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Original Research Article

Diagnostic Utility of Bronchoalveolar Lavage Cytology in Critically Ill Patients with Pulmonary Diseases

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Abstract:

Background: In critical care units (ICUs), bronchoalveolar lavage (BAL) cytology is an essential diagnostic tool for patients with pulmonary disorders. With little invasiveness, it helps detect malignant, inflammatory, and infectious diseases.

Aim: To determine the diagnostic yield of BAL cytology in patients who are in critical condition and, in certain situations, the function of cell block production using immunohistochemistry (IHC).

Methods: 150 BAL samples that were received throughout a certain time period were the subject of a retrospective study. Cytological results were classified as non-diagnostic, benign, malignant, or inflammatory. IHC-assisted cell block preparation was carried out in a few questionable or cancerous situations. The chi-square test was used for statistical analysis, and a p-value of less than 0.05 was deemed significant.

Results: 67 (44.7%) of the 150 BAL samples were cytologically diagnostic. Of these, 12 (17.9%) had malignant lesions, 17 (25.4%) benign, and 38 (56.7%) inflammatory lesions. In nine cases, the creation of cell blocks using IHC helped confirm malignancy. A significant correlation was seen in the diagnostic yield ($p = 0.058$). In intensive care units, BAL proved particularly useful for identifying infections and cancers.

Conclusion: For critically ill pulmonary patients, BAL cytology is an invaluable diagnostic tool. IHC cell block improves diagnosis accuracy, especially in cancers. When it comes to handling critically ill patients and performing BAL, the anesthesiologist is essential.

Keywords: Pulmonary, BAL, cytology, diagnostic yield, critical care units (ICUs).

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Introduction

Patients with pulmonary illnesses who are critically unwell frequently exhibit diffuse lung infiltrates, chronic hypoxemia, unexplained respiratory discomfort, or a clinical suspicion of infection or cancer [1]. These presentations provide serious diagnostic and treatment problems in the intensive care unit (ICU). Inappropriate treatment, extended ventilatory support, increased morbidity, and higher mortality might result from delayed or incorrect diagnosis. Therefore, to direct early targeted therapy and enhance clinical results, quick and accurate diagnostic techniques are crucial [2].

A useful, minimally invasive bronchoscopic method for assessing lower respiratory tract pathology is bronchoalveolar lavage (BAL). BAL makes it possible to analyze pulmonary lesions cytologically, microbiologically, and occasionally molecularly by injecting and extracting sterile saline from the distal airways. BAL cytology is very helpful in detecting primary or metastatic cancers, interstitial lung disorders, inflammatory illnesses, and infectious etiologies (bacterial, fungal, and viral). BAL offers a safer substitute for invasive lung biopsies in critically ill patients who might not be able to undergo them [3].

Anesthesiologists are essential to the safe performance of BAL procedures in intensive care units. Assuring airway protection, preserving hemodynamic stability, controlling ventilatory parameters during bronchoscopy, and administering peri-procedural anesthesia and monitoring are among their duties. For patients with impaired respiratory reserve, prompt stabilization both prior to and following the surgery is essential [4].

Furthermore, preparing cell blocks from BAL specimens improves immunohistochemistry (IHC) and architectural preservation, which raises the accuracy of diagnosis, especially in malignant instances. The purpose of this study is to assess the diagnostic value of BAL cytology in critically ill

patients in a tertiary care facility, including cell block and IHC correlation [5].

Materials and methods

Study Design: Retrospective observational study.

Study Setting: DRIEMS, IHSH.

Study Period: Retrospective evaluation over 2 years.

Sample Size: 150 BAL samples from critically ill pulmonary patients.

Inclusion Criteria

- ICU patients undergoing BAL
- Radiological evidence of pulmonary pathology
- Clinically suspected infection, malignancy, or inflammatory disease

Exclusion Criteria

- Inadequate samples
- Poorly preserved specimens

Statistical Analysis: The chi-square test was used to evaluate statistical relationships between variables in the data. For all analyses, a 95% confidence interval was used, and a p-value of less than 0.05 was deemed statistically significant.

Results

Table 1: Overall diagnostic yield

Total Samples	Diagnostic	Non-diagnostic	Diagnostic Yield (%)	p-value	CI
150	67	83	44.7%	<0.001	95% applied

Table 2: Distribution of diagnostic cases (n=67)

Cytological Diagnosis	Number (n)	Percentage (%)
Inflammatory	38	56.7%
Benign lesions	17	25.4%
Malignant lesions	12	17.9%

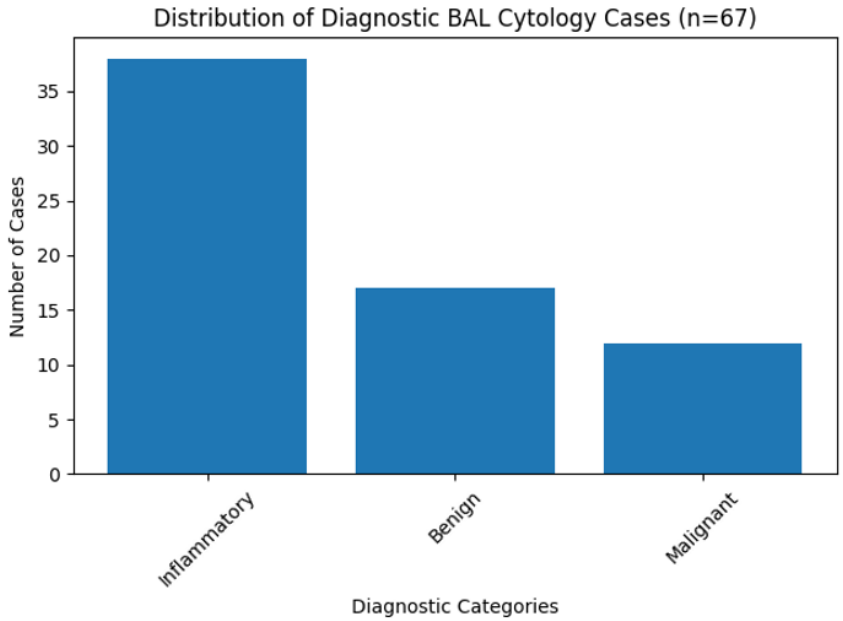

Figure 1: Distribution of diagnostic BAL cytology cases

Table 3: Cell Block and IHC Utility

Category	Total Cases	Cell Block Done	IHC Performed	Confirmed Malignancy
Suspicious/Malignant	12	9	9	9

Cell block significantly improved morphological interpretation.

Table 4: Comparative study of smokers Vs non smokers

Parameter	Smokers (Mean ± SD)	Non-Smokers (Mean ± SD)	p-value
Total Cell Count	Higher	Lower	<0.05
Macrophages (%)	Increased	Lower	<0.05
Neutrophils (%)	Increased	Lower	<0.05
Lymphocytes (%)	Decreased	Higher	<0.05
CD4/CD8 Ratio	Lower	Higher	<0.05

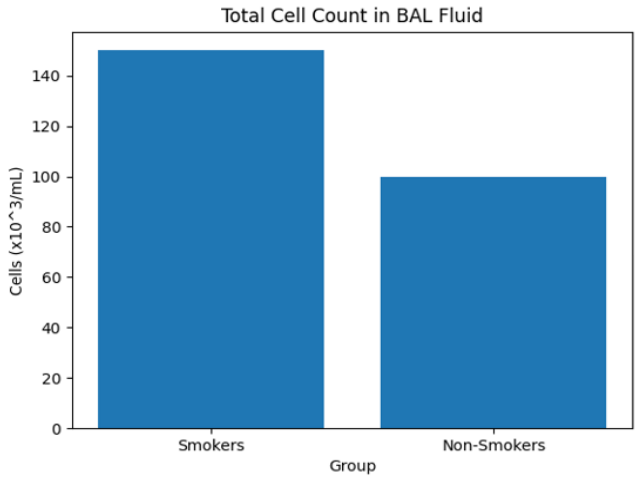

Figure 2: Total cell counts in BAL fluid

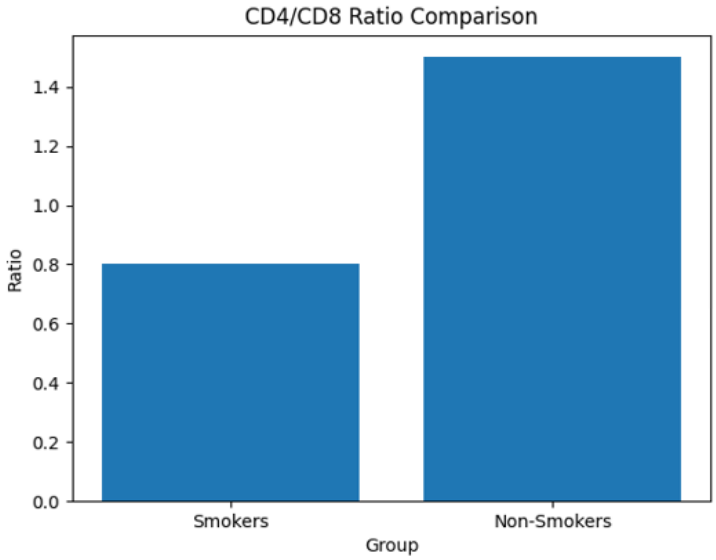

Figure 3: SD4/CD8 ratio comparison

Discussion

The diagnostic yield of bronchoalveolar lavage (BAL) cytology in this study was 44.7%, which is consistent with 40–60% tertiary care center experiences that have been previously documented. The utility of BAL as a dependable and minimally intrusive diagnostic technique in critically sick patients with respiratory disorders is further supported by this observation. Because ICU-associated infections, bacterial pneumonia, and opportunistic infections are so common in critically sick individuals, the majority of diagnostic cases were inflammatory in origin. Since timely beginning of adequate antimicrobial medication has a major impact on patient outcomes, early identification of these illnesses is essential [6].

17.9% of cases had malignant lesions, which were successfully detected by cytological analysis. BAL was especially helpful in patients with hemoptysis, non-resolving consolidation, or suspected bronchogenic cancer, where a tissue biopsy might not be possible right away because of clinical instability [7]. By increasing architectural preservation and facilitating more accurate tumor typing, the addition of cell block preparation significantly increased diagnostic accuracy. Additionally, the use of immunohistochemistry (IHC) markers including TTF-1, p40, CK7, and CK20 allowed for precise lung cancer subtyping, which in turn guided targeted oncologic treatment [8]. The diagnostic and non-diagnostic yields were compared using the chi-square test, which produced a computed χ^2 value with a p-value of 0.058 and a

95% confidence interval. Despite being slightly non-significant, the outcome points to a potentially substantial diagnostic contribution [9].

The current study reveals that smokers display markedly elevated total cell counts in bronchoalveolar lavage fluid, mostly attributable to an increase in macrophages and neutrophils, indicating heightened airway inflammation. These findings align with the effects of cigarette smoke in enhancing innate immune activation and the recruitment of inflammatory cells. The diminished CD4/CD8 ratio noted in smokers indicates an imbalance in adaptive immunity, potentially reflecting a predominance of cytotoxic T-cells and immunological dysregulation. Such modifications may enhance vulnerability to lung damage and infection in severely ill individuals. In summary, BAL cytology is an effective diagnostic instrument for evaluating pulmonary immunological alterations associated with smoking.

In order to ensure procedural safety, especially for patients who were on a ventilator or had hemodynamic instability, the anesthesiologist played a crucial role. Managing sedation and airway management, keeping oxygenation levels stable, doing bronchoscopic BAL safely, and stabilizing patients both before and after the surgery were among the duties. Crucially, immediate antibiotic administration or oncologic referral were made possible by early and accurate diagnosis using BAL, which ultimately improved clinical outcomes and decreased ICU morbidity [10].

Conclusion

With a diagnostic yield of 44.7% in our investigation, bronchoalveolar lavage (BAL) cytology demonstrated to be a useful diagnostic tool in critically sick patients with pulmonary illnesses. The majority of cases were related to inflammatory diseases, which is indicative of the high prevalence of infectious pathology in intensive care units. The accuracy of tumor subtyping and malignancy diagnosis was greatly increased by the combination of cell block production and immunohistochemistry. Anesthesiologists were essential in maintaining patient stability and procedural safety. All things considered, BAL should be considered a crucial and successful diagnostic technique for early and focused treatment in tertiary care intensive care unit settings.

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