

Utility of Bronchial washing in Modern Pulmonology: An 8-Year Retrospective Study

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Abstract: ***Background:** Bronchial washing is a widely utilized diagnostic modality in respiratory medicine, particularly in the evaluation of infectious and diffuse parenchymal lung diseases. Over time, the spectrum of pulmonary diseases diagnosed using Bronchial washing has evolved due to changing epidemiological and environmental factors [7]. **Aim:** To analyze the diagnostic profile and temporal trends of diseases identified through Bronchial washing over an 8-year period at a tertiary care center. **Methods:** This retrospective observational study included 2123 patients who underwent flexible bronchoscopy with Bronchial washing between January 2017 and December 2024. Diagnoses were broadly classified into infectious and non-infectious etiologies. Year-wise trends in disease distribution were analyzed using descriptive statistics. **Results:** Infections accounted for the largest proportion of BAL diagnoses, comprising 52% (n = 1,105) of all samples. Among these, bacterial culture-positive infections were the most common at 37% (n = 786), followed by tuberculosis at 11% (n = 234) and non-tuberculous mycobacterial (NTM) infections at 4% (n = 85). Non-infectious causes were less frequent, with cytology-positive findings accounting for 3% (n = 64) and others 1% (n = 21). Bronchial washing were negative for any infective and non infective causes in rest (44%). The annual number of bronchoscopic procedures increased steadily, with a significant decline in 2020 due to the COVID-19 pandemic. Tuberculosis showed a peak in 2019 (56 cases), followed by a decline during the pandemic and gradual increase number thereafter. A progressive increase in NTM infections was observed, reaching a maximum of 17 cases in 2022, followed by 12 cases in 2024, indicating a sustained rise in recent years. **Conclusion:** Bronchial washing remains an invaluable diagnostic tool for evaluation of respiratory diseases, particularly in identifying infectious etiologies, which predominated in this study. It also plays a crucial role in diagnosis of lung disease by providing a good-quality lower respiratory tract sample, Thus, highlighting its utility in guiding appropriate decision-making and clinical management for a good standard of care.*

Keywords: Bronchial washing, bronchoscopy, tuberculosis, non-tuberculous mycobacteria, interstitial lung disease, malignancy

1. Introduction

Bronchoscopy with Bronchial washing has become an integral component of modern pulmonary practice. It allows for direct sampling of the lower respiratory tract and provides valuable diagnostic information in a wide range of pulmonary conditions. Bronchial washing is particularly useful in differentiating infectious from non-infectious causes, identifying opportunistic infections, and supporting the diagnosis of malignancies and interstitial lung diseases (ILDs) [1,2,7].

In India, the burden of pulmonary diseases is substantial and diverse. Tuberculosis continues to be a major public health challenge, while non-tuberculous mycobacterial (NTM) infections are increasingly being recognized [3,4]. Simultaneously, there has been a noticeable rise in chronic respiratory diseases such as ILDs and lung malignancies, likely influenced by environmental exposure, smoking, occupational hazards, and improved diagnostic capabilities [5].

Over the past decade, advancements in microbiological techniques, imaging modalities, and bronchoscopic interventions have significantly improved diagnostic yield [6,7]. However, the relative contribution of different disease entities diagnosed through Bronchial washing has also evolved. Understanding these trends is important for clinicians, as it aids in refining diagnostic algorithms and optimizing patient care.

This study was undertaken to analyze an 8-year dataset of Bronchial washing procedures from a tertiary care centre, with the objective of evaluating the diagnostic spectrum and identifying temporal trends in pulmonary diseases.

2. Materials and Methods

2.1 Study Design and Setting

This retrospective observational study was conducted in the Department of Pulmonary Medicine at a tertiary care teaching hospital.

2.2 Study Population

A total of 2123 patients who underwent bronchoscopy with Bronchial washing between January 2017 and December 2024 were included. Patients across all age groups and both genders were considered. Cases with incomplete records or inadequate samples were excluded from the analysis.

2.3 Procedure

Flexible bronchoscopy was performed using standard protocols under local anesthesia with or without conscious sedation [6]. The bronchoscope was guided to the affected bronchopulmonary segment based on radiological findings. Bronchial washing was performed by instilling around 100 cc sterile saline and aspirating the fluid for analysis.

The collected samples were subjected to:

- Microbiological analysis (Gram stain, culture and sensitivity, AFB staining, CB-NAAT, TBMGIT)
- Cytological examination
- Additional tests where clinically indicated

2.4 Classification of Diagnoses [1,3,4,9,10]

Final diagnoses were categorized as follows:

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Infectious Etiologies:

- Tuberculosis (confirmed microbiologically or clinically)
- Non-tuberculous mycobacterial infections
- Bacterial infections (culture-positive)

Non-Infectious Etiologies:

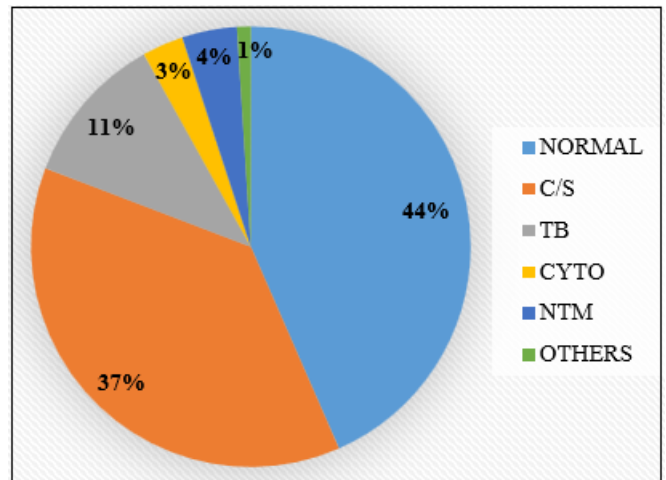
- Interstitial lung diseases
- Malignancy
- Other inflammatory or undiagnosed conditions

2.5 Statistical Analysis

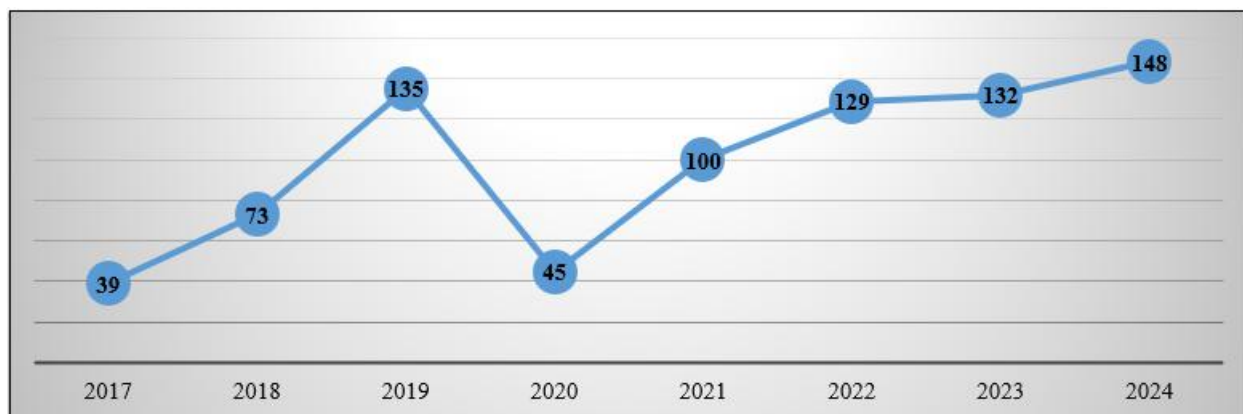
Data were analyzed using descriptive statistics. Categorical variables were expressed as percentages. Year-wise trends were assessed to understand variations in disease patterns and procedural volume.

3. Results**3.1 Overall Diagnostic Profile**

Among the 2123 bronchial washing samples analyzed, Infections contributed for major proportion with bacterial infections (37%), followed by tuberculosis (11%). NTM and cytology-positive findings contributed 4% and 3% of cases, respectively, while a small proportion (1%) was categorized as others.

**Figure 1: Analysis of Bronchial Washings****3.2 Bacterial Culture and Sensitivity Findings**

Bacterial culture and sensitivity (C/S) analysis constituted a significant proportion of the diagnostic yield in the present study. Among the BAL samples, a considerable number were culture-positive, accounting for approximately 37% of total cases, highlighting the continued burden of bacterial lower respiratory tract infections.

**Figure 2: Yearly Trend of Bacterial Infections**

The graphical representation demonstrates year-wise variation in culture-positive bacterial cases. An overall increasing trend in bacterial isolates was observed from 2017 to 2019, followed by a decline in 2020, likely reflecting reduced hospital admissions and diagnostic procedures during the COVID-19 pandemic [8]. Subsequently, there was a steady rise in culture-positive cases from 2021 onwards, paralleling the recovery of healthcare services.

The C/S graph also suggests variability in bacterial detection rates across different years, which may be influenced by factors such as seasonal variation, antibiotic usage patterns, and changes in hospital admission profiles. The increasing trend in recent years may also indicate improved microbiological techniques and higher clinical suspicion for bacterial infections.

3.3 Bacterial Culture and Sensitivity Profile

A total of 259 bronchoscopic procedures were performed in 2021, 296 in 2022, 204 in 2023, and 232 in 2024. *Klebsiella* species emerged as the most frequently isolated bacterial pathogen throughout the study period, with culture positivity increasing from 30 cases in 2021 to 44 cases in 2024. *Pseudomonas* species represented the second most common isolate, demonstrating a gradual increase from 25 cases in 2021 to 37 cases in 2024.

Staphylococcus aureus was identified in 20 cases in 2021, increasing steadily to 30 cases by 2024. Streptococcal isolates similarly increased from 10 to 15 cases during the study period. Methicillin-resistant *Staphylococcus aureus* (MRSA) remained relatively less common but showed a slight upward trend, rising from 5 cases in 2021 to 7 cases in both 2023 and 2024. Other bacterial organisms accounted for 10 cases in 2021, 13 cases in 2022 and 2023, and 15 cases in 2024.

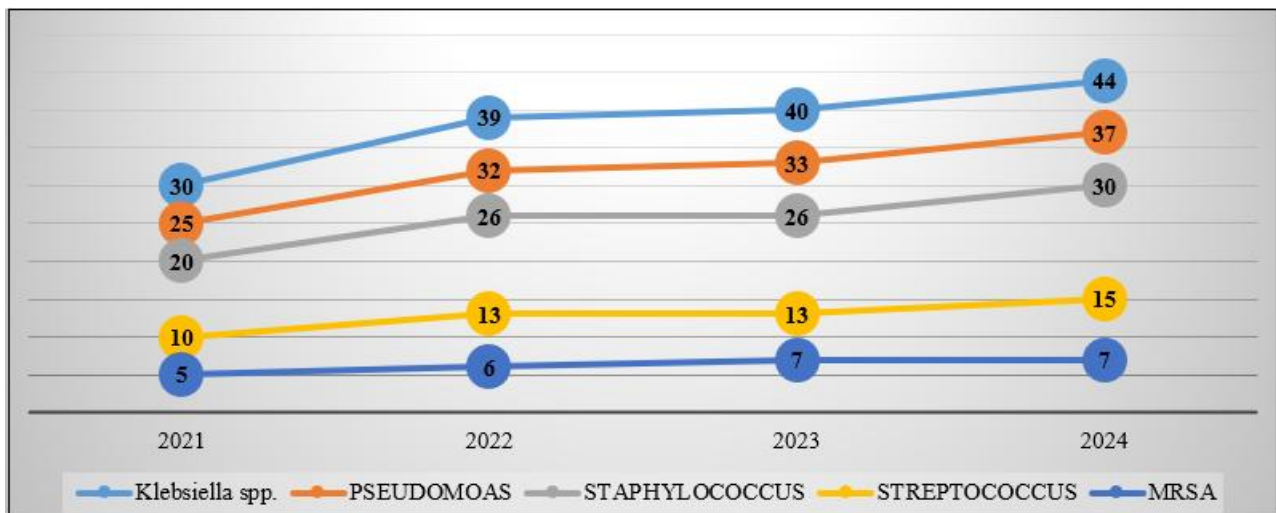


Figure 3: Year-wise Distribution of Bacterial Isolates

3.4 Tuberculosis

Tuberculosis cases demonstrated a fluctuating pattern. The number peaked in 2019, followed by a sharp decline in 2020.

This was likely due to reduced healthcare access and underreporting during the pandemic [8]. Post-2020, TB cases gradually increased and stabilized, reflecting restoration of diagnostic services.

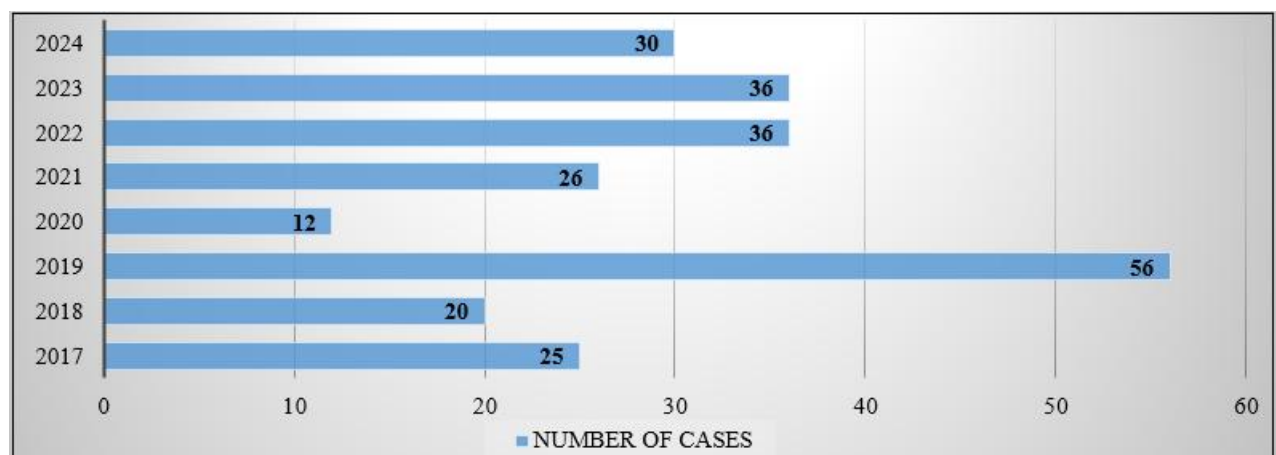


Figure 4: Yearly Trend of Tuberculosis Cases

3.5 Trends in Drug-Sensitive (DS) and Drug-Resistant (DR) Tuberculosis Among BAL-Positive Cases

Drug-Sensitive Tuberculosis (DS-TB)

All tuberculosis cases detected during the study period were BAL positive. The total number of TB cases increased from 26 cases in 2021 to 36 cases in 2022 and remained unchanged at 36 cases in 2023. A decline was observed in 2024, with 30 cases reported. After excluding drug-resistant cases, the number of drug-sensitive tuberculosis (DS-TB) cases was 20 in 2021, 29 in 2022, 26 in 2023, and 24 in 2024. DS-TB constituted the majority of BAL-positive TB cases throughout the study period, accounting for approximately three-fourths of all cases.

Drug-Resistant Tuberculosis (DR-TB)

Among the BAL-positive tuberculosis cases, drug-resistant tuberculosis (DR-TB) accounted for 6 cases in 2021, 7 cases in 2022, 10 cases in 2023, and 6 cases in 2024. The proportion of DR-TB among total TB cases was 23.1% in 2021, 19.4% in 2022, 27.8% in 2023, and 20.0% in 2024. An increasing trend in DR-TB cases was observed from 2021 to 2023, reaching a peak of 10 cases in 2023, followed by a decline to 6 cases in 2024. The highest burden of drug resistance was observed in 2023, highlighting the importance of routine drug-susceptibility testing and early initiation of appropriate therapy.

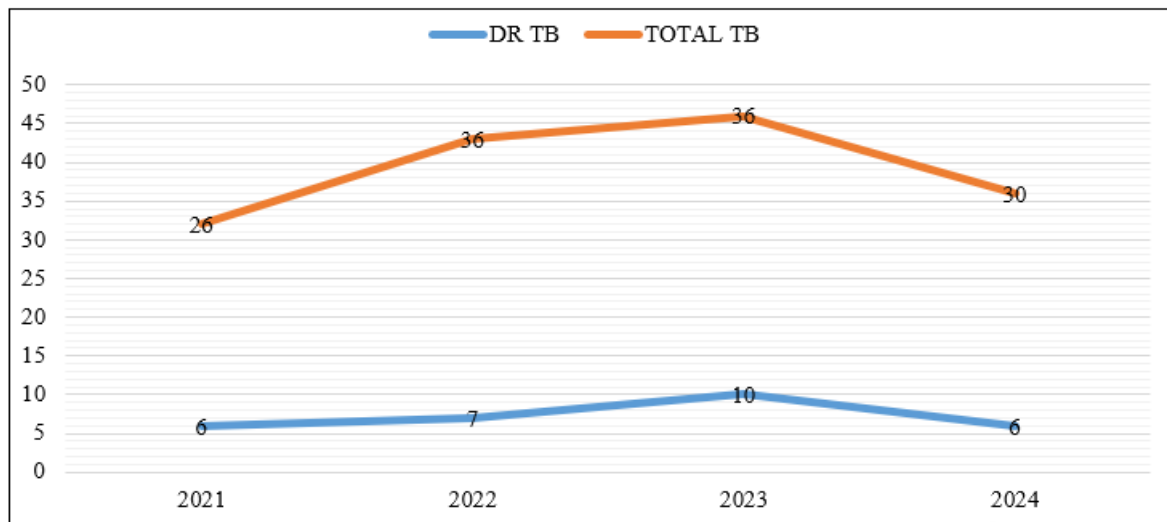


Figure 5: Trends in Drug-Sensitive (DS) and Drug-Resistant (DR) Tuberculosis

3.6 Non-Tuberculous Mycobacteria

A gradual but consistent increase in NTM cases was observed over the years. Initially reported in small numbers, NTM

infections became more frequently identified in later years [4,9].

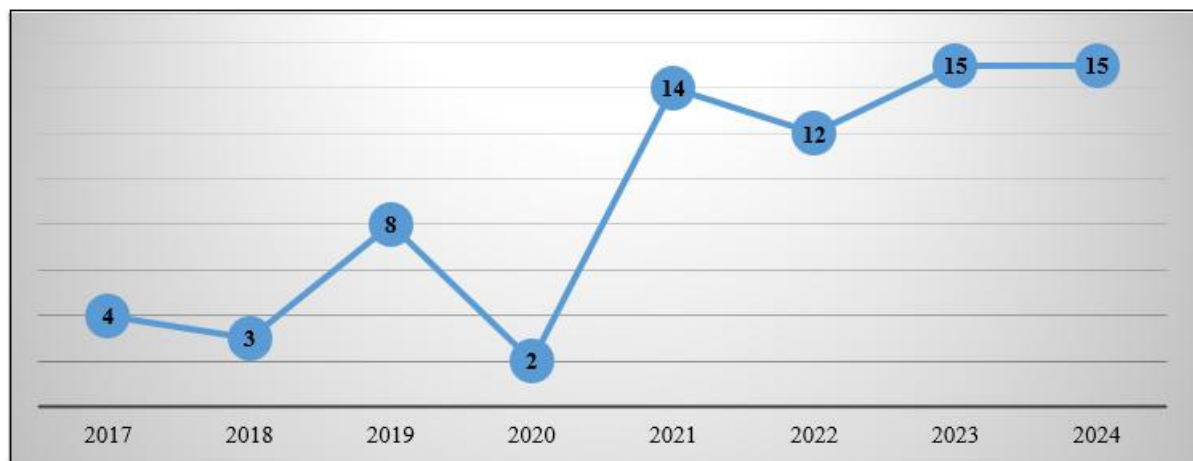


Figure 6: Yearly Trend of Non-Tuberculous Mycobacterial Cases

3.7 Malignancy

The detection of malignancy through Bronchial washing showed an overall increasing trend, despite some year-to-year

variation. The rise in recent years may be attributed to better utilization of bronchoscopy in suspected lung cancer cases and advancements in cytological evaluation [10].

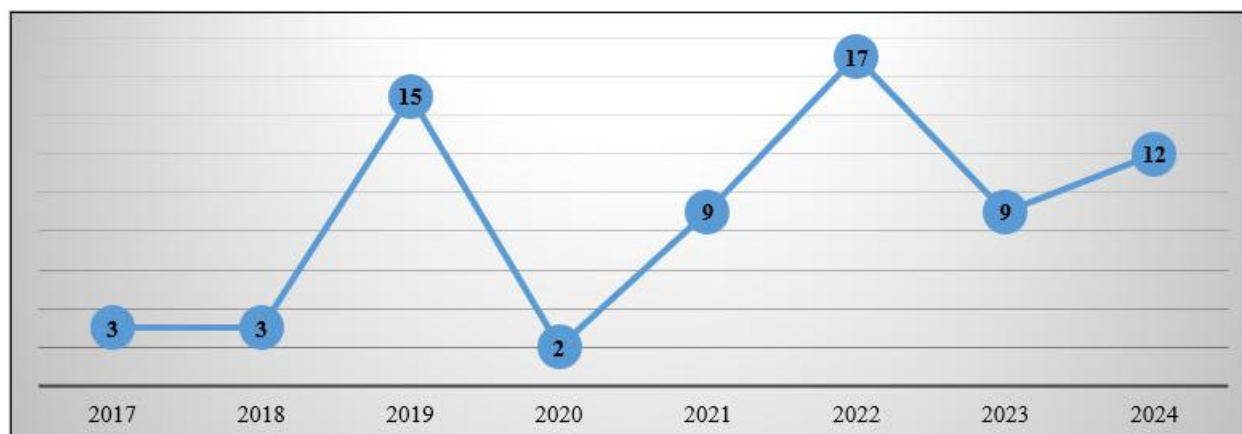


Figure 7: Yearly Trend of Malignancy Cases

4. Discussion

This study provides a comprehensive overview of Bronchial washing findings over an extended period, offering valuable insights into evolving trends in pulmonary disease diagnosis.

Infectious diseases, however, continue to contribute significantly. Tuberculosis remains an important diagnosis, although its relative proportion appears to be declining [3]. The disruption caused by the COVID-19 pandemic had a noticeable impact on TB detection, a phenomenon reported globally [8].

The rising trend of NTM infections is particularly noteworthy. Previously underdiagnosed, NTM is now increasingly identified due to better laboratory capabilities and awareness among clinicians [4,9]. Given the differences in treatment protocols between TB and NTM, accurate diagnosis is essential.

The increase in malignancy detection highlights the growing role of bronchoscopy in oncology. Early diagnosis of lung cancer remains a challenge, and Bronchial washing, along with other bronchoscopic techniques, contributes meaningfully in selected cases [10].

Drug-sensitive tuberculosis (DS-TB) remained the predominant form of tuberculosis throughout the study period. However, the presence of a substantial proportion of drug-resistant tuberculosis (DR-TB), particularly the peak observed in 2023, highlights the ongoing challenge of antimicrobial resistance and underscores the importance of early diagnosis and routine drug-susceptibility testing.[1]

Among bacterial pathogens, *Klebsiella* spp. and *Pseudomonas* spp. were the most frequently isolated organisms, with a gradual increase in detection over time. The predominance of these Gram-negative organisms emphasizes the value of bronchoscopic sampling in identifying causative pathogens and guiding appropriate antimicrobial therapy.

Overall, the findings reflect a dynamic and evolving pulmonary disease spectrum, emphasizing the need for adaptability in diagnostic approaches.

5. Limitations

The retrospective nature of the study introduces inherent limitations, including potential data gaps and selection bias. Due to COVID-19 Pandemic between 2020-2022 there were many restrictions for bronchoscopic procedures thus there was limited data during this period. Being a single-centre study, the findings may not be universally generalizable. Additionally, detailed clinical correlation and long-term follow-up data were not available.

6. Conclusion

Bronchial washing remains an invaluable diagnostic tool for evaluation of respiratory diseases, particularly in identifying infectious etiologies, which predominated in this study.

It also plays a crucial role in excluding infections by providing a good-quality lower respiratory tract sample. Thus, highlighting its utility in guiding appropriate decision-making and clinical management for a good standard of care.

These findings underscore the importance of maintaining a broad diagnostic perspective and adapting to evolving disease patterns in clinical practice.

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