



## CYTOLOGICAL EVALUATION OF BODY FLUIDS FOR MALIGNANCY: A TERTIARY CARE CENTER EXPERIENCE

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### ABSTRACT

**Background:** Effusion cytology is a simple, minimally invasive, and cost-effective diagnostic modality for evaluating serous cavity fluids and cerebrospinal fluid, particularly in patients with suspected malignancy. Despite advances in imaging and histopathology, cytological examination remains an important first-line investigation in routine pathological practice.

**Objectives:** To study the cytological profile of body fluids received at a tertiary care center, with emphasis on demographic distribution, type of fluid, cytomorphological patterns, and spectrum of malignant lesions.

**Materials and Methods:** This hospital-based observational study included 275 body fluid samples comprising pleural, peritoneal, cerebrospinal, pericardial, and synovial fluids. Samples were processed using centrifugation, and smears were stained with Hematoxylin and Eosin, Leishman, and Papanicolaou stains. Cell blocks were prepared whenever feasible. Cytological findings were categorized as benign, suspicious for malignancy, or malignant. Statistical analysis was performed using Chi-square and Fisher's exact tests, with  $p < 0.05$  considered significant.

**Results:** Pleural fluid was the most common specimen (41.5%), followed by peritoneal fluid (31.3%). A significant male predominance was observed overall (59.3%,  $p = 0.002$ ). Most effusions were benign (93.5%), while malignant effusions constituted 5.5%, predominantly involving pleural and peritoneal fluids ( $p = 0.001$ ). Lymphocytes were the predominant cell type (68.7%,  $p < 0.001$ ). Adenocarcinoma was the most common malignancy (40%), with a significant female predominance among malignant cases ( $p = 0.04$ ).

**Conclusion:** Effusion cytology is a valuable diagnostic tool that aids in early detection of malignancy and serves as an effective complementary modality to histopathology, especially in tertiary care and resource-limited settings.

**Keywords:** Effusion cytology; Body fluids; Pleural effusion; Malignant effusion; Adenocarcinoma; Cell block technique.

### INTRODUCTION

Effusion cytology is a well-established, minimally invasive diagnostic modality for the evaluation of serous cavity fluids and cerebrospinal fluid, particularly when malignancy is suspected. Pleural effusion is a common clinical problem, with recent epidemiological data suggesting that approximately 1.5 million individuals develop pleural effusion annually in the United States, making it a frequent indication for diagnostic thoracentesis and laboratory evaluation [1]. Malignant pleural effusion (MPE) represents an advanced stage of malignancy and is associated with significant morbidity and reduced survival. The annual incidence of MPE has been estimated to be around 150,000 cases per year, with prognosis largely dependent on the underlying primary tumor and clinical status of the patient [2,3].

Malignant ascites is another important manifestation of serosal involvement and accounts for nearly 10% of all cases of ascites, most commonly associated with ovarian and gastrointestinal malignancies [4,5]. Cytological examination of body fluids allows direct visualization of exfoliated cells from extensive serosal surfaces and plays a vital role in diagnosis, staging, prognosis, and therapeutic planning. However, interpretation may be challenging due to overlapping cytomorphological features between reactive mesothelial proliferations, inflammatory conditions, and malignant cells [6,7].

Large interlaboratory analyses, including data from the College of American Pathologists involving more than 344,000 body fluid cytology responses, have highlighted both the diagnostic value of fluid cytology and the need for standardized reporting and quality assurance [8]. The diagnostic sensitivity of fluid cytology varies with the type of fluid and primary malignancy. A recent meta-analysis reported an overall sensitivity of approximately 58% for pleural fluid cytology in detecting malignant pleural effusions, with higher yields in adenocarcinomas and lower sensitivity in mesothelioma [9,10]. To improve diagnostic accuracy, adjunctive techniques such as cytocentrifugation, cell block preparation, and immunocytochemistry are increasingly employed, with several studies demonstrating superior diagnostic yield using cell block techniques compared to conventional smears alone [11].

Indian tertiary-care studies consistently report that pleural and peritoneal fluids constitute the majority of specimens submitted for cytological analysis, while malignant effusions form a smaller but clinically significant proportion [12–15]. Adenocarcinoma has been repeatedly identified as the most common malignant lesion detected in effusion cytology, reflecting the metastatic patterns of common solid tumors [16–18]. In this context, the present study evaluates the cytological profile of body fluids received in a tertiary care center, with emphasis on demographic distribution, predominant cytomorphological patterns, and the spectrum of malignant lesions, thereby reinforcing the diagnostic utility of body fluid cytology in routine pathological practice [19–23].

## MATERIALS AND METHODS

This hospital-based observational study was conducted in the Department of Pathology of a tertiary care teaching hospital over a defined study period. A total of 275 body fluid samples received for cytological evaluation were included in the study. The samples comprised pleural, peritoneal, cerebrospinal, pericardial, and synovial fluids obtained from patients of all age groups and both genders. Samples from patients already on definitive treatment for malignancy were excluded. Relevant clinical details including age, gender, and type of fluid were recorded at the time of receipt. All specimens were processed promptly. Fluids were subjected to centrifugation, and smears were prepared from the sediment. The smears were stained using Hematoxylin and Eosin (H&E) and Leishman stain, with Papanicolaou stain applied wherever atypical or suspicious cells were identified. Cell block preparation was performed whenever adequate material was available. Cytological evaluation was carried out by experienced pathologists, focusing on cellularity, cell arrangement, cytoplasmic features, nuclear morphology, and background elements. Based on cytomorphological findings, cases were categorized as benign, suspicious for malignancy, or malignant. Data were entered into Microsoft Excel and analyzed using SPSS software. Categorical variables were expressed as frequencies and percentages. Associations between variables were assessed using the Chi-square test or Fisher's exact test, with a p value < 0.05 considered statistically significant.

## RESULTS

The present study analyzed cytological findings from 275 body fluid samples received during the study period. The results are presented with respect to demographic characteristics, type of body fluid, cytomorphological features, and final cytological diagnosis. Findings have been summarized using appropriate descriptive statistics, and associations between variables were assessed where applicable. The detailed results are shown in Tables 1–6 and corresponding figures.

**Table 1. Gender Distribution of Study Population (n = 275)**

Gender	Number	Percentage (%)
Male	163	59.3
Female	112	40.7
<b>Total</b>	<b>275</b>	<b>100.0</b>

Out of the 275 patients included in the study, 163 (59.3%) were males and 112 (40.7%) were females, indicating a clear male predominance in the study population. Statistical analysis using the Chi-square goodness-of-fit test showed that this difference in gender distribution was statistically significant ( $p = 0.002$ ). This finding suggests that body fluid samples requiring cytological evaluation were more frequently obtained from male patients in the present study. The observed male predominance may reflect a higher burden of underlying conditions leading to effusions among males or differences in healthcare-seeking behavior, although causal inferences cannot be drawn from this observation alone.

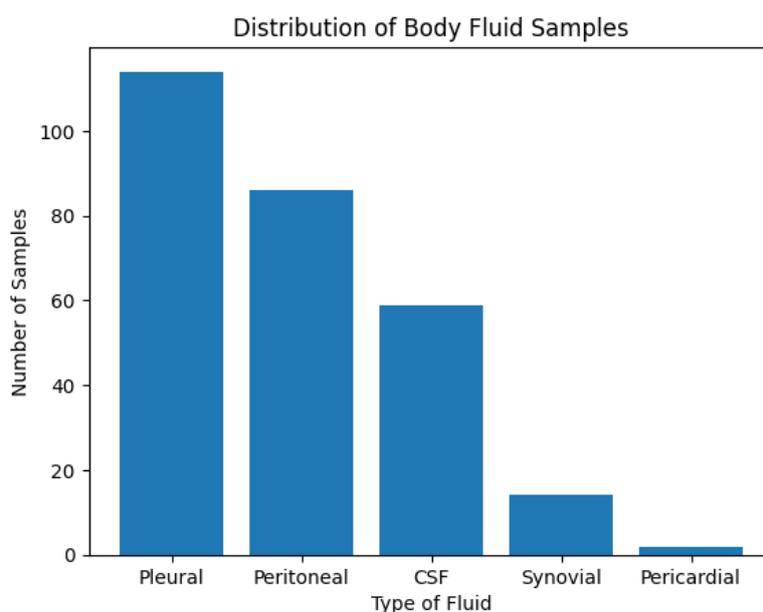
**Table 2. Age Group Distribution According to Type of Fluid (n = 275)**

Age Group (years)	CSF n (%)	Pericardial n (%)	Peritoneal n (%)	Pleural n (%)	Synovial n (%)	Total
≤1	32 (54.2)	0 (0)	3 (3.5)	0 (0)	0 (0)	35
2–18	10 (16.9)	0 (0)	0 (0)	7 (6.1)	2 (14.3)	19
19–30	4 (6.8)	0 (0)	8 (9.3)	31 (27.2)	1 (7.1)	44
31–40	4 (6.8)	0 (0)	11 (12.8)	14 (12.3)	2 (14.3)	31
41–50	5 (8.5)	1 (50.0)	26 (30.2)	25 (21.9)	2 (14.3)	59
51–60	0 (0)	0 (0)	24 (27.9)	12 (10.5)	4 (28.6)	40
61–70	0 (0)	0 (0)	13 (15.1)	18 (15.8)	1 (7.1)	32
71–80	2 (3.4)	0 (0)	1 (1.2)	6 (5.3)	1 (7.1)	10
81–90	2 (3.4)	1 (50.0)	0 (0)	1 (0.9)	0 (0)	4
<b>Total</b>	<b>59 (21.5)</b>	<b>2 (0.7)</b>	<b>86 (31.3)</b>	<b>114 (41.5)</b>	<b>14 (5.1)</b>	<b>275</b>

The age of patients in the study ranged from ≤1 year to 90 years, with a distinct variation in the type of body fluid analyzed across different age groups. Cerebrospinal fluid (CSF) samples were predominantly obtained from the ≤1 year age group, accounting for 54.2% of all CSF samples, reflecting the higher clinical need for CSF evaluation in infants. In contrast, pleural fluid was most commonly observed in young adults aged 19–30 years (27.2%), while peritoneal fluid was most frequently encountered in the 41–50 year age group (30.2%). Synovial fluid samples were mainly seen in patients aged 51–60 years (28.6%). Pericardial fluid samples were rare and confined to the middle and older age groups. Statistical analysis using the Chi-square test demonstrated a highly significant association between age group and type of fluid analyzed ( $p < 0.001$ ). This indicates that the distribution of body fluid types varies significantly with age, likely reflecting age-specific disease patterns and clinical indications for fluid aspiration in different age groups.

**Table 3. Type of Fluid vs Nature of Lesion (n = 275)**

Type of Fluid	Benign n (%)	Suspicious n (%)	Malignant n (%)	Total
CSF	59 (23.0)	0 (0)	0 (0)	59
Pericardial	2 (0.8)	0 (0)	0 (0)	2
Peritoneal	77 (30.0)	2 (66.7)	8 (53.3)	87
Pleural	106 (41.2)	1 (33.3)	7 (46.7)	114
Synovial	13 (5.0)	0 (0)	0 (0)	13
<b>Total</b>	<b>257 (93.5)</b>	<b>3 (1.1)</b>	<b>15 (5.5)</b>	<b>275</b>



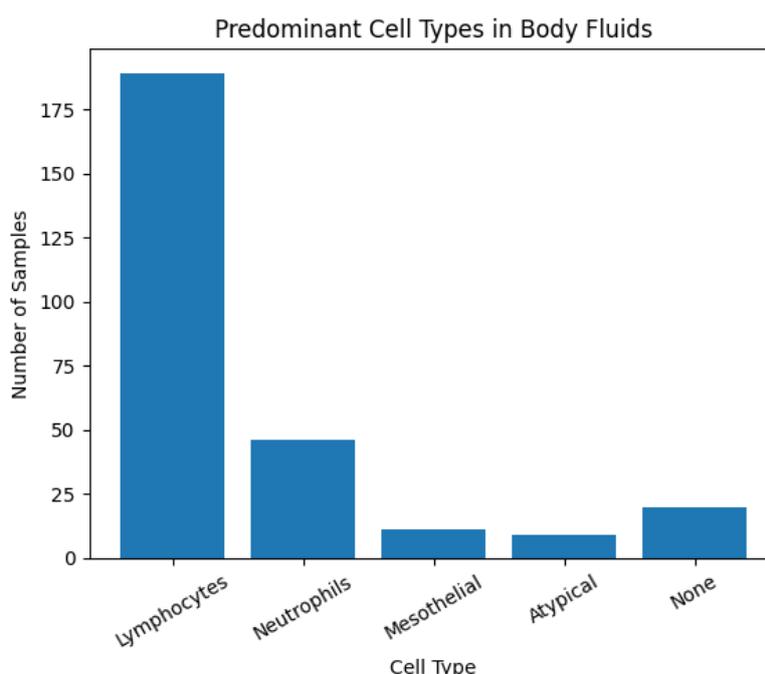
**Figure 1. Distribution of body fluid samples:** Bar chart showing the distribution of different types of body fluid samples analyzed in the study. Pleural fluid constituted the largest proportion of samples, followed by peritoneal fluid and cerebrospinal fluid, while synovial and pericardial fluids were comparatively less frequent.

Analysis of the relationship between type of body fluid and nature of lesion showed that the majority of samples across all fluid types were benign (93.5%), while malignant lesions constituted 5.5% of the total cases and 1.1% were reported as suspicious for malignancy. Cerebrospinal, pericardial, and synovial fluids demonstrated exclusively benign cytological

findings, with no malignant or suspicious lesions identified in these categories. In contrast, malignant and suspicious lesions were confined to peritoneal and pleural fluids. Among malignant cases, peritoneal fluid accounted for the highest proportion (53.3%), followed by pleural fluid (46.7%). Similarly, most cases reported as suspicious for malignancy were observed in peritoneal fluid (66.7%). Statistical evaluation using Fisher's exact test revealed a significant association between the type of fluid and the presence of malignancy ( $p = 0.001$ ). This finding indicates that the likelihood of detecting malignant cells on cytological examination varies significantly by fluid type, with peritoneal and pleural effusions providing the highest diagnostic yield for malignancy in the present study.

**Table 4. Predominant Cell Type in Body Fluids (n = 275)**

Predominant Cell Type	Number	Percentage (%)
Lymphocytes	189	68.7
Neutrophils	46	16.7
Mesothelial cells	11	4.0
Atypical cells	9	3.3
No predominant cell type	20	7.3
<b>Total</b>	<b>275</b>	<b>100.0</b>



**Figure 2. Predominant cell types observed in body fluid cytology:** Bar chart illustrating the distribution of predominant cellular components in body fluid samples. Lymphocytes were the most frequently observed predominant cell type, followed by neutrophils, while mesothelial cells, atypical cells, and samples without a single predominant cell type were less common.

Analysis of the predominant cell type in body fluid samples showed that lymphocytes were the most common cellular component, identified in 189 cases (68.7%), followed by neutrophils in 46 cases (16.7%). Mesothelial cells were the predominant cell type in 11 cases (4.0%), while atypical cells were observed in 9 cases (3.3%). In 20 samples (7.3%), no single predominant cell type could be identified. The predominance of lymphocytes was found to be statistically significant on Chi-square analysis ( $p < 0.001$ ). This finding suggests that most effusions evaluated in the present study were associated with benign or chronic inflammatory conditions, whereas neutrophilic predominance likely reflected acute inflammatory processes. The distribution of predominant cell types is graphically represented in Figure 2.

**Table 5. Distribution of Malignant Lesions (n = 15)**

Malignant Diagnosis	Number	Percentage (%)
Adenocarcinoma	6	40.0
Ovarian carcinoma	4	26.7
Breast carcinoma	3	20.0
Carcinoma of unknown primary	2	13.3
<b>Total</b>	<b>15</b>	<b>100.0</b>

**Table 6. Gender Distribution among Malignant Cases (n = 15)**

Gender	Number	Percentage (%)
Male	5	33.3
Female	10	66.7
<b>Total</b>	<b>15</b>	<b>100.0</b>

Among the 15 cases diagnosed as malignant, adenocarcinoma was the most frequent malignancy, accounting for 6 cases (40.0%), followed by ovarian carcinoma in 4 cases (26.7%) and breast carcinoma in 3 cases (20.0%). Carcinoma of unknown primary was identified in 2 cases (13.3%). This distribution highlights adenocarcinoma as the predominant malignant lesion detected on body fluid cytology in the present study.

Gender-wise analysis of malignant cases revealed a female predominance, with 10 cases (66.7%) occurring in females compared to 5 cases (33.3%) in males. Statistical evaluation using Fisher's exact test demonstrated that this difference was statistically significant ( $p = 0.04$ ). This finding suggests a higher likelihood of malignant effusions among female patients in the study population, which may be related to the contribution of gynecological and breast malignancies to malignant body fluid effusions.

## DISCUSSION

Effusion cytology remains a cornerstone in the diagnostic evaluation of serous cavity fluids and continues to serve as a reliable, minimally invasive tool for the detection of malignant and non-malignant conditions. In the present study, pleural fluid was the most frequently analyzed specimen, followed by peritoneal fluid. This observation is in concordance with reports by Shen-Wagner et al. [1], Penz et al. [3], and Indian studies by Deshpande et al. [12] and Sharma et al. [17], all of whom reported pleural effusions as the commonest samples submitted for cytological evaluation. The high prevalence of pleural effusions reflects the substantial global burden of pleural diseases, as highlighted by Shen-Wagner et al., who reported nearly 1.5 million new cases annually in the United States [1].

A male predominance was noted in the overall study population, similar to findings reported by Deshpande et al. [12], El-Sheikh et al. [16], and Gupta et al. [18]. This male preponderance may be attributable to higher exposure to risk factors such as smoking, occupational hazards, and chronic systemic illnesses. However, among malignant effusions, the present study demonstrated a statistically significant female predominance, a finding also supported by El-Sheikh et al. [16], who emphasized the contribution of breast and gynecological malignancies to malignant effusions.

The overall frequency of malignant effusions in the present study was 5.5%, which is comparable to rates reported by El-Sheikh et al. [16], Sharma et al. [17], and Kol et al. [20], who documented malignant effusions in approximately 5–10% of cases. Similar to observations by Gupta et al. [18] and Pradhan et al. [21], malignant and suspicious lesions in the present study were confined to pleural and peritoneal fluids, while cerebrospinal, synovial, and pericardial fluids showed exclusively benign findings.

With respect to cytomorphological patterns, lymphocytes were the predominant cell type in the majority of effusions, a finding consistent with studies by Sharma et al. [17] and Shulbha et al. [19], suggesting a predominance of benign or chronic inflammatory conditions. Neutrophilic predominance, as observed in a smaller subset of cases, was indicative of acute inflammatory processes, as also noted by Bibbo et al. [15].

Among malignant lesions, adenocarcinoma was the most common diagnosis, followed by ovarian and breast carcinoma. This pattern is well documented in the literature, with similar findings reported by El-Sheikh et al. [16], Gupta et al. [18], and classic studies by Sears et al. [22]. Adenocarcinomas are known to exfoliate malignant cells readily into serous cavities, accounting for their frequent detection in effusion cytology.

Overall, the present study reinforces the conclusions drawn by Tabatabai et al. [8] and Santwani et al. [11] that body fluid cytology is a rapid, cost-effective, and diagnostically valuable modality. Although it does not replace histopathology, effusion cytology serves as an important complementary tool, particularly in advanced malignancies and resource-limited settings, as emphasized by Wong et al. [23]

## CONCLUSION

The present study highlights the continued relevance of effusion cytology as a simple, rapid, and minimally invasive diagnostic tool in the evaluation of body fluid samples. Pleural fluid was the most frequently analyzed specimen, followed by peritoneal fluid, reflecting the common clinical indications for fluid aspiration in routine practice. The majority of effusions were benign in nature; however, a clinically significant proportion showed malignant cytological features, emphasizing the diagnostic value of fluid examination. Malignant effusions were predominantly observed in pleural and peritoneal fluids, with adenocarcinoma emerging as the most common malignant diagnosis. A significant female

predominance among malignant cases was noted, likely related to gynecological and breast malignancies. Lymphocytes constituted the predominant cell type in most effusions, supporting the association of benign and chronic inflammatory conditions with fluid accumulation. Overall, the findings reinforce that cytological evaluation of body fluids provides valuable diagnostic and prognostic information, aids in early detection of malignancy, and serves as an important complementary modality to histopathology, particularly in tertiary care and resource-limited settings.

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