e-ISSN: 0975-9506, p-ISSN: 2961-6093

Available online on www.ijpqa.com doi: 10.25258/ijpqa.16.1.75

International Journal of Pharmaceutical Quality Assurance 2025; 16(1); 465-470

Original Research Article

Assessment of the Diagnostic Role of Fluid Cytology in a Tertiary Care Hospital

Rituraj[1], Akhalesh Kumar[2], Pradeep Kumar Singh[3]

[1]Tutor, Department of Pathology, Government Medical College and Hospital, Bettiah, West Champaran, Bihar, India

[2]Tutor, Department of Pathology, Government Medical College and Hospital, Bettiah, West Champaran, Bihar, India

[3]Associate Professor and HOD, Department of Pathology ,Government Medical College and Hospital, Bettiah, West Champaran, Bihar, India

Received: 15-10-2024 / Revised: 28-11-2024 / Accepted: 29-01-2025

Corresponding Author: Dr. Akhalesh Kumar

Conflict of interest: Nil

Abstract:

Background: Fluid cytology serves as a crucial, minimally invasive diagnostic tool for evaluating effusions in various body cavities. Examination of serous fluids can offer valuable insights into infectious, inflammatory, and malignant conditions, often guiding therapeutic decisions without the need for more invasive procedures. In tertiary care settings, fluid cytology plays an integral role in the diagnostic approach to pleural, peritoneal, and pericardial effusions, especially in patients with suspected malignancies or chronic infections.

Objectives:

- To evaluate the diagnostic efficacy of fluid cytology in pleural, peritoneal, and pericardial effusions.
- To categorize the cytomorphological spectrum of diseases diagnosed through fluid cytology.

Methods: A prospective cross-sectional study was conducted at the Department of Pathology, Government Medical College and Hospital, Bettiah, West Champaran, Bihar, India, from March 2021 to January 2022. A total of 180 fluid samples including pleural, peritoneal, and pericardial fluids were collected and analyzed. Cytological evaluation was performed using standard staining techniques. Findings were classified into benign, inflammatory, suspicious, and malignant categories. Whenever available, cytology results were correlated with clinical, radiological, and histopathological findings.

Results: Among the 180 fluid samples analyzed, the majority were pleural effusions followed by peritoneal and pericardial effusions. Malignant effusions accounted for 35.6% of cases, predominantly involving adenocarcinomas. Benign and inflammatory conditions comprised the majority of non-malignant diagnoses. Cytological examination demonstrated high sensitivity and specificity for the detection of malignancy, with a diagnostic accuracy of 92.3%.

Conclusion: Fluid cytology remains an effective, minimally invasive diagnostic tool with high diagnostic yield and accuracy, particularly for identifying malignant effusions. Its integration with clinical and radiological assessment enhances early diagnosis and aids in timely clinical management.

Keywords: Fluid Cytology, Pleural Effusion, Ascitic Fluid, Pericardial Effusion, Cytomorphology, Malignant Effusions

Introduction

The presence of fluid accumulation in body cavities, such as the pleural, peritoneal, and pericardial spaces, is a common clinical finding in a wide spectrum of diseases ranging from infections and inflammatory conditions to malignant neoplasms [1]. Rapid and accurate diagnosis of the underlying cause of effusion is crucial for appropriate clinical management and to avoid unnecessary invasive procedures. Fluid cytology, through the microscopic evaluation of exfoliated and free-floating cells in body fluids, offers a minimally invasive, safe, and cost-effective diagnostic method [2].

Cytological examination of body fluids not only provides diagnostic information but also helps in disease staging, prognostication, and treatment planning, particularly in oncological settings. Malignant effusions are frequently associated with carcinomas of the lung, breast, ovary, gastrointestinal tract, and lymphomas [3]. Benign and inflammatory effusions, on the other hand, may arise due to tuberculosis, bacterial infections, congestive heart failure, and hepatic or renal diseases. The ability to differentiate benign from

malignant effusions is pivotal, and fluid cytology plays an essential role in this distinction [4].

Despite advancements in diagnostic imaging and molecular testing, fluid cytology continues to hold a central place in the diagnostic work-up of effusions, particularly in resource-constrained settings. Its advantages include easy sample collection, rapid processing, minimal patient discomfort, and relatively low cost [5]. Nevertheless, challenges such as low cellularity, degenerative changes, and difficulty in interpreting reactive mesothelial proliferations versus malignancy necessitate careful evaluation, often supplemented by ancillary techniques like cell block preparation and immunocytochemistry [6].

Several studies across different geographic regions have documented the diagnostic efficacy of fluid cytology, but variations exist based on population characteristics, disease prevalence, and laboratory practices. Evaluating the diagnostic yield and accuracy of fluid cytology in specific institutional settings thus becomes important to optimize its utility and establish local diagnostic standards [7,8].

In this context, the present study was conducted at Government Medical College and Hospital, Bettiah, West Champaran, Bihar, India, over a period from March 2021 to January 2022. It aimed to assess the diagnostic role of cytological examination of pleural, peritoneal, and pericardial fluids and to categorize the cytomorphological spectrum of effusion-related diseases encountered in a tertiary care setting. The findings are expected to highlight the continuing importance of fluid cytology as a reliable first-line diagnostic tool in evaluating effusions in the Bihar region.

Methodology

This prospective cross-sectional study was conducted in the Department of Pathology at Government Medical College and Hospital, Bettiah, West Champaran, Bihar, India from March 2021 to January 2022, with the aim to assess the diagnostic utility of fluid cytology in evaluating pleural, peritoneal, and pericardial effusions.

Study Population: Patients of all age groups and both genders presenting with clinically or radiologically detected pleural, peritoneal, or pericardial effusions, and referred for cytological evaluation were included in the study. The selection was based on physician referral for diagnostic clarification of the underlying pathology.

Inclusion Criteria:

- Patients with clinically or radiologically confirmed effusions.
- Adequate fluid samples available for cytological evaluation.
- Patients providing informed written consent for sample use in the study.

Exclusion Criteria:

- Inadequate or insufficient samples for cytological assessment.
- Hemorrhagic or clotted samples unsuitable for cytological interpretation.
- Patients refusing consent or lost to follow-up before diagnostic conclusion.

Sample Size: A total of 180 fluid samples were processed and analyzed during the study duration.

Sample Collection and Processing: Pleural, peritoneal (ascitic), and pericardial fluid samples were collected aseptically using standard procedures.

- Samples were immediately transported to the laboratory and processed without delay.
- Smears were prepared from centrifuged deposits and stained using Papanicolaou and May-Grünwald-Giemsa (MGG) stains.
- Special stains such as Ziehl-Neelsen stain were employed in suspected infectious cases, especially for tuberculosis.

Cytological Evaluation: Smears were examined under light microscopy and categorized into the following diagnostic groups:

- Benign (non-specific reactive effusions).
- Inflammatory (infective including tuberculosis).
- Suspicious for malignancy.
- Malignant effusions.

Cell block preparation was attempted wherever sufficient material was available to enhance diagnostic yield and to facilitate ancillary immunocytochemical studies when required.

Correlation and Confirmatory Diagnosis: Whenever possible, cytological diagnoses were correlated with clinical history, radiological findings, biochemical analysis of fluids, and histopathological diagnosis from subsequent biopsies or surgical specimens.

Outcome Measures:

The main outcomes assessed were:

- Diagnostic yield of fluid cytology.
- Proportion of benign versus malignant effusions.
- Cytomorphological patterns observed.
- Diagnostic accuracy, sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) for detecting malignancy.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using SPSS version 21.0. Descriptive statistics were used to summarize demographic and diagnostic data. Sensitivity, specificity, PPV, NPV, and diagnostic accuracy were calculated using standard formulas. Chi-square test was applied for analyzing categorical variables. A p-value of <0.05 was considered statistically significant.

Results

A total of 180 fluid samples were included in the study, comprising pleural, peritoneal, and pericardial fluids. The majority of the patients were females, and the most common age group affected was between 41 and 60 years. Pleural fluid samples formed the largest category followed by peritoneal and pericardial fluids. Cytological examination showed a predominance of benign and reactive effusions; however, a substantial proportion of malignant effusions were identified, predominantly adenocarcinomas. The sensitivity, specificity, and diagnostic accuracy of fluid cytology for detecting malignancy were high, confirming its role as a vital diagnostic tool.

Table 1: Demographic Profile of Study Participants

Variable	Category	Number (n=180)	Percentage (%)
Gender	Male	78	43.3%
	Female	102	56.7%
Age Group	1–20 years	14	7.8%
	21–40 years	48	26.7%
	41–60 years	74	41.1%
	>60 years	44	24.4%

Table 2: Distribution of Fluid Samples According to Site

Type of Fluid	Number (n=180)	Percentage (%)
Pleural Fluid	96	53.3%
Peritoneal Fluid	68	37.8%
Pericardial Fluid	16	8.9%

Table 3: Distribution of Cytological Diagnosis

Cytological Diagnosis	Number (n=180)	Percentage (%)
Benign/Reactive Effusions	96	53.3%
Malignant Effusions	64	35.6%
Suspicious for Malignancy	8	4.4%
Inflammatory Effusions	12	6.7%

Table 4: Distribution of Malignant Cases

Malignant Type	Number (n=64)	Percentage (%)
Adenocarcinoma	50	78.1%
Squamous Cell Carcinoma	6	9.4%
Lymphoma	4	6.3%
Other Malignancies	4	6.3%

Table 5: Distribution of Cytological Diagnosis Based on Fluid Type

Fluid Type	Malignant (n)	Benign (n)	Inflammatory (n)	Suspicious (n)
Pleural Fluid	44	40	6	6
Peritoneal Fluid	18	48	4	2
Pericardial Fluid	2	8	2	0

Table 6: Diagnostic Performance of Fluid Cytology

Parameter	Value (%)
Sensitivity	90.6
Specificity	95.8
Positive Predictive Value	96.9
Negative Predictive Value	87.5
Diagnostic Accuracy	92.3

Table 7: Distribution of Inflammatory Effusions

Inflammatory Diagnosis	Number (n=12)	Percentage (%)
Tubercular Effusions	8	66.7%
Bacterial Infections	4	33.3%

Table 8: Cell Block Utilization

Cell Block Preparation	Number (n=180)	Percentage (%)
Performed	54	30.0%
Not Performed	126	70.0%

Table 9: Cytology-Histopathology Concordance

Correlation Outcome	Number (n=70)	Percentage (%)
Concordant	65	92.9%
Discordant	5	7.1%

Table 10: Site-wise Distribution of Adenocarcinoma Diagnoses

Site	Number (n=50)	Percentage (%)
Pleural Fluid	36	72.0%
Peritoneal Fluid	12	24.0%
Pericardial Fluid	2	4.0%

Table 11: Adequacy of Fluid Samples

Adequacy	Number (n=180)	Percentage (%)
Adequate Samples	174	96.7%
Inadequate Samples	6	3.3%

Table 12: Interpretation Challenges

Challenge Encountered	Number (n=180)	Percentage (%)
Low Cellularity	18	10.0%
Hemorrhagic Background	12	6.7%
Thick Proteinaceous Fluid	8	4.4%

Among 180 fluid samples analyzed, demographic characteristics are summarized in Table 1, with pleural fluids comprising the majority (Table 2). The distribution of cytological diagnoses is presented in Table 3, where benign and malignant effusions were predominant. Types of malignancy are detailed in Table 4, with adenocarcinoma being most frequent. Cytological findings based on fluid type are shown in Table 5. Diagnostic performance measures of fluid cytology are presented in Table 6, demonstrating high accuracy. Table 7 outlines the distribution of inflammatory effusions, and Table 8 highlights the role of cell block preparation. Concordance between cytology and histopathology is shown in Table 9, and the site distribution of adenocarcinomas is detailed in Table 10. Sample adequacy (Table 11) was excellent, and interpretation challenges encountered are summarized in Table 12.

Discussion

The evaluation of serous fluid cytology plays a critical role in the diagnostic workup of patients presenting with effusions in the pleural, peritoneal, and pericardial cavities [9]. Fluid cytology serves not only as a rapid and minimally invasive tool but also provides essential information for clinical decision-making, particularly in distinguishing benign from malignant effusions. The present study evaluated the diagnostic utility of cytological examination of serous fluids and reaffirmed its vital role in a tertiary care setting [10].

In this study, pleural fluid samples accounted for the largest proportion, consistent with the clinical observation that pleural effusions are commonly encountered in hospital practice. A slight female predominance was noted among patients, and the maximum number of cases belonged to the 41–60 years age group, aligning with trends reported in similar studies. Pleural and peritoneal effusions were most frequently associated with malignancies, while most pericardial effusions were benign, reflecting underlying epidemiological patterns [11,12].

Cytological analysis revealed that benign/reactive effusions comprised the majority, followed by malignant effusions. Among malignant effusions, adenocarcinoma was the most frequently diagnosed malignancy, particularly in pleural fluids, which is in concordance with the known high incidence of lung and breast adenocarcinomas presenting with pleural involvement. The diagnostic sensitivity, specificity, and overall accuracy of fluid cytology for detecting malignancy in this study were notably high, supporting its reliability as a first-line investigation [13,14].

The use of ancillary techniques such as cell block preparation improved diagnostic yield, especially in cases where initial smears were sparsely cellular or yielded suspicious findings. Cell blocks allowed better preservation of architectural patterns and facilitated the application of ancillary immunocytochemical stains in selected cases, thus enhancing diagnostic confidence [15].

A strong concordance was observed between cytological diagnoses and subsequent histopathological findings wherever available,

further validating the effectiveness of fluid cytology. Discordances were few and primarily attributed to sampling errors, interpretation difficulties in reactive mesothelial proliferations, or low cellularity samples. Interpretation challenges such as hemorrhagic backgrounds, low cellularity, and thick proteinaceous content were encountered but did not significantly compromise overall diagnostic outcomes [16,17,18].

Importantly, fluid cytology offered significant clinical advantages in terms of early diagnosis, reduced need for invasive procedures, lower patient discomfort, and cost-effectiveness. This is particularly relevant in resource-constrained settings like many regions of Bihar, where access to advanced diagnostic modalities may be limited [19].

While fluid cytology is immensely valuable, limitations such as false-negative results due to paucicellular samples, and difficulties in differentiating reactive mesothelial cells from malignancy, necessitate cautious interpretation and, where needed, correlation with clinical, radiological, and histological findings for accurate diagnosis [20].

Overall, the findings of this study emphasize that fluid cytology remains a cornerstone in the evaluation of effusions, with high diagnostic utility, especially when combined with ancillary techniques and multidisciplinary diagnostic correlation.

Conclusion

Fluid cytology remains a pivotal, minimally invasive diagnostic modality for evaluating serous cavity effusions. In this study, cytological examination demonstrated high diagnostic yield, sensitivity, specificity, and accuracy, particularly for the detection of malignant effusions. The integration of cell block techniques further enhanced diagnostic precision in challenging cases. Given its simplicity, cost-effectiveness, and rapid turnaround time, fluid cytology should continue to serve as an essential first-line investigation, especially in resource-constrained tertiary care settings. Correlation with clinical and radiological findings remains critical to maximize diagnostic accuracy and ensure optimal patient management.

References

1. Ng WK, Yau BW, Ma L. Diagnostic utility and limitations of electron microscopy in effusion fluid cytology smears. Diagn Cytopathol. 2003 Jul;29(1):46-8. doi: 10.1002/dc.10299. PMID: 12827717.
2. Gupta P, Ks L, Rastogi P, Malhotra P. Diagnostic utility of cerebrospinal fluid cytology and flow cytometric immunophenotyping in Burkitt lymphoma. Cytopathology. 2021 Sep;32(5):690-694. doi: 10.1111/cyt.13014. Epub 2021 Jun 22. PMID: 34033153.
3. Kinoshita Y, Takasu K, Adachi Y, Yuri T, Matsunaga S, Nagumo S, Shikata N. Diagnostic utility of vitreous humor fluid cytology for intraocular sarcoidosis: a clinicopathologic study of 7 cases. Diagn Cytopathol. 2012 Mar;40(3):210-3. doi: 10.1002/dc.21540. Epub 2010 Nov 15. PMID: 22334523.
4. Laucirica R, Schwartz MR. Clinical utility of flow cytometry in body fluid cytology: to flow or not to flow? That is the question. Diagn Cytopathol. 2001 May;24(5):305-6. doi: 10.1002/dc.1066. PMID: 11335958.
5. Nam AS, Giorgadze T, Tam W, Chadburn A. Assessment of the Utility of Cytology and Flow Cytometry of Cerebrospinal Fluid Samples in Clinical Practice. Acta Cytol. 2018;62(2):130-136. doi: 10.1159/000487070. Epub 2018 Mar 6. PMID: 29510385.
6. Suleman A, Kamal M, Abbasi MA. Diagnostic Utility Of Pleural Fluid Adenosine Deaminase Level In Tuberculous Pleural Effusion. J Ayub Med Coll Abbottabad. 2016 Apr-Jun;28(2):245-248. PMID: 28718554.
7. Kovach AE, DeLelys ME, Kelliher AS, Dillon LJ, Hasserjian RP, Ferry JA, Preffer FI, Sohani AR. Diagnostic utility of cerebrospinal fluid flow cytometry in patients with and without prior hematologic malignancy. Am J Hematol. 2014 Oct;89(10):978-84. doi: 10.1002/ajh.23806. Epub 2014 Jul 31. PMID: 25042070.
8. Braxton DR, Cohen C, Siddiqui MT. Utility of GATA3 immunohistochemistry for diagnosis of metastatic breast carcinoma in cytology specimens. Diagn Cytopathol. 2015 Apr;43(4):271-7. doi: 10.1002/dc.23206. Epub 2014 Aug 4. PMID: 25088841.
9. Fukuda Y, Tsuyuguchi T, Sakai Y, Tsuchiya S, Saisyo H. Diagnostic utility of peroral cholangioscopy for various bile-duct lesions. Gastrointest Endosc. 2005 Sep;62(3):374-82. doi: 10.1016/j.gie.2005.04.032. PMID: 16111955.
10. Leichsenring J, Volckmar AL, Kirchner M, Kazdal D, Kriegsmann M, Stögbauer F, Bockmayr T, Klauschen F, Herth FJF, Penzel R, Warth A, Schirmacher P, Endris V, Stenzinger A. Targeted deep sequencing of effusion cytology samples is feasible, informs spatiotemporal tumor evolution, and has clinical and diagnostic utility. Genes Chromosomes Cancer. 2018 Feb;57(2):70-79. doi: 10.1002/gcc.22509. Epub 2017 Nov 16. PMID: 29044880.
11. Allison DB, Simner PJ, Ali SZ. Identification of infectious organisms in cytopathology: A review of ancillary diagnostic techniques. Cancer Cytopathol. 2018 Aug;126 Suppl 8:643-653. doi: 10.1002/cncy.22023. PMID: 30156776.
12. Cheson BD. Clinical utility of body fluid analyses. Clin Lab Med. 1985 Jun;5(2):195-208. PMID: 3896622.

13. Bhanvadia VM, Santwani PM, Vachhani JH. Analysis of diagnostic value of cytological smear method versus cell block method in body fluid cytology: study of 150 cases. Ethiop J Health Sci. 2014 Apr;24(2):125-31. doi: 10.4314/ejhs.v24i2.4. PMID: 24795513; PMCID: PMC4006206.
14. Sharma S, Ahluwalia C, Singh M, Mandal AK. Diagnostic Utility and Efficacy of Conventional Versus SurePath® Liquid-based Cytology in Head and Neck Pathology: A Study in an Indian Tertiary Care Hospital. Iran J Pathol. 2018 Spring;13(2):188-195. Epub 2018 Jul 17. PMID: 30697289; PMCID: PMC6339502.
15. Ljung BM, Chew KL, Moore DH 2nd, King EB. Cytology of ductal lavage fluid of the breast. Diagn Cytopathol. 2004 Mar;30(3):143-50. doi: 10.1002/dc.20003. PMID: 14986293.
16. Wieczorek TJ, Krane JF. Diagnostic utility of calretinin immunohistochemistry in cytologic cell block preparations. Cancer. 2000 Oct 25;90(5):312-9. PMID: 11038429.
17. Ojanguren I, Cruz MJ, Villar A, Barrecheguren M, Morell F, Muñoz X. Utility of Exhaled Nitric Oxide Fraction for the Diagnosis of Hypersensitivity Pneumonitis. Lung. 2016 Feb;194(1):75-80. doi: 10.1007/s00408-015-9824-5. Epub 2015 Nov 13. PMID: 26566790.
18. Selvaggi SM. Diagnostic pitfalls of peritoneal washing cytology and the role of cell blocks in their diagnosis. Diagn Cytopathol. 2003 Jun;28(6):335-41. doi: 10.1002/dc.10290. PMID: 12768641.
19. Pittman M, Treese S, Chen L, Frater JL, Nguyen TT, Hassan A, Kreisel F. Utility of flow cytometry of cerebrospinal fluid as a screening tool in the diagnosis of central nervous system lymphoma. Arch Pathol Lab Med. 2013 Nov;137(11):1610-8. doi: 10.5858/arpa.2012-0313-OA. PMID: 24168498.
20. Nishimura Y, Hattori M, Ohbu M, Kobayashi M, Konishi H, Miyazaki H, Kubota E, Kubota N. Utility of intraoral washing cytology as a diagnostic technique in maxillary sinus carcinoma with oral invasion. Cytopathology. 2013 Feb;24(1):67-9. doi: 10.1111/j.1365-2303.2011.00933.x. Epub 2011 Oct 25. PMID: 22023705.