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Original Research Article

Role of Early Fiberoptic Bronchoscopy and Bronchoalveolar Lavage in Diagnosing Non-Resolving Pneumonia at a Tertiary Care Hospital

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Abstract:

Pneumonia, a significant cause of morbidity and mortality globally, often presents diagnostic challenges due to unidentified etiologic agents. Non-resolving pneumonia, particularly, complicates clinical management, as standard antibiotic therapy may be ineffective. This study aimed to investigate the role of early bronchoscopy and bronchoalveolar lavage (BAL) in identifying causative agents in patients with non-resolving pneumonia at a tertiary care hospital. This observational cross-sectional study, conducted at DR. BRAMH, Raipur, from January 2023 to February 2024, included 140 patients presenting with pneumonia symptoms and radiographic findings. Fiberoptic bronchoscopy was performed on all participants, with BAL samples analyzed for bacterial, fungal, and mycobacterial pathogens. Histopathological biopsies were conducted whererever necessary. The study identified pathogenic organisms in 86.43% of cases, with Pseudomonas aeruginosa (40.71%) and Klebsiella pneumoniae (21.43%) as the predominant pathogens. Notably, malignancies were detected in 13.57% of cases, with squamous cell carcinoma being most common. Bronchoscopy findings indicated mucosal inflammation in 80.71% and endobronchial masses in 12.86% of patients. The results emphasize the diagnostic importance of early bronchoscopy and BAL in non-resolving pneumonia, allowing for tailored treatments and potentially improved patient outcomes. This study supports the integration of bronchoscopy in managing complex pneumonia cases to address diagnostic gaps and treatment challenges, ultimately aiming to reduce mortality in this patient population.

Keywords: Non-resolving pneumonia, Bronchoalveolar lavage (BAL), Malignancy in pneumonia, Respiratory infections.

Introduction

Pneumonia is defined as an infection of the lung parenchyma, often resulting in significant morbidity and mortality worldwide. Identifying the causative agent for pneumonia is crucial not only for appropriate treatment but also for epidemiological tracking. However, clinical practice reveals that the etiologic agent is frequently unidentified; studies indicate that a single cause of pneumonia is confirmed in less than 10% of patients presenting to emergency departments.

This underscores the complexity of pneumonia pathogenesis, where a delicate balance exists between microorganisms in the lower respiratory tract and the body's systemic and local defense mechanisms. When this balance is disrupted, an inflammatory response occurs, leading to pneumonia. [1] Compromised systemic defense mechanisms, such as impaired immunity, reduced mucociliary clearance, and diminished cough reflex, play critical roles in the development of pneumonia. [2] Patients often present with systemic symptoms such as fever, chills, malaise, and myalgia. Pulmonary symptoms commonly include cough with varying sputum production, dyspnea, pleuritic chest pain, and occasionally, blood-tinged sputum.

The CURB-65 scale is widely employed for pneumonia management, yet when pneumonia does not resolve with standard antibiotic therapy, a condition termed non-resolving pneumonia, diagnostic challenges increase. [1,2] Non-resolving pneumonia may result from various factors, including impaired host defenses, resistant

pathogens, tuberculosis, malignancy, inadequate treatment, or non-infectious causes, particularly among patients over 50 years old. Mortality rates remain high for these patients due to delays in accurate diagnosis and intervention. [3,4]

Flexible fiberoptic bronchoscopy (FFB) is an established diagnostic and therapeutic tool, allowing direct visualization of the airways and facilitating procedures like bronchoalveolar lavage (BAL), which helpsto identify the etiological agent in suspected respiratory infections. FFB is effective in diagnosing persistent lung infiltrates, unexplained lung nodules, and mediastinal lymphadenopathy. [5,6] BAL, specifically, allows the collection of lung samples for diagnostic evaluation. Studies indicate that bronchoscopic evaluation, including BAL, can yield an etiologic diagnosis in up to 90% of non-resolving pneumonia cases, aiding clinicians in tailoring effective treatments and potentially reducing mortality. [7] Given the diagnostic challenges associated with non-resolving pneumonia, the present study aims to investigate the role of early bronchoscopy and BAL in determining the causative agents at a tertiary care hospital.

Aims: To assess the impact of early bronchoscopy and bronchoalveolar lavage in identifying the etiological diagnosis in patients with non-resolving pneumonia.

Objectives:

1. Primary Objective: To identify the common etiological agents responsible for non-resolving pneumonia.

2. Secondary Objective: To determine the antimicrobial susceptibility profiles, including resistance and sensitivity, of pathogens isolated from BAL samples.

Methodology

Study Design: This hospital-based observational cross-sectional study evaluated the diagnostic role of fiberoptic bronchoscopy and bronchoalveolar lavage (BAL) in patients with non-resolving pneumonia.

Setting and Period: Conducted in the Department of Respiratory Medicine at DR. BRAMH, Raipur, from January 2023 to February 2024.

Population and Sample Size: The study included 140 patients with pneumonia symptoms and radiological signs, admitted to a tertiary care center. Consecutive sampling was used, with strict inclusion and exclusion criteria to ensure relevance and ethical compliance.

Data Collection and Diagnostic Procedures: Upon meeting inclusion criteria, patients underwent a thorough evaluation, including demographic data, physical examination, comorbidity assessment, and diagnostic imaging. Each patient received bronchoscopy, and BAL fluid was collected and analyzed for bacterial, fungal, and AFB presence. Additional histopathological biopsies were performed as necessary. All samples followed standard laboratory protocols to prevent contamination.

Statistical Analysis: Data was analyzed using SPSS version 26. Descriptive statistics were used to summarize categorical and continuous data. The Chi-square test assessed associations, with a significance level set at $p < 0.05$.

Results

The study analyzed a cohort of 140 patients with non-resolving pneumonia who underwent fiberoptic bronchoscopy and bronchoalveolar lavage (BAL). Patient distribution across age groups showed that the majority were within 21-40 years (42.14%) and 41-60 years (35.71%), with a mean age of 44.59 ± 16.15 years. Gender-wise, 68.57% were male, aligning with previous research indicating a higher prevalence of pneumonia in males.

Occupational distribution revealed that farmers constituted the largest group (31.43%), followed by housewives (25%) and laborers (15.71%). Presenting symptoms included cough (100%), breathlessness (95.71%), generalized weakness (92.86%), and hemoptysis (22.14%).

Co-morbidities showed that diabetes mellitus was most common (25.71%), while 32.86% had a history of pulmonary TB. Addiction patterns highlighted alcohol use (60%) and smoking (53.57%) as prevalent. Diagnostic tests, including Sputum Acid-Fast Bacilli (AFB) and CBNAAT, were negative in all cases.

Table 1: Socio Demographic Characteristics among the study participants.

Variables		Frequency	Percent
Age Group	< 20	05	3.57%
	21 - 40	59	42.14%
	41 – 60	50	35.71%
	> 60	26	18.58%
Gender	Male	96	68.57%
	Female	44	31.43%
Occupation	Farmer	44	31.43%

	Housewife	35	25.00%
	Laborer	22	15.71%
	Skilled	21	15.00%
	Semi-Skilled	13	9.29%
	Student	05	3.57%
Present complaints	Cough	140	100.00%
	Breathlessness	134	95.71%
	Generalized Weakness	130	92.86%
	Expectoration	126	90.00%
	Fever	128	91.43%
	Chest pain	115	82.14%
	Loss of Appetite	75	53.57%
	Loss of weight	74	52.86%
	Hemoptysis	31	22.14
	Wheeze	13	9.29%
Co-morbidities	PTB History	46	32.86%
	DM	36	25.71%
	Renal Disease	09	6.43%
	Liver Disease	10	7.14%
Addiction	Alcohol	84	60.00%
	Smoking	75	53.57%

Table 2: Chest x – ray and Bronchoscopy findings among study participants.

Findings		**Frequency**	**Percent**
X – ray	Unilateral Lesions	89	63.57%
	Bilateral Lesions	51	36.43%
	Right Sided Lesions	110	78.57%
	Left Sided Lesions	81	57.86%
	Pleural Effusion	16	11.43%
Bronchoscopy	Mucosal Inflammation & Purulent Secretion	113	80.71%
	Endobronchial Mass	18	12.86%
	Narrowing of Bronchi	16	11.43%

Chest X-rays indicated that 63.57% had unilateral lesions, predominantly on the right side (78.57%), and 11.43% had pleural effusion. Bronchoscopy findings revealed mucosal inflammation and purulent secretions in 80.71% of cases, with 12.86% showing endobronchial masses.

Table 3: BAL fluid analysis organism's findings distribution among study participants

Organisms	**Frequency**	**Percent**
Pseudomonas aeruginosa	57	40.71 %
Klebsiella Pneumoniae	30	21.43 %
Fungal	21	15.00 %
AFB	08	5.71 %
Hemophilus Influenzae	06	4.29 %
Acinetobacter Baumanii	03	2.14 %
Streptococcus Pneumonia	02	1.43 %
Staphylococcus Aureus	01	0.71 %
Enterococcus	01	0.71 %
Dual organism	08	5.71%

BAL fluid analysis identified organisms in 86.43% of cases, with Pseudomonas aeruginosa (40.71%) and Klebsiella pneumoniae (21.43%) being most common. Histopathological examination from endobronchial biopsies indicated malignancy in 13.57% of patients, primarily squamous cell carcinoma (31.58%).

Table 4: Histopathology of malignancy findings among study participants.

Histopathology	Frequency	Percent
Squamous Cell Carcinoma	06	31.58%
Adenocarcinoma	04	21.05%
Non-small Cell Lung Carcinoma	04	21.05%
Poorly Differentiated Carcinoma	03	15.79%
Lymphoma	02	10.53%

Discussion

This study corroborates findings from previous research, emphasizing the diagnostic importance of fiberoptic bronchoscopy and BAL in non-resolving pneumonia. The predominance of younger (21-40 years) and middle-aged (41-60 years) patients aligns with findings by Majeed Pasha et al. [8] and Chaudhuri et al. [9], who noted similar age distributions in their non-resolving pneumonia studies. Gender distribution also mirrored prior studies, where males were disproportionately affected, potentially due to higher exposure to occupational hazards and risk behaviors such as smoking and alcohol use. Our findings align with other research, such as the study by Kirtland et al. [10], in which cough was the primary complaint, followed by respiratory and systemic symptoms. Diabetes mellitus emerged as a significant co-morbidity, supporting the work of Avijgan et al. [11], who linked diabetes with delayed pneumonia resolution. Regarding diagnostic procedures, the negative AFB and CBNAAT results emphasize that bronchoscopy and BAL are critical for identifying cases undetectable by conventional sputum tests. Chest X-ray patterns observed, including right lung involvement, support studies by Boyd et al. [12], which found that the right lung is more susceptible to chronic inflammatory lesions in non-resolving pneumonia. The BAL fluid culture outcomes, identifying Pseudomonas aeruginosa as the predominant pathogen, underscore the role of resistant organisms in treatment failure, similar to studies by Begamy et al. [13] this highlights the limitation of empirical antibiotic therapy and supports the need for early bronchoscopy intervention in non-resolving cases. Malignancy, particularly squamous cell carcinoma, was observed in 13.57% of cases, comparable with findings from Arunabha D. Chaudhuri et al. [9], further establishing bronchoscopy as an effective diagnostic tool in uncovering malignancy in non-resolving pneumonia patients. These findings affirm the utility of bronchoscopy and BAL in accurately diagnosing infectious and non-infectious causes of non-resolving pneumonia, allowing for targeted interventions and improving patient outcomes.

Conclusion

This study underscores the critical role of early bronchoscopy and bronchoalveolar lavage (BAL) in diagnosing non-resolving pneumonia cases that do not respond to standard antibiotic therapy. By enabling the identification of causative pathogens, such as Pseudomonas aeruginosa and Klebsiella pneumonia, bronchoscopy aids in tailoring targeted treatments, particularly for resistant organisms. Additionally, the detection of malignancies, especially squamous cell carcinoma, highlights the utility of bronchoscopy in uncovering non-infectious causes of persistent lung infiltrates.

These findings suggest that incorporating bronchoscopy and BAL into the diagnostic protocol for non-resolving pneumonia can improve clinical outcomes by addressing diagnostic delays, ensuring precise treatment, and potentially reducing mortality rates in this challenging patient population.

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