Section: Pathology

Original Research Article

CYTOMORPHOLOGICAL ANALYSIS OF NON-FNAC BODY FLUIDS AND BRONCHOALVEOLAR LAVAGE: A RETROSPECTIVE OBSERVATIONAL STUDY OF 500 CONSECUTIVE CASES AT A PULMONARY TERTIARY CARE CENTER

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ABSTRACT

Background: Cytological evaluation of body cavity fluids (pleural, ascitic) and respiratory samples like Bronchoalveolar Lavage (BAL) serves as a rapid, minimally invasive diagnostic modality. This study evaluates the cytomorphological spectrum, specimen distribution, diagnostic accuracy, adequacy rates, and standardized risk-stratified categorization of 500 consecutive non-FNAC fluid/BAL cases.

Materials and Methods: A retrospective audit was conducted on 500 non-FNAC cytological records. Data parameters transcribed included patient demographics, clinical setting (OPD vs IPD), physical findings (volume, color, appearance, clot presence), microscopic cellularity, Differential Leukocyte Count (DLC), presence of reactive mesothelial cells or atypia, and assigned diagnostic categories (Negative for Malignancy, Atypia of Undetermined Significance (AUS), Suspicious for Malignancy, Malignant, and Inadequate). All Fine Needle Aspiration Cytology (FNAC) entries were strictly excluded.

Results: Among 500 valid cases, pleural fluids constituted the predominant specimen (74.60%, n=373), followed by BAL (21.20%, n=106), ascitic fluid (3.80%, n=19), lung parenchymal fluid (0.20%, n=1), and abscess pus (0.20%, n=1). Male predominance was observed (75.60%, n=378; M:F ratio = 3.1:1). Overall age ranged from 6 to 90 years (mean 50.75 ± 18.97 years). Outpatient (OPD) referrals comprised 55.60% (n=278) and inpatient (IPD) cases 44.40% (n=222). Diagnostic categories revealed Negative for Malignancy in 76.00% (n=380), Inadequate/Non-diagnostic in 16.80% (n=84), Atypia of Undetermined Significance (AUS) in 4.80% (n=24), Suspicious for Malignancy in 2.00% (n=10), and Malignant in 0.40% (n=2). Specimen adequacy rate was 83.40% (n=417). High lymphocytic predominance (>85-90%) was the single most frequent microscopic pattern (40.40%, n=202).

Conclusion: Standardized cytological reporting of non-FNAC effusions provides high diagnostic yield (83.4% adequacy) and effectively stratifies inflammatory, atypical, and neoplastic conditions, facilitating clinical triage, cell-block preparation, and targeted tissue biopsy.

Keywords: Cytopathology, Pleural Effusion, Bronchoalveolar Lavage, Serous Fluid Cytology, Exfoliative Cytology, Diagnostic Cytology

INTRODUCTION

Accurate cytological diagnosis of pleural effusions, peritoneal ascites, and bronchoalveolar lavage (BAL) fluids is indispensable in clinical practice.[1-6] Body cavity effusions act as passive reservoirs where benign inflammatory and neoplastic cells exfoliate.[3,6] Differentiating non-neoplastic exudates

such as tubercular effusions, parapneumonic effusions, and congestive heart failure transudates from primary or metastatic malignancy is a daily diagnostic challenge.[4,9]

Unlike Fine Needle Aspiration Cytology (FNAC), which targets localized solid nodules, non-FNAC exfoliative samples reflect generalized pathophysiological changes across serous membranes and respiratory airways.[4,6] Implementing a risk-stratified 5-tier diagnostic reporting framework modeled after the International System for Reporting Serous Fluid Cytology (TIS) enhances path-clinician communication, reduces ambiguous reporting, and standardizes patient management algorithms.[2,7,11,14]

Aims and Objectives

- To analyze the cytomorphological spectrum and diagnostic yield of 500 consecutive non-FNAC body fluid and BAL samples.[1,5]
- To evaluate demographic variations, specimen-wise distribution, and clinical settings (OPD vs IPD).[1,5]
- To classify cases into standardized risk-based categories: Inadequate (Category I), Negative for Malignancy (Category II), Atypia of Undetermined Significance (AUS, Category III), Suspicious for Malignancy (Category IV), and Malignant (Category V).[2,7,11]
- To assess physical properties (volume, gross appearance, clot presence) and microscopic cellularity/DLC patterns in relation to specimen adequacy.[3,6]

MATERIALS AND METHODS

Study Design & Dataset Selection: A retrospective observational study was conducted using the digitized master logbook register of a tertiary care cytopathology laboratory at a pulmonary center. Exactly 500 consecutive non-FNAC cases (Case #27826 through #89326) were audited.[1,5]

Inclusion Criteria

All exfoliative fluid samples including Pleural Fluid (PF), Ascitic Fluid, Bronchoalveolar Lavage (BAL), and related cavity drain/parenchymal fluids with complete physical, microscopic, and diagnostic records.[1,4]

Exclusion Criteria: All Fine Needle Aspiration Cytology (FNAC) procedures (e.g., lymph node, breast, thyroid, subcutaneous mass aspirations) and unreadable or missing logbook entries.

Laboratory Processing & Diagnostic Criteria: Fresh fluid samples were examined for gross physical parameters (volume, color, appearance, clot formation).[3,5] Smears were prepared through direct centrifugation or cytocentrifugation using REMI R-8C PLUS cytocentrifuged machine (3200 revolution for 3 minute) fixed in 95% ethanol and air-dried, and stained with Giemsa techniques.[3,6] Diagnostic categories were defined as.[2,7,11]

1. **Category I (Inadequate/Non-diagnostic):** Hypocellular smears, obscuring blood/debris, or severe cellular degeneration.
2. **Category II (Negative for Malignancy):** Polymorphonuclear or lymphocytic effusions, acute/chronic inflammatory exudates, and reactive mesothelial cells without atypia.[2]
3. **Category III (Atypia of Undetermined Significance - AUS):** Nuclear enlargement, altered N:C ratio, or architectural crowding exceeding typical reactive changes but quantitatively or qualitatively insufficient for malignancy.[2, 11]
4. **Category IV (Suspicious for Malignancy):** Cytological features strongly suggestive of neoplasia but lacking definitive quantitative or unequivocal criteria.[2, 4]
5. **Category V (Malignant):** Unequivocal cytological criteria for primary malignant mesothelioma, lung malignancy or metastatic carcinoma/lymphoma.[2,3,14]

RESULTS

Table 1: Demographic Profile and Clinical Setting Distribution (n=500)

Demographic / Setting Parameter	Cases (n)	Percentage (%)	Statistical Summary / Metrics
Gender: Male	378	75.60%	Male:Female Ratio = 3.1:1
Gender: Female	122	24.40%	Predominantly adult / elderly females
Outpatient Setting (OPD)	278	55.60%	Direct ambulatory clinical referrals
Inpatient Setting (IPD / Wards)	222	44.40%	Admitted ward & critical care patients
Overall Age Profile	500	100.00%	Mean: 50.75 ± 18.97 yrs (Range: 6–90, Median: 53.5)
Male Age Profile	378	75.60%	Mean: 52.80 ± 17.85 yrs (Median: 55.0 yrs)
Female Age Profile	122	24.40%	Mean: 44.40 ± 20.90 yrs (Median: 41.5 yrs)

Table 2: Specimen-Wise Distribution and Adequacy Yield (n=500)

Specimen Category	Total (n)	% Share	Adequate	Inadequate	Adequacy Rate (%)
Pleural Fluid (PF)	373	74.60%	319	54	85.52%
Bronchoalveolar Lavage (BAL)	106	21.20%	84	22	79.25%
Ascitic Fluid	19	3.80%	12	7	63.16%
Lung Parenchymal Fluid	1	0.20%	1	0	100.00%
Abscess Pus Fluid	1	0.20%	1	0	100.00%
TOTAL DATASET	500	100.00%	417	83	83.40%

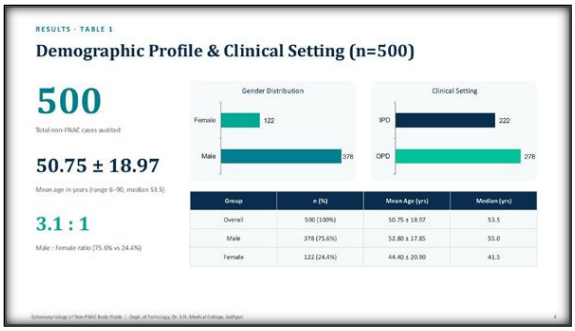


Chart 1: Visual breakdown of demographic profile and clinical setting distribution.

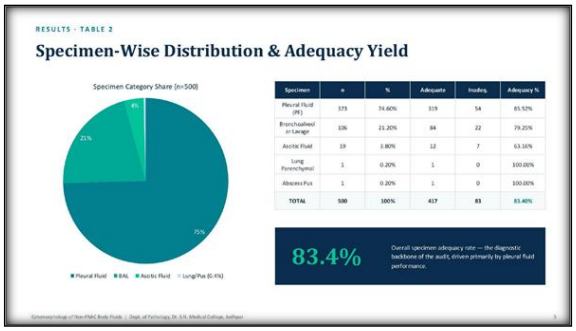


Chart 2: Specimen-wise share and diagnostic adequacy yield.

Table 3: Diagnostic Category Cross-Tabulation by Specimen Type (n=500)

Diagnostic Category	Pleural Fluid	BAL Fluid	Ascitic Fluid	Lung/Pus	Total (n)	Overall %
Negative for Malignancy (Cat II)	287	83	9	1	380	76.0%
Inadequate / Non-Diagnostic (Cat I)	55	22	7	0	84	16.8%
Atypia of Undetermined Sig. (AUS - Cat III)	22	1	1	0	24	4.8%
Suspicious for Malignancy (Cat IV)	7	0	2	1	10	2.0%
Malignant (Cat V)	2	0	0	0	2	0.4%
TOTAL SUMMARY	373	106	19	2	500	100.00%

Table 4: Microscopic Cytomorphological Patterns & DLC Breakdown (n=500)

Cytomorphological / DLC Pattern	Count (n)	Percentage (%)	Key Cytological Features Observed
Marked Lymphocytic Predominance (>85-90%)	202	40.40%	Mature small lymphocytes, proteinaceous background; characteristic of tubercular or chronic exudates
Mixed Acute & Chronic Inflammatory	179	35.80%	Mixed neutrophils, lymphocytes, histiocytes, and occasional mesothelial cells
Marked Neutrophilic Predominance (>85-90%)	50	10.00%	Intact and degenerated polymorphs, pus cells, granular debris (empyema / parapneumonic)
Nonevaluable / Hypocellular Smears	42	8.40%	Scant cellularity, scattered occasional lymphocytes, insufficient for definitive diagnosis
Atypical / Malignant Cellularity	19	3.80%	Nuclear enlargement, hyperchromasia, altered N:C ratio, 3D clusters or single atypical cells
Hemorrhagic / RBC Only Background	8	1.60%	Full field of red blood cells without diagnostic nucleated cellular elements

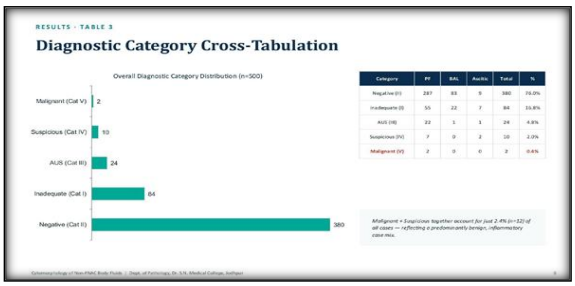


Chart 3: Overall diagnostic category distribution and cross-tabulation.

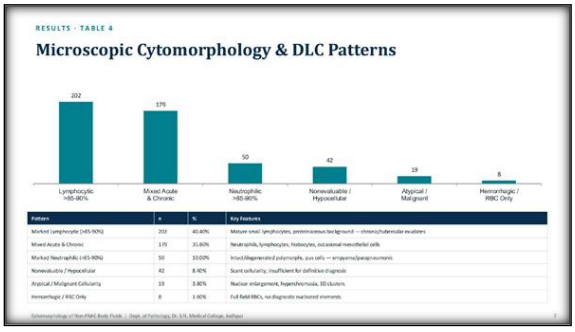
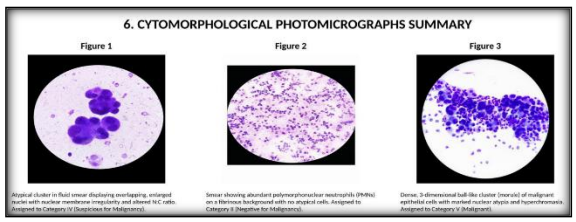


Chart 4: Microscopic cytomorphology and differential leukocyte count (DLC) patterns.

Cytomorphological Photomicrographs Summary: Representative microscopic images of fluid smears cytomorphology obtained during laboratory evaluation:



[Figure 1] Atypical cluster in fluid smear displaying overlapping, enlarged nuclei with nuclear membrane irregularity and altered N:C ratio. Assigned to Category IV (Suspicious for Malignancy).
[Figure 2] Smear showing abundant polymorphonuclear neutrophils (PMNs) on a fibrinous background with no atypical cells. Assigned to Category II (Negative for Malignancy).
[Figure 3] Dense, 3-dimensional ball-like cluster (morule) of malignant epithelial cells with marked nuclear atypia and hyperchromasia. Assigned to Category V (Malignant).

DISCUSSION

Pleural Effusions (n=373): Pleural fluid comprised nearly three-quarters of all non-FNAC requests.[1,5] The majority (76.94%, n=287) were Negative for Malignancy, dominated by lymphocytic effusions (>85-90% DLC).[8,9] In tuberculosis-endemic regions, lymphocytic pleural exudates strongly correlate with tubercular pleurisy.[8, 9, 13] Atypia of Undetermined Significance (AUS) was assigned in 22 pleural cases, primarily caused by florid reactive mesothelial hyperplasia secondary to severe inflammation, pulmonary infarction, or uremia.[2,6,12]

Bronchoalveolar Lavage (n=106): BAL fluid analysis demonstrated a high adequacy yield of 79.25% (n=84).[4] Negative cases (78.30%, n=83) contained bronchial epithelial cells, alveolar macrophages, and variable leucocytes.[4] Neutrophil-rich BAL samples correlated with acute bacterial pneumonia, whereas lymphocyte-rich BAL fluids suggested interstitial pulmonary disease or granulomatous etiology.[4,15]

Ascitic Fluid (n=19): Peritoneal fluid samples showed a higher Inadequacy rate (36.84%, n=7), mainly driven by low sample volumes or hemodilution.[1,3,16] Adequate cases demonstrated chronic inflammatory profiles.[3]

Analysis of Inadequate/Non-Diagnostic Cases (n=84, 16.80%): Inadequacy was primarily attributed to low cellularity (scant nucleated cells), excessive peripheral blood obscuration, or severe autolysis due to transit delays.[2,6,11]

Clinical Implications and Recommendations:

- **Implementation of Cell-Block Preparation:** Routine cell-block creation for Category III (AUS) and Category IV (Suspicious) fluid specimens enables immunohistochemical (IHC) panels (e.g., Calretinin, WT1, CK5/6 for mesothelial cells vs BerEP4, CEA, TTF-1 for adenocarcinoma).[10,14]
- **Standardized TIS Triage Protocols:** Adopting standardized diagnostic reporting bridges the communication gap between pathologists and clinicians, establishing clear management pathways for repeat sampling versus tissue biopsy.[2,7,11]
- **Sample Collection Quality Assurance:** Minimizing inadequacy requires enforcing minimum volume thresholds (20-50 mL for effusions) and rapid laboratory transport or immediate refrigeration.[3,9,16]

Limitations: This study is limited by its single-center retrospective design.[1,5] Additionally, complete long-term histopathological or clinical follow-up for all Category III (AUS) and Category IV (Suspicious) cases was not fully accessible at the time of logbook transcription.

CONCLUSION

This comprehensive audit of 500 non-FNAC fluid and BAL samples highlights the diagnostic reliability and clinical utility of exfoliative cytology.[1,5] Pleural fluids comprised the vast majority of submissions, with benign inflammatory conditions (Category II) representing 76.0% of cases.[1,5] The overall adequacy rate of 83.4% reinforces the strength of fluid cytology as a first-line diagnostic investigation.[1] Adopting risk-stratified diagnostic reporting optimizes clinical decision-making and patient care.[2,7,10, 1]

REFERENCES

1. Chandra S, Chandra H, Sharma A. Diagnostic utility of effusion cytology in a tertiary care center: A retrospective study. J Clin Diagn Res. 2012;6(6):1001-1004.
2. Chandra A, Crothers J, Kurtycz D, Schmitt F. The International System for Reporting Serous Fluid Cytology (TIS). 1st ed. Springer International Publishing; 2020.
3. Naylor B. Pleural, peritoneal and pericardial effusions. In: Bibbo M, Wilbur DC, eds. Comprehensive Cytopathology. 4th ed. Elsevier Saunders; 2015:515-576.
4. Perdanasari AT, et al. Diagnostic yield and accuracy of bronchoalveolar lavage cytology in pulmonary lesions. Diagn Cytopathol. 2019;47(8):789-795.
5. Shivakumarswamy U, Yogesh Babu S, Gopalakrishnan A. Cytological evaluation of body fluids in a tertiary care hospital. Int J Res Med Sci. 2015;3(11):3225-3229.
6. Shidham VB, Atkinson BF. Cytopathologic Diagnosis of Serous Fluids. 1st ed. WB Saunders; 2007.
7. Kundu R, et al. Application of the International System for Reporting Serous Fluid Cytology: A tertiary care experience. Acta Cytol. 2021;65(5):410-418.
8. Valdes L, Alvarez D, San Jose E, et al. Tuberculous pleurisy: a study of 254 patients. Arch Intern Med. 1998;158(18):2017-2021.
9. Porcel JM. Diagnostic approach to pleural effusions in adults. Am Fam Physician. 2006;73(7):1211-1220.
10. Bocking A, et al. DNA cytometry and cell block preparation in serous effusions: Enhancing diagnostic sensitivity for malignancy. Cancer Cytopathol. 2014;122(4):280-289.
11. Pinto D, Chandra A, Crothers BA, Kurtycz DFI, Schmitt F. The international system for reporting serous fluid cytopathology diagnostic categories and clinical management. J Am Soc Cytopathol. 2020;9(6):469-477.
12. Wang M, Chandra A, Cai G. The International System for Reporting Serous Fluid Cytopathology An updated review. J Clin Transl Pathol. 2023;3(4):160-177.
13. Kala C, Kala S, Singh A, Jauhari RK, Bajpai A, Khan L. The International System for Reporting Serous Fluid Cytopathology: An institutional experience on its implication and assessment of risk of malignancy in effusion cytology. J Cytol. 2023;40(3):159-164.
14. Pinto D, Chandra A, Schmitt F. The International System for Reporting Serous Fluid Cytopathology: How to incorporate molecular data in cytopathology reports. J Mol Pathol. 2021;2(2):66-76.
15. Shen-Wagner J, Gamble C, MacGilvray P. Pleural effusion: diagnostic approach in adults. Am Fam Physician. 2023;108(5):464-475.
16. Karger Medical Publishers Cytology of the body fluids – A brief review. Monogr Clin Cytol. 2015;20:1-18.