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Clinical, radiological, and microbiological profile of non-resolving pneumonia in adults: a hospital-based cross-sectional observational study.

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Abstract

Background
Non-resolving pneumonia is a clinically important condition in which pulmonary infiltrates and symptoms persist despite initial antimicrobial therapy. It requires structured evaluation because the underlying cause includes resistant bacterial infection, tuberculosis, fungal disease, bronchiectasis, aspiration, inflammatory lung disease, and malignancy.

Objectives
To assess the clinical, radiological, microbiological, and etiological profile of non-resolving pneumonia among adult patients.

Methods
This hospital-based cross-sectional observational study consecutively enrolled 100 adults with non-resolving pneumonia at CMR Institute of Medical Sciences from August 2025 to January 2026. Participants underwent structured clinical assessment, chest radiography, high-resolution computed tomography, sputum microbiology, tuberculosis testing, bronchoscopy with bronchoalveolar lavage, and tissue diagnosis when indicated.

Results
Of 118 adults examined for eligibility, 108 fulfilled the eligibility criteria and 100 consented, completed the diagnostic evaluation, and were analyzed. The mean age was 56.8 ± 14.2 years, and males accounted for 64.0% of cases. Smoking, diabetes mellitus, chronic obstructive pulmonary disease, and previous pulmonary tuberculosis were common risk factors. Lobar consolidation was the leading radiological finding. Microbiological diagnosis was obtained in 62.0% of patients; bacterial infection was most common, followed by pulmonary tuberculosis, fungal infection, and mixed infection. Bacterial pneumonia with delayed resolution was the leading final diagnosis, followed by tuberculosis, bronchiectasis-associated infection, lung malignancy, and inflammatory lung disease.

Conclusion
Non-resolving pneumonia in adults showed heterogeneous causes, with infections forming the major group and malignancy remaining an important hidden diagnosis.

Recommendations
Adults with persistent clinical or radiological pneumonia should undergo early stepwise evaluation using HRCT, microbiological testing, tuberculosis work-up, bronchoscopy, and biopsy when clinically indicated.

Keywords: *Non-resolving pneumonia; Bronchoscopy; High-resolution computed tomography; Tuberculosis; Lung malignancy; Microbiological profile*
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Introduction

Pneumonia remains a major cause of morbidity among adults and continues to impose a considerable diagnostic and therapeutic burden in clinical practice. In most patients with community-acquired pneumonia, fever, cough, dyspnea, and inflammatory markers improve earlier than chest radiographic opacities. Radiological clearing is influenced by age, smoking, comorbid illness, extent of lobar involvement, severity of infection, and the causative pathogen [1-3]. Therefore, persistent opacity after initial therapy does not always indicate treatment failure; however, persistence of symptoms together with incomplete radiological resolution requires careful reassessment.

Non-resolving or slowly resolving pneumonia refers to a clinical-radiological syndrome in which pulmonary infiltrates fail to improve within the expected time despite apparently adequate treatment. The definition varies across studies, but most authors emphasize delayed clinical response, lack of radiographic regression, or progression after antimicrobial therapy [4-6]. This entity is particularly relevant in adults because its etiological spectrum is broad. Resistant bacterial infection, atypical organisms, pulmonary tuberculosis, fungal pneumonia, aspiration, bronchiectasis, obstructing endobronchial lesions, organizing pneumonia, and lung malignancy can present with a similar clinical picture [6,14]. A practical approach therefore requires moving beyond empirical antibiotics toward structured etiological diagnosis.

Radiological evaluation has a central role in such patients. Chest radiography provides the first evidence of persistent consolidation, cavitation, nodularity, pleural effusion, or multilobar disease, while high-resolution computed tomography improves localization and characterization of parenchymal, airway, pleural, and mediastinal abnormalities [10,11]. CT also helps identify mass-like consolidation, post-obstructive changes, bronchiectasis, necrosis, cavitation, and lesions suitable for bronchoscopic or image-guided sampling [11,13]. Microbiological evaluation is equally important because sputum examination alone has limitations, especially after prior antibiotic exposure. Bronchoscopy with bronchoalveolar lavage and biopsy enhances diagnostic yield in selected patients with poor sputum yield, hemoptysis, suspected obstruction, persistent lobar collapse, or unexplained radiological persistence [4,5].

In India, the evaluation of non-resolving pneumonia has additional relevance due to the coexistence of bacterial pneumonia, tuberculosis, diabetes mellitus, chronic lung disease, and delayed healthcare access. A hospital-based profile helps clinicians recognize common presentations and select investigations rationally. The present study was conducted with the objectives of describing the demographic and clinical profile of adults with non-resolving pneumonia, assessing their radiological patterns, identifying microbiological findings, and determining the final etiological diagnosis among patients evaluated at CMR Institute of Medical Sciences, Hyderabad, Telangana, India.

Methodology

Study design and setting

A hospital-based cross-sectional observational study was conducted in the Department of Respiratory Medicine at CMR Institute of Medical Sciences, Kandlakoya, Medchal, Hyderabad, Telangana, India, from August 2025 to January 2026. The institute is a tertiary-care teaching hospital serving patients from Medchal-Malkajgiri district and surrounding areas. It provides multispecialty outpatient, emergency, inpatient, and intensive-care services, supported by on-site radiology, microbiology, clinical laboratory, and bronchoscopy facilities. These services enabled integrated clinical, imaging, microbiological, and invasive evaluation of adults with persistent pneumonia.

Study population, eligibility, and participant selection

Adults aged 18 years or older who attended the respiratory medicine or general medicine outpatient clinics, presented to the emergency department, or were admitted to the medical wards with suspected non-resolving pneumonia were screened. Non-resolving pneumonia was defined as persistence of respiratory symptoms with incomplete clinical response or persistent radiological opacity after an adequate course of antimicrobial therapy, or radiological progression requiring further evaluation [3,6]. Consecutive sampling was used; every potentially eligible patient encountered during the study period was assessed against predefined criteria until the required final sample was obtained. Patients with incomplete diagnostic records, those

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unwilling to participate in the required evaluation, paediatric patients, and patients whose pulmonary opacity was attributable to acute pulmonary edema or trauma were excluded. Eligible patients were enrolled after written informed consent.

Study size

The minimum sample size was estimated for a descriptive cross-sectional study using the single-proportion formula $n = Z^2p(1 - p)/d^2$. A prevalence of 50% was selected because it provides the maximum required sample when the expected proportion is uncertain, with a 95% confidence level (Z = 1.96) and an absolute precision of 10%. The calculated minimum sample was 96.04 participants. This value was rounded upward to a target of 100 evaluable participants to improve precision and allow for a small proportion of incomplete records or non-participation.

Bias

Potential selection bias was reduced by consecutive screening and enrolment of all eligible patients rather than convenience selection. A predefined case definition, eligibility checklist, and structured data-collection form were used to limit classification and information bias. Clinical histories, previous prescriptions, laboratory reports, and imaging records were cross-checked whenever available, and prior antimicrobial exposure was documented. Radiological and microbiological findings were reported by the respective specialists using routine institutional protocols, while final etiological classification was made only after integration of clinical, imaging, microbiological, bronchoscopic, and histopathological evidence. No patient was excluded after enrolment because of a negative microbiological test, and complete-case analysis was used without data imputation.

Clinical and radiological evaluation

Demographic details, symptom duration, smoking history, alcohol use, previous pulmonary tuberculosis, diabetes mellitus, chronic obstructive pulmonary disease, immunosuppression, and prior antibiotic exposure were recorded. Clinical features including cough, fever, expectoration, dyspnea, chest pain, hemoptysis, wheeze, weight loss, and night sweats were documented. All patients underwent chest radiography. High-resolution computed tomography of the thorax was performed when chest radiography showed persistent consolidation, cavitation, nodularity, pleural effusion, bronchiectatic changes, mass-like opacity, or multilobar involvement [10,11].

Microbiological and invasive diagnostic work-up

Sputum samples were evaluated by Gram stain, bacterial culture and sensitivity, acid-fast bacilli smear, tuberculosis nucleic acid amplification testing/GeneXpert where indicated, and fungal studies when clinically suspected. Bronchoscopy was performed in selected patients with persistent radiological abnormalities, poor sputum yield, hemoptysis, suspected endobronchial obstruction, or non-diagnostic initial microbiological testing. Bronchoalveolar lavage was processed for bacterial, mycobacterial, and fungal investigations. Endobronchial biopsy, transbronchial biopsy, or CT-guided sampling was undertaken when malignancy, organizing pneumonia, or focal non-resolving consolidation was suspected [12,13].

Outcome measures and statistical analysis: The primary outcomes were clinical profile, radiological pattern, microbiological diagnosis, and final etiological diagnosis. Data were entered into a spreadsheet and analysed using descriptive statistics. Categorical variables were expressed as frequency and percentage. Continuous variables were expressed as mean with standard deviation where applicable. As the purpose was descriptive profiling, no inferential comparison was planned.

Ethical considerations

Institutional Ethics Committee approval was obtained from CMR Institute of Medical Sciences, Hyderabad, Telangana, India, before the commencement of the study. The study was conducted in accordance with standard ethical principles applicable to observational clinical research. Patient confidentiality was ensured by anonymizing all clinical data during analysis, interpretation, and reporting.

Results

Participant flow: During the study period, 118 potentially eligible adults were identified and examined for eligibility. Ten patients were excluded: five demonstrated expected clinical or radiological resolution after initial treatment and therefore did not meet the case definition, three had pulmonary opacities attributable to acute pulmonary edema or trauma, and two had incomplete diagnostic records. Of the 108 patients confirmed to be eligible, eight declined participation or the required diagnostic evaluation. The remaining 100 patients were enrolled. All 100 completed the protocol-defined diagnostic evaluation and follow-up, none were lost after enrolment, and all were included in the final analysis (Figure 1).

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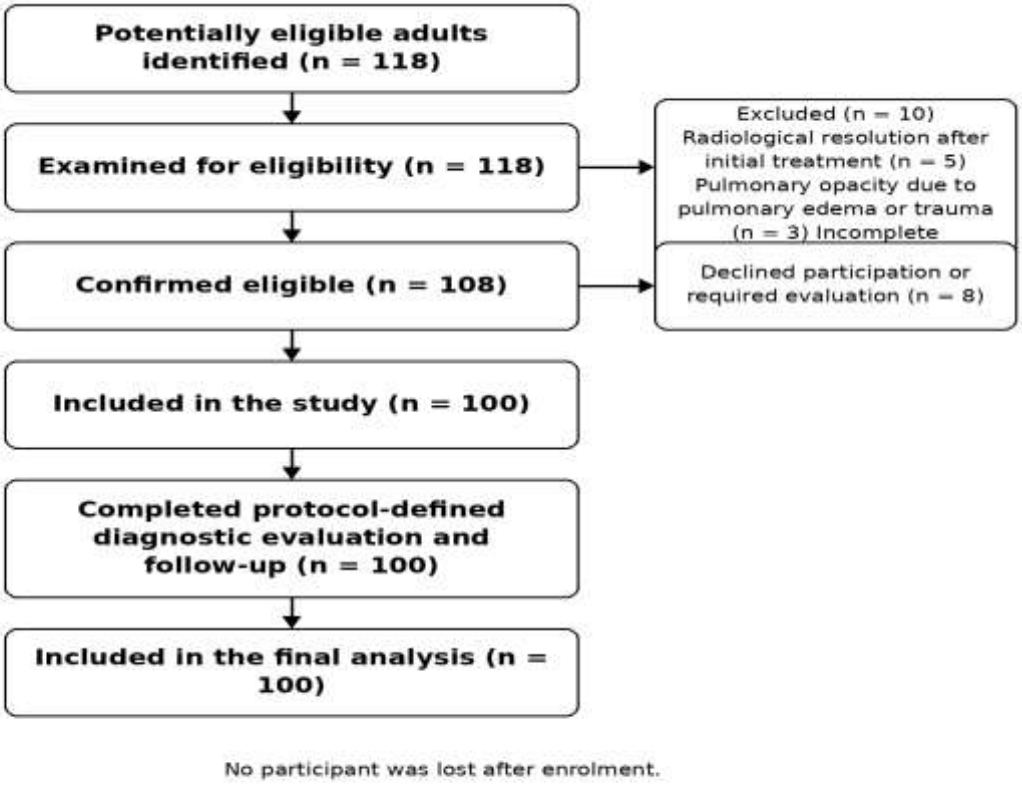
Figure 1: *Participant Flow Through the Study*



The mean age of the study population was 56.8 ± 14.2 years, with an age range of 19 to 82 years. The largest proportion of patients belonged to the 46–60-year age group, followed by the 61–75-year age group. Males constituted nearly two-thirds of the cohort. Smoking history, diabetes mellitus, alcohol use, chronic obstructive pulmonary disease, previous pulmonary tuberculosis, and immunosuppression were the important associated risk factors. The baseline demographic and risk-factor profile is shown in Table 1.

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Table 1: *Baseline Demographic and Risk-Factor Profile of Patients With Non-Resolving Pneumonia*

Variable	Number of patients	Percentage
Age group		
18-30 years	8	8.0
31-45 years	18	18.0
46-60 years	34	34.0
61-75 years	28	28.0
>75 years	12	12.0
Sex		
Male	64	64.0
Female	36	36.0
Risk factors/comorbidities*		
Smoking history	42	42.0
Diabetes mellitus	36	36.0
Alcohol use	28	28.0
Chronic obstructive pulmonary disease	24	24.0
Previous pulmonary tuberculosis	18	18.0
Immunosuppression	10	10.0

Note. Multiple risk factors or comorbidities were present in some patients.

Cough was present in all patients and was the most frequent clinical feature. Fever, expectoration, and dyspnea were also common. Weight loss and night sweats were observed in a notable proportion of patients, supporting the need to evaluate for tuberculosis, chronic infection, and malignancy. Hemoptysis was documented in 16.0% of patients, and wheeze was present in 18.0%. The clinical presentation is summarized in Table 2.

Table 2

Clinical Presentation of Patients With Non-Resolving Pneumonia

Clinical feature*	Number of patients	Percentage
Cough	100	100.0
Fever	82	82.0
Expectoration	76	76.0
Dyspnea	64	64.0
Weight loss	34	34.0
Chest pain	28	28.0
Night sweats	22	22.0
Wheeze	18	18.0
Hemoptysis	16	16.0

Note. More than one clinical feature was observed in several patients.

On radiological assessment, lobar consolidation was the predominant finding. Multilobar consolidation was found in nearly one-fourth of patients. Bronchiectatic changes, cavitary lesions, pleural effusion, ground-glass opacities, nodular opacities, mass-like consolidation, and mediastinal lymphadenopathy were also observed. These findings indicated that non-resolving pneumonia had a mixed parenchymal, airway, pleural, and occasionally obstructive pattern. The radiological profile is presented in Table 3.

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Table 3: *Radiological Profile of Patients With Non-Resolving Pneumonia*

Radiological finding*	Number of patients	Percentage
Lobar consolidation	54	54.0
Multilobar consolidation	24	24.0
Bronchiectatic changes	22	22.0
Cavitary lesion	18	18.0
Pleural effusion	18	18.0
Ground-glass opacities	16	16.0
Nodular opacities	14	14.0
Mass-like consolidation	12	12.0
Mediastinal lymphadenopathy	10	10.0

Note. Radiological findings were not mutually exclusive.

Microbiological diagnosis was established in 62 patients. Bacterial infection was the most common microbiological category, followed by Mycobacterium tuberculosis, fungal infection, and mixed infection. No organism was isolated in 38.0% of patients despite clinical and laboratory evaluation. Final etiological assessment showed bacterial pneumonia with delayed resolution as the leading diagnosis. Pulmonary tuberculosis, bronchiectasis-associated infection, lung malignancy, non-infective inflammatory lung disease, aspiration-related pneumonia, fungal pneumonia, mixed infection, and undetermined causes accounted for the remaining cases. Microbiological findings and final etiological diagnosis are shown in Table 4.

Table 4: *Microbiological Findings and Final Etiological Diagnosis*

Parameter	Number of patients	Percentage
Microbiological profile		
Bacterial infection	34	34.0
Mycobacterium tuberculosis	18	18.0
Fungal infection	6	6.0
Mixed infection	4	4.0
No organism isolated	38	38.0
Final etiological diagnosis		
Bacterial pneumonia with delayed resolution	34	34.0
Pulmonary tuberculosis	18	18.0
Bronchiectasis-associated infection	10	10.0
Lung malignancy	10	10.0
Non-infective inflammatory lung disease	8	8.0
Aspiration-related pneumonia	6	6.0
Fungal pneumonia	6	6.0
Mixed infection	4	4.0
Undetermined cause	4	4.0
Total final diagnoses	100	100.0

Overall, infectious etiologies accounted for the majority of cases. However, the presence of lung malignancy in 10.0% and non-infective inflammatory lung disease in 8.0% emphasized that persistent consolidation should not be treated only as prolonged bacterial infection. A combined approach using clinical assessment, HRCT, microbiological tests, bronchoscopy, BAL, and tissue diagnosis helped establish a final diagnosis in most patients.

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Discussion

The present study evaluated 100 adults with non-resolving pneumonia and demonstrated that this condition represents a heterogeneous clinical-radiological syndrome rather than a single disease entity. The mean age was 56.8 years and males formed 64.0% of cases, reflecting the higher burden of smoking, chronic lung disease, occupational exposure, and comorbid illness in adult men. Previous studies have shown that older age, smoking, chronic obstructive pulmonary disease, diabetes mellitus, and multilobar involvement contribute to delayed recovery and radiological resolution in pneumonia [7-10]. In the present study, smoking history, diabetes mellitus, chronic obstructive pulmonary disease, previous pulmonary tuberculosis, and immunosuppression were frequent risk factors, supporting this pattern.

Cough, fever, expectoration, and dyspnea were the principal clinical manifestations. Weight loss, night sweats, and hemoptysis were less frequent but clinically important, as these symptoms raise suspicion for tuberculosis, malignancy, bronchiectasis, and chronic fungal infection. Non-resolving pneumonia requires reassessment because continued empirical

antibiotic treatment without further evaluation delays diagnosis of tuberculosis, endobronchial obstruction, organizing pneumonia, and lung cancer [6,14]. The observed symptom pattern therefore supports an early diagnostic shift from routine pneumonia management to etiological evaluation when response is incomplete.

Radiologically, lobar consolidation was the most common finding, while multilobar consolidation, bronchiectatic changes, cavitation, pleural effusion, nodular opacities, mass-like consolidation, and mediastinal lymphadenopathy were also observed. These findings are clinically meaningful because persistent lobar disease suggests unresolved bacterial infection or obstruction, cavitation suggests tuberculosis, necrotizing bacterial infection or fungal disease, and mass-like consolidation requires exclusion of malignancy. CT improves detection of parenchymal and airway abnormalities that are underestimated on chest radiography and guides bronchoscopy or image-guided biopsy in focal non-resolving lesions [10,11,13].

Microbiological confirmation was obtained in 62.0% of patients. Bacterial infection was the leading microbiological category, followed by pulmonary tuberculosis, fungal infection, and mixed infection. This profile is consistent with the known spectrum of non-resolving pneumonia, where common bacterial pathogens coexist with mycobacteria, fungi, and non-infectious mimics [6]. The absence of organism isolation in 38.0% of patients reflects prior antimicrobial exposure, inadequate sputum quality, intracellular or fastidious pathogens, and non-infectious disease. Bronchoscopy with BAL and biopsy has been shown to improve diagnostic yield in selected cases, especially when sputum testing is unrevealing or an endobronchial lesion is suspected [12].

Final etiological assessment showed that bacterial pneumonia with delayed resolution and pulmonary tuberculosis together formed the largest diagnostic group. Bronchiectasis-associated infection and lung malignancy each accounted for 10.0% of cases, while inflammatory lung disease, aspiration-related pneumonia, fungal pneumonia, and mixed infection contributed smaller but important proportions. These findings underline the value of a stepwise algorithm: review adequacy of prior therapy, reassess host risk factors, perform HRCT, obtain microbiological samples, test for tuberculosis, and proceed to bronchoscopy or biopsy when radiology or symptoms remain unexplained. Such an approach reduces diagnostic delay and prevents prolonged inappropriate antimicrobial exposure [7,14].

Generalizability

The findings are applicable to adult patients attending tertiary-care hospitals with persistent clinical or radiological pneumonia after initial treatment. The results are especially relevant to settings with a high burden of diabetes mellitus, smoking, chronic lung disease, previous tuberculosis, and delayed presentation. Since this was a single-centre study, extrapolation to community clinics, immunocompromised units, and centres with different tuberculosis or fungal prevalence should be done cautiously.

Conclusion

Non-resolving pneumonia in adults was associated with diverse infectious and non-infectious etiologies. Bacterial pneumonia with delayed resolution was the most common final diagnosis, followed by pulmonary tuberculosis, bronchiectasis-associated infection, lung malignancy, inflammatory lung disease, aspiration-related pneumonia, fungal pneumonia, and mixed infection. Lobar consolidation was the predominant radiological finding, while microbiological confirmation was achieved in nearly two-thirds of patients. Persistent symptoms, cavitation, mass-like consolidation, hemoptysis, weight loss, and prior tuberculosis history require careful evaluation. A combined diagnostic strategy using HRCT, sputum microbiology, tuberculosis testing, BAL, bronchoscopy, and biopsy provides

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clinically useful etiological clarification in most patients with non-resolving pneumonia.

Limitations

This was a single-centre cross-sectional observational study with a modest sample size. Advanced diagnostic methods such as multiplex PCR, fungal biomarkers, and drug-resistance profiling were not uniformly available for all patients. Follow-up duration was limited, so long-term radiological clearance and recurrence were not assessed. Some final diagnoses depended on clinical-radiological judgment when microbiological confirmation was unavailable.

Recommendations

Adults with non-resolving pneumonia should undergo structured reassessment rather than repeated empirical antibiotic courses. Initial review should include adherence, adequacy of antimicrobial therapy, comorbidities, smoking, diabetes, tuberculosis exposure, aspiration risk, and immune status. HRCT should be performed when chest radiographic abnormalities persist or symptoms continue. Sputum Gram stain, culture, AFB smear, GeneXpert, and fungal studies should be selected according to clinical probability. Bronchoscopy with BAL and biopsy should be considered for hemoptysis, poor sputum yield, suspected obstruction, mass-like consolidation, cavitation, and unexplained focal disease. Tissue diagnosis should be pursued early when malignancy or organizing pneumonia is suspected.

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Abbreviations

AFB: Acid-fast bacilli;
BAL: Bronchoalveolar lavage;
CAP: Community-acquired pneumonia;
COPD: Chronic obstructive pulmonary disease;
CT: Computed tomography;
HRCT: High-resolution computed tomography;
NRP: Non-resolving pneumonia;
TB: Tuberculosis.

Source of funding

The study had no funding.

Conflict of interest

The authors declare no conflict of interest.

Author contributions

DPR -Concept and design of the study, results interpretation, review of literature and preparing first draft of manuscript. Statistical analysis and interpretation, revision of manuscript. **MS**- Design of the study, results interpretation, review of literature and preparing first draft of manuscript, revision of manuscript. **NSJ**- results interpretation, review of literature and preparing first draft of manuscript, revision of manuscript

Data availability

Data Available

Author biographies

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