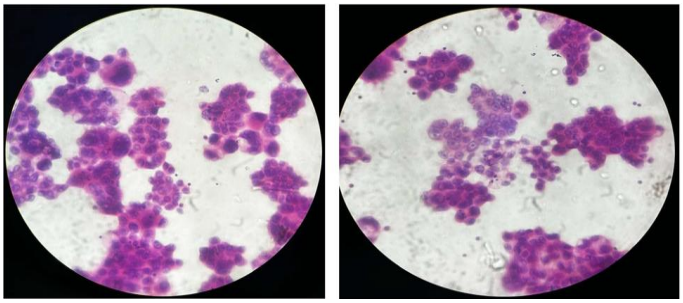
- Tuberculous pleural effusion (TPE) has mainly lymphocyte predominance. However, chronic effusions from other causes may also display a lymphocyte count exceeding 50%. Common causes of lymphocytic effusions mainly tuberculosis, malignancy, and congestive cardiac failure (CCF). Less frequently, they may arise from lymphoma, post-cardiac surgery, renal or hepatic failure, rheumatoid arthritis, or—rarely—parapneumonic effusions.
- Parapneumonic effusions generally exhibit a neutrophilic predominance (>50% of leukocytes), though approximately 10% of tuberculous cases may also present with a similar pattern.
- A systematic review of 225 pleural effusion cases found that 4% were malignant, 6% were suspicious for malignancy, and 90% were benign or idiopathic. Interestingly, a higher eosinophil count in the fluid was inversely related to the likelihood of malignancy.
- While the cellular profile of pleural fluid is not diagnostic on its own, it can aid in narrowing the differential diagnosis when considered alongside clinical and radiologic data.
- In a local series of 10 malignant pleural effusion cases, adenocarcinoma and metastatic signet ring cell carcinoma were commonly identified.

Malignant Pleural Effusion

- A malignant pleural effusion (MPE) is most reliably diagnosed through a positive pleural fluid cytology or pleural biopsy, with cytology having a sensitivity of approximately 60%.

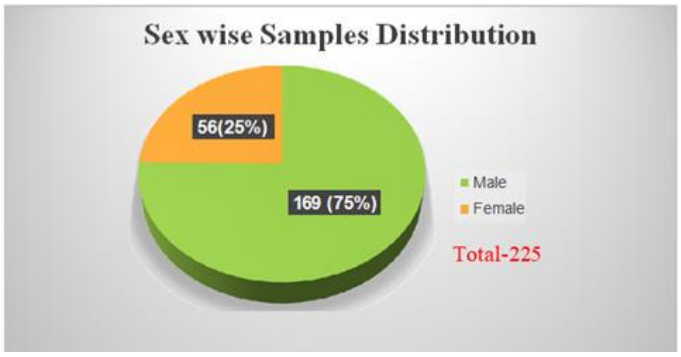
- In most cases, a diagnosis is made within the first two fluid samples; further aspirations rarely improve diagnostic yield.
- At least 50 mL of pleural fluid should be submitted for cytological analysis, according to British Thoracic Society guidelines
- Lung and breast cancers are the leading causes of MPE, followed by hematologic malignancies and malignancies of unknown origin.

Figure 1:

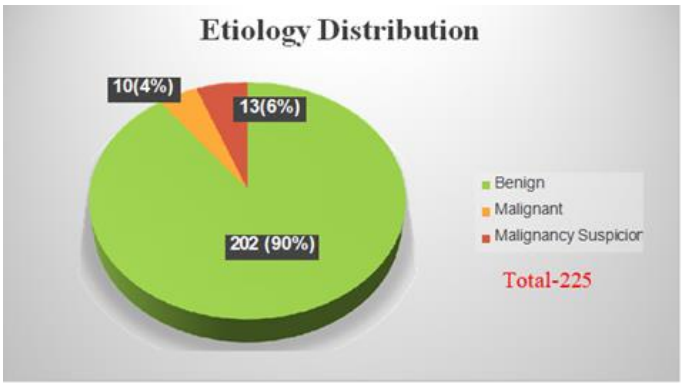


Studied sample showing Clusters of cohesive cells, foamy / vacuolated cytoplasm, fine chromatin, variable prominent nucleoli. S/O Adenocarcinoma

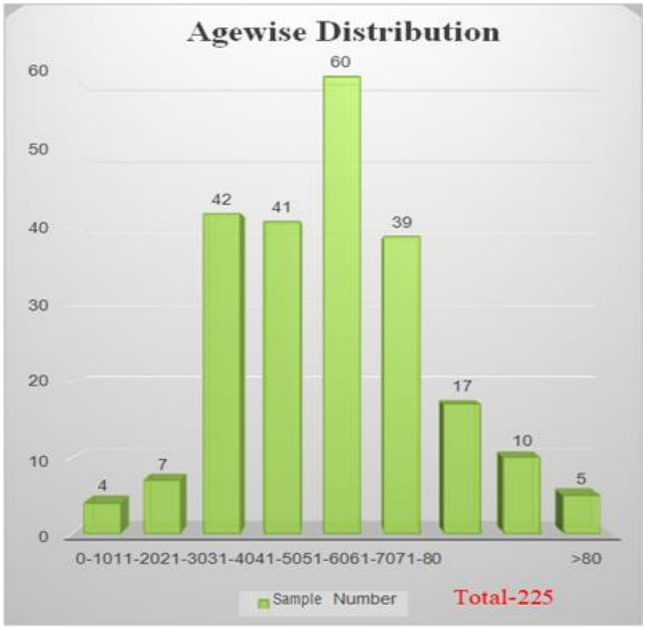
Graph 1:



Graph 2:



Graph 3:



Conclusion

Pleural fluid cytology remains a key diagnostic tool in evaluating the cause of pleural effusions. It provides valuable information about both the underlying etiology and potential prognosis. The method is relatively straightforward, affordable, and feasible even in resource-limited environments.

Interpreting pleural fluid analysis accurately is essential for proper diagnosis and management. While many pleural fluid tests offer high sensitivity and specificity, false positives and negatives can still occur. Therefore, results should always be considered alongside the patient's clinical presentation and imaging findings to guide appropriate care.

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