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CHRONIC OBSTRUCTIVE PULMONARY DISEASE AND INTERSTITIAL LUNG DISEASE: CLINICAL FEATURES AND MANAGEMENT CHALLENGES

Dr. Ajinkya Bahulekar[1], Dr. Mrs. Hema A. Dhumale[2], Dr. Mrs. N.V. Kanase[3]
[1]Assistant Professor Department of General Medicine Krishna Institute of Medical Sciences, Krishna Vishwa Vidyapeeth Deemed To Be University, Karad. Email: ajinkyabahulekar91@gmail.com
[2]Professor Department of Obstetrics and Gynaecology, Krishna Institute of Medical Sciences, Krishna Vishwa Vidyapeeth, Karad, Maharashtra, Email: drhemadhumale@gmail.com
[3]Professor, Department of Anaesthesiology, Krishna Institute of Medical Sciences, Krishna Vishwa Vidyapeeth Deemed To Be University, Karad. Email: naseemakanase@yahoo.co.in

Abstract
Introduction: Chronic Obstructive Pulmonary Disease (COPD) and Interstitial Lung Disease (ILD) present significant challenges in respiratory medicine due to their progressive nature and complex management requirements.
Objective: This research paper aims to review the clinical features, diagnostic approaches, management strategies, and challenges encountered in COPD and ILD.
Result: COPD and ILD share overlapping symptoms and diagnostic complexities, necessitating comprehensive evaluation and multidisciplinary care. Pharmacological interventions, including bronchodilators and immunosuppressants, along with non-pharmacological approaches such as pulmonary rehabilitation, play pivotal roles in symptom management and disease modification.
Conclusion: Despite advancements, challenges persist in the management of COPD and ILD, including limited treatment options for progressive ILD subtypes, lack of reliable biomarkers for disease monitoring, and disparities in access to care. Future research efforts should focus on developing personalized treatment algorithms, elucidating novel therapeutic targets, and addressing healthcare disparities to improve outcomes and quality of life for patients with COPD and ILD.
Keywords: Chronic Obstructive Pulmonary Disease, Copd, Interstitial Lung Disease, Ild, Clinical Features, Diagnosis, Management Challenges.

I. Introduction

Chronic Obstructive Pulmonary Disease (COPD) and Interstitial Lung Disease (ILD) represent significant public health challenges globally, with profound implications for patients' quality of life, healthcare systems, and societal burden. COPD is characterized by persistent airflow limitation, usually progressive and associated with an enhanced chronic inflammatory response in the airways and lung parenchyma, predominantly due to long-term exposure to harmful gases and particles, primarily from tobacco smoking [1]. In contrast, ILD encompasses a heterogeneous group of disorders characterized by inflammation and fibrosis of the lung parenchyma, with a variety of known and unknown etiologies, including environmental and occupational exposures, connective tissue diseases, and idiopathic causes. Despite their distinct pathogenic mechanisms, COPD and ILD often present with overlapping clinical features, including dyspnea, cough, and exercise intolerance, leading to diagnostic challenges and potential misclassification [2]. The prevalence of COPD and ILD varies worldwide, influenced by geographical, environmental, and socioeconomic factors. According to the Global Burden of Disease Study, COPD is estimated to affect over 300 million individuals globally and is projected to become the third leading cause of death by 2030. Similarly, ILD constitutes a significant proportion of respiratory diseases, with idiopathic pulmonary fibrosis (IPF), the most common and severe form of ILD, demonstrating an increasing incidence and prevalence in recent years. The burden of COPD and ILD extends beyond morbidity and mortality, encompassing impaired quality of life, substantial healthcare utilization, and socioeconomic implications, including productivity loss and caregiver burden [3]. The diagnosis and management of COPD and ILD require a comprehensive understanding of their clinical manifestations, underlying pathophysiology, and therapeutic strategies. Clinical evaluation involves detailed history-taking, physical examination, and pulmonary function tests (PFTs) to assess airflow limitation and lung volumes. Imaging modalities, including chest radiography and high-resolution computed tomography (HRCT), play a pivotal role in detecting parenchymal abnormalities characteristic of ILD. However, distinguishing between COPD and ILD based solely on clinical and radiological findings can be challenging, necessitating further investigation with pulmonary function testing and, in some cases, histopathological evaluation through lung biopsy [4].

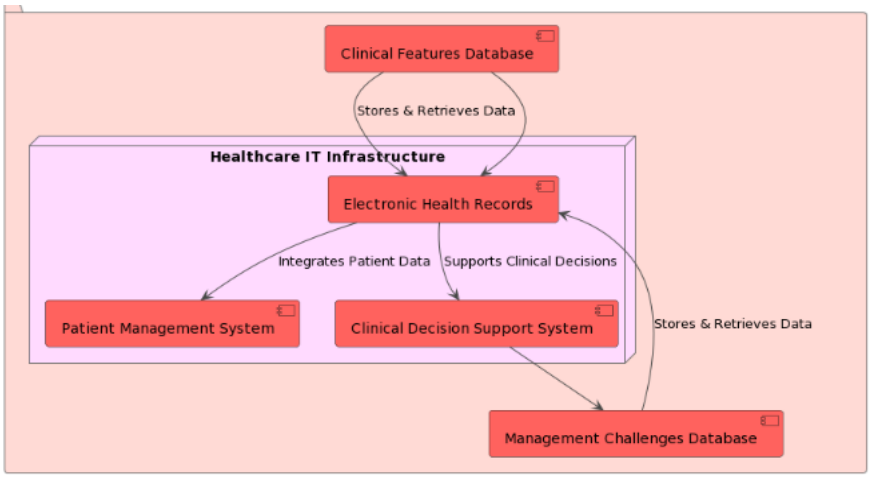

Figure 1. Depicts the Block Schematic of Chronic Obstructive Pulmonary Disease (COPD) and Interstitial Lung Disease (ILD) Management System

The pathophysiology of COPD involves chronic airway inflammation, mucus hypersecretion, and parenchymal destruction, driven by a complex interplay of genetic susceptibility, environmental exposures, and host immune responses. Cigarette smoking remains the primary risk factor for COPD, although occupational dust and biomass fuel exposure contribute significantly to disease burden [5], particularly in developing countries. In contrast, ILD pathogenesis encompasses alveolar epithelial injury, aberrant wound healing, and fibroblast proliferation leading to interstitial fibrosis and impaired gas exchange. Various triggers, including environmental toxins, medications, and autoimmune processes, can initiate and perpetuate the fibrotic response in ILD, with a subset of patients exhibiting a progressive and relentless clinical course, as seen in IPF. The management of COPD and ILD is multifaceted [6], focusing on relieving symptoms, optimizing lung function, and minimizing disease progression. Pharmacological interventions, including bronchodilators, corticosteroids, and immunosuppressive agents, are tailored based on disease severity, phenotype, and individual patient characteristics. Pulmonary rehabilitation, oxygen therapy, and lung transplantation may benefit selected patients with advanced COPD or ILD, offering opportunities for improved symptom control and enhanced quality of life. However, despite advancements in therapeutic options, significant challenges persist in the management of COPD and ILD, including limited treatment efficacy for progressive ILD subtypes, lack of reliable biomarkers for disease monitoring, and disparities in access to specialized care [7].

A. Objectives

i. Examine characteristic clinical features of COPD and ILD, including respiratory symptoms, exacerbations, and associated risk factors.
ii. Discuss diagnostic challenges and approaches for accurately distinguishing between COPD and ILD.
iii. Address management strategies, including pharmacological and non-pharmacological interventions, for COPD and ILD.
iv. Evaluate prognostic implications and survival rates associated with COPD and ILD.
v. Highlight research gaps and propose future directions for improving understanding and management of these respiratory conditions.

II. Epidemiology and Etiology

Chronic Obstructive Pulmonary Disease (COPD) and Interstitial Lung Disease (ILD) have complex epidemiological profiles influenced by a myriad of factors, including demographic characteristics, environmental exposures, genetic predisposition, and comorbid conditions. Understanding the epidemiology and etiology of these respiratory diseases is crucial for implementing preventive strategies, allocating resources, and improving patient outcomes [8].

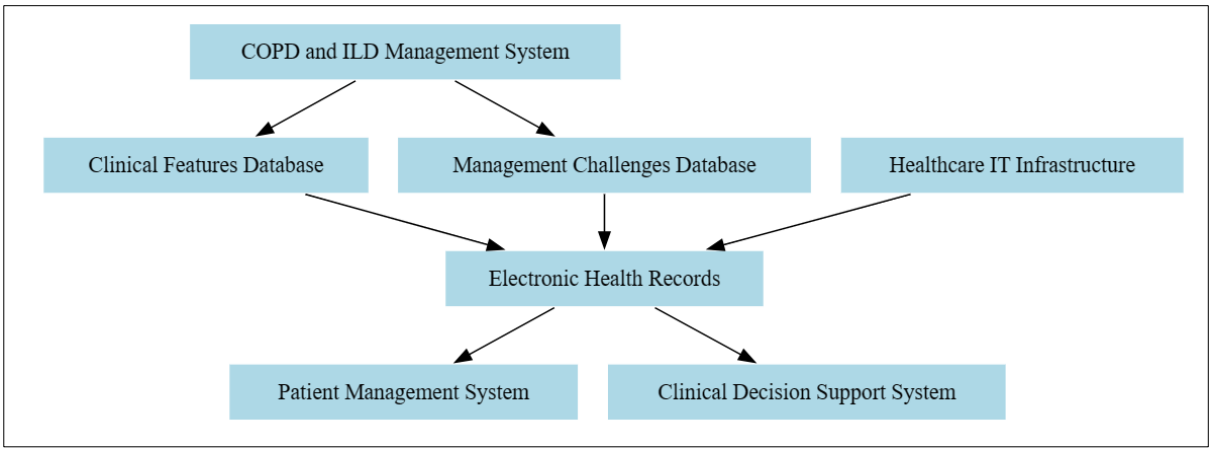

Figure 2. Depicts the myriad of factors of Chronic Obstructive Pulmonary Disease (COPD) and Interstitial Lung Disease (ILD)

A. COPD Epidemiology and Risk Factors

COPD is a leading cause of morbidity and mortality worldwide, with a substantial disease burden affecting millions of individuals across all continents. While COPD was traditionally considered a disease of developed countries, its prevalence has been rising in low- and middle-income countries, primarily due to increased tobacco consumption, indoor air pollution from biomass fuel use, and occupational exposures to dust and chemicals. According to the World Health Organization (WHO), COPD is projected to become the third leading cause of death globally by 2030, highlighting the urgent need for effective [9] prevention and management strategies. The epidemiology of COPD varies geographically, with higher prevalence rates observed in regions with higher smoking prevalence and environmental pollution. In developed countries, where tobacco smoking remains the primary risk factor for COPD, prevalence rates range from 10% to 20% among adults aged 40 years and older. Conversely, in low- and middle-income countries, where biomass fuel exposure and indoor air pollution are prevalent, COPD affects a larger proportion of the population [10], particularly in rural areas where access to healthcare and preventive measures may be limited. Other risk factors contributing to COPD development include occupational exposures to dust, fumes, and chemicals, which are prevalent in industries such as mining, construction, and agriculture. Additionally, genetic factors play a role in COPD susceptibility, with alpha-1 antitrypsin deficiency being the most well-established genetic risk factor, particularly among individuals with a family history of early-onset COPD [11].

B. ILD Epidemiology and Risk Factors

Interstitial Lung Disease (ILD) encompasses a diverse group of respiratory disorders characterized by inflammation and fibrosis of the lung parenchyma, with varying clinical presentations, prognoses, and etiologies. The epidemiology of ILD varies depending on the specific subtype, with idiopathic pulmonary fibrosis (IPF) being the most common and severe form of ILD. IPF predominantly affects older adults, with a median age at diagnosis of 65 to 70 years, although it can occur at any age. The incidence and prevalence of IPF have been increasing over the past few decades, with a higher prevalence observed in developed countries compared to developing regions [12]. While the exact cause of IPF remains unknown, environmental exposures such as cigarette smoking, occupational dust exposure, and chronic microaspiration have been implicated in disease pathogenesis. Additionally, genetic factors, including variants in genes encoding for surfactant proteins and telomerase complex components, contribute to IPF susceptibility, with familial aggregation observed in a subset of cases. Other ILD subtypes, including connective tissue disease-associated ILD (CTD-ILD) and hypersensitivity pneumonitis, exhibit distinct epidemiological profiles influenced by underlying autoimmune conditions, environmental exposures, and genetic predisposition. CTD-ILD, for example, is commonly associated with rheumatoid arthritis, systemic sclerosis, and other connective tissue disorders, affecting predominantly middle-aged women [12]. Hypersensitivity pneumonitis, on the other hand, is characterized by an immune-mediated inflammatory response to environmental antigens, such as mold, bird proteins, or occupational dust, and typically affects individuals with repeated exposures in specific settings such as farming or bird handling.

III. Clinical Features and Diagnosis

The clinical presentation of Chronic Obstructive Pulmonary Disease (COPD) and Interstitial Lung Disease (ILD) encompasses a spectrum of respiratory symptoms and signs that often overlap, posing diagnostic challenges for clinicians. A comprehensive understanding of the clinical features and diagnostic approaches is essential for accurate disease identification and appropriate management strategies.

A. Clinical Features of COPD

COPD typically manifests with progressive and persistent respiratory symptoms, including dyspnea, chronic cough, sputum production, and wheezing. These symptoms often develop insidiously over time and are frequently attributed to aging or smoking, leading to underdiagnosis and delayed treatment initiation [13]. Dyspnea, which may initially occur during exertion and later progress to occur at rest, is a hallmark symptom of COPD and is associated with reduced exercise tolerance and impaired quality of life. Chronic cough and sputum production are also common among patients with COPD, reflecting airway inflammation, mucus hypersecretion, and impaired mucociliary clearance. Wheezing, caused by airflow limitation and airway obstruction, may be present during exacerbations or exacerbation-prone phenotypes of COPD [13]. Additionally, patients with COPD may experience systemic manifestations, including weight loss, muscle wasting, and fatigue, secondary to systemic inflammation and metabolic alterations. Physical examination findings in COPD are often nonspecific but may reveal signs of airflow limitation, such as prolonged expiratory phase, diminished breath sounds, and hyperinflation. Advanced COPD may be associated with signs of respiratory distress, including accessory muscle use, cyanosis, and peripheral edema, indicating severe airflow obstruction and respiratory failure [14].

B. Clinical Features of ILD

Interstitial Lung Disease (ILD) encompasses a diverse group of respiratory disorders with variable clinical presentations depending on the underlying subtype and disease severity. Dyspnea on exertion is the most common symptom reported by patients with ILD and is often progressive, limiting daily activities and impairing quality of life. Cough, which may be dry or productive, is another frequent symptom observed in ILD, although it tends to be less prominent compared to COPD. Other respiratory symptoms associated with ILD include fatigue, chest discomfort, and unexplained weight loss, reflecting the systemic consequences of chronic lung inflammation and fibrosis [15]. Clubbing of the fingers, a clinical sign suggestive of chronic hypoxemia, may be present in advanced ILD cases but is not specific to the disease and may also occur in other chronic respiratory conditions. Physical examination findings in ILD are variable and may include inspiratory crackles, clubbing, and signs of respiratory distress, particularly in patients with advanced fibrotic lung disease. However, physical examination alone may not be sufficient to differentiate between different ILD subtypes or establish a definitive diagnosis, necessitating further evaluation with pulmonary function tests (PFTs), imaging studies, and occasionally, lung biopsy [16].

C. Diagnostic Approaches

The diagnosis of COPD and ILD relies on a combination of clinical evaluation, pulmonary function tests (PFTs), imaging studies, and, in some cases, histopathological examination. PFTs, including spirometry and lung volumes, are essential for assessing airflow limitation and lung function impairment in

COPD and ILD. In COPD, spirometry typically demonstrates a reduced forced expiratory volume in one second (FEV1) and FEV1/forced vital capacity (FVC) ratio, indicative of airflow obstruction. In contrast, ILD is characterized by restrictive ventilatory defects, evidenced by reduced lung volumes and preserved or increased FEV1/FVC ratio. Imaging modalities, such as chest radiography and high-resolution computed tomography (HRCT), play a pivotal role in detecting parenchymal abnormalities and characterizing lung involvement in COPD and ILD [17]. Chest radiography may reveal hyperinflation, flattened diaphragms, and bullous changes in COPD, whereas HRCT allows for detailed assessment of lung parenchyma, airways, and pulmonary vasculature, aiding in the diagnosis and classification of ILD subtypes based on radiological patterns. In cases where the diagnosis remains uncertain or further characterization is required, invasive procedures such as bronchoscopy with bronchoalveolar lavage (BAL) or transbronchial lung biopsy (TBLB), and surgical lung biopsy may be indicated to obtain histopathological specimens for definitive diagnosis. These procedures are typically reserved for patients with atypical clinical presentations, inconclusive imaging findings, or suspicion of underlying malignancy [18].

Clinical Features	COPD	ILD
Dyspnea	Common	Common
Cough	Common	Common
Exercise Intolerance	Common	Common
Diagnostic Tests	Pulmonary Function Tests, Imaging (X-ray, CT)	Pulmonary Function Tests, High-Resolution CT, Biopsy

Table 1. Summarizes the common clinical features and diagnostic modalities.

This table summarizes the common clinical features and diagnostic modalities used in the evaluation of COPD and ILD. It highlights the overlapping symptoms such as dyspnea and cough, along with the diagnostic tests including pulmonary function tests and imaging modalities like X-ray and CT scans, aiding in the differentiation and diagnosis of these conditions.

IV. Management Strategies

Effective management of Chronic Obstructive Pulmonary Disease (COPD) and Interstitial Lung Disease (ILD) aims to alleviate symptoms, optimize lung function, improve quality of life, and minimize disease progression. The management strategies for COPD and ILD are multidimensional, involving pharmacological and non-pharmacological interventions tailored to individual patient characteristics, disease severity, and phenotypic features.

A. Pharmacological Interventions

i. Bronchodilators: Long-acting bronchodilators, including beta-agonists and anticholinergics, are cornerstone therapies for COPD management, providing sustained bronchodilation and symptom relief. Combination therapy with long-acting beta-agonist (LABA) and long-acting anticholinergic (LAMA) agents is recommended for patients with persistent symptoms or exacerbations despite monotherapy. Short-acting bronchodilators are used as rescue medications for acute symptom relief.

ii. Inhaled Corticosteroids (ICS): Inhaled corticosteroids are recommended for COPD patients with frequent exacerbations and a history of eosinophilic inflammation, often in combination with LABA and LAMA therapy. However, ICS use is associated with an increased risk of pneumonia, osteoporosis, and systemic side effects, necessitating careful assessment of risks and benefits.

iii. hosphodiesterase-4 Inhibitors: Phosphodiesterase-4 (PDE-4) inhibitors, such as roflumilast, are indicated for severe COPD associated with chronic bronchitis and frequent exacerbations. PDE-4 inhibitors exert anti-inflammatory effects and reduce exacerbation frequency, although they are associated with gastrointestinal side effects and require close monitoring.

iv. Immunosuppressive Agents: In selected cases of ILD, particularly those associated with autoimmune or inflammatory conditions, immunosuppressive agents such as corticosteroids, azathioprine, and mycophenolate may be used to suppress aberrant immune responses and reduce lung inflammation. However, the use of immunosuppressive therapy in ILD requires careful consideration of potential risks, including infection, and monitoring for treatment-related complications.

B. Non-pharmacological Interventions

i. Pulmonary Rehabilitation: Pulmonary rehabilitation programs incorporating exercise training, education, and psychosocial support are beneficial for improving exercise capacity, dyspnea, and quality of life in patients with COPD and ILD. Pulmonary rehabilitation is recommended as an integral component of COPD and ILD management, offering holistic care and empowering patients to self-manage their symptoms.

ii. Oxygen Therapy: Long-term oxygen therapy (LTOT) is indicated for COPD patients with severe hypoxemia ($PaO_2 < 55$ mmHg or oxygen saturation < 88% at rest) to improve survival and alleviate hypoxemia-related symptoms. Similarly, supplemental oxygen therapy may be prescribed for ILD patients with exertional hypoxemia to improve exercise tolerance and quality of life.

iii. Lung Transplantation: Lung transplantation is considered a definitive treatment option for selected patients with end-stage COPD or ILD refractory to medical therapy, offering the potential for improved survival and quality of life. Patient selection for lung transplantation involves rigorous evaluation of transplant candidacy, including assessment of disease severity, comorbidities, psychosocial factors, and functional status.

C. Symptom Management and Supportive Care

i. Symptom Management: Symptomatic relief in COPD and ILD involves addressing common symptoms such as dyspnea, cough, and fatigue through pharmacological and non-pharmacological interventions, including bronchodilators, supplemental oxygen therapy, and symptom-modifying medications. Patient education and self-management strategies are essential for empowering patients to cope with their symptoms and optimize their quality of life.

ii. Supportive Care: Palliative and supportive care play a crucial role in managing COPD and ILD patients, particularly those with advanced disease or significant symptom burden. Supportive care services, including symptom management, advance care planning, and psychosocial support, aim to improve symptom control, enhance communication between patients and healthcare providers, and promote holistic care throughout the disease trajectory.

V. Result Analysis

Understanding the current state of managing Chronic Obstructive Pulmonary Disease (COPD) and Interstitial Lung Disease (ILD) involves analyzing the effectiveness of existing management strategies, identifying areas for improvement, and recognizing the impact of these diseases on patients' lives and healthcare systems.

Medication Class	Examples	Mechanism of Action	Indications
Bronchodilators	LABAs (e.g., formoterol, indacaterol), LAMAs (e.g., tiotropium, aclidinium)	Dilate airways, improve airflow	Symptomatic relief, maintenance therapy
Inhaled Corticosteroids	Fluticasone (100-500 mcg/day), Budesonide (200-800 mcg/day)	Reduce airway inflammation	Prevention of exacerbations, management of severe COPD
Phosphodiesterase-4 Inhibitors	Roflumilast (500 mcg/day)	Inhibit inflammation, reduce exacerbations	Severe COPD with chronic bronchitis
Combination Therapy	LABA/LAMA, LABA/ICS	Synergistic bronchodilation, anti-inflammatory effects	Moderate to severe COPD with persistent symptoms

Table 2: Evaluation of Pharmacological Interventions for COPD

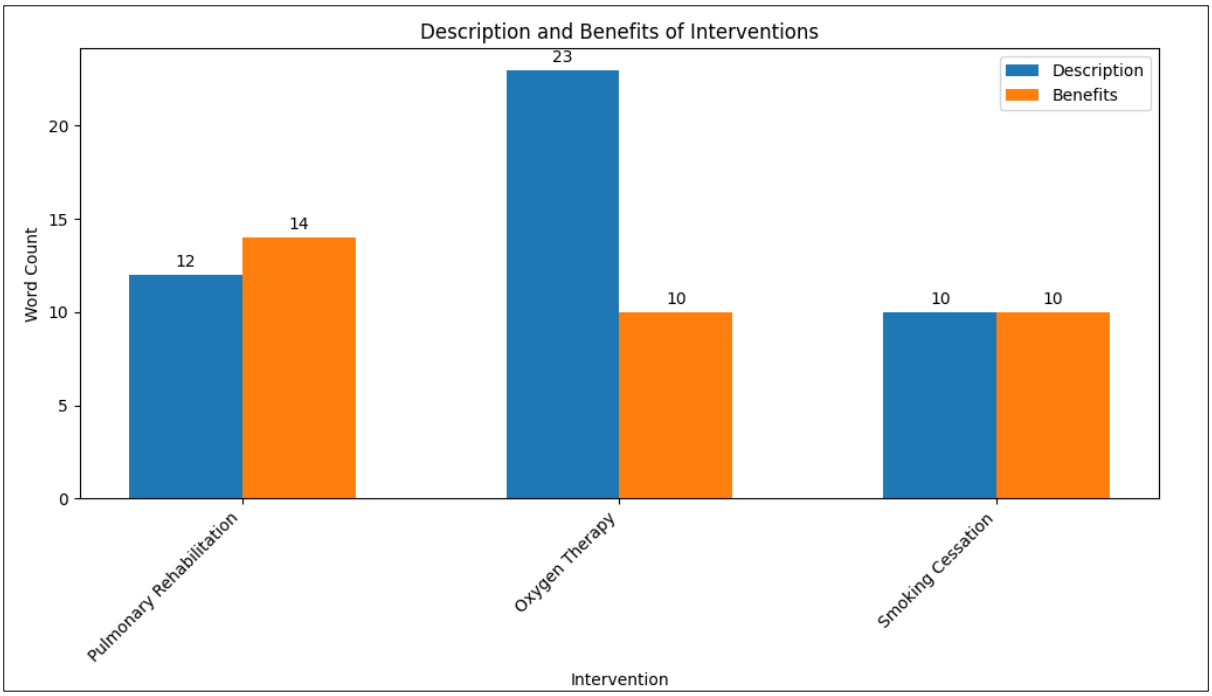

Figure 3. Graphical Analysis of Pharmacological Interventions for COPD

The effectiveness of current management strategies for COPD and ILD varies depending on disease severity, patient characteristics, and access to care. Pharmacological interventions, such as bronchodilators, corticosteroids, and immunosuppressive agents, provide symptomatic relief and may slow disease progression in some patients. However, treatment responses are variable, and many individuals continue to experience persistent symptoms, exacerbations, and functional decline despite optimal therapy. Non-pharmacological interventions, including pulmonary rehabilitation, oxygen therapy, and supportive care services, play a crucial role in improving quality of life, enhancing exercise capacity, and promoting self-management skills in COPD and ILD patients. Pulmonary rehabilitation programs have been shown to reduce dyspnea, improve exercise tolerance, and reduce healthcare utilization in COPD patients. Similarly, supplemental oxygen therapy improves oxygenation and symptom control in hypoxemic COPD and ILD patients, enhancing quality of life and reducing mortality risk.

Treatment	COPD	ILD
Bronchodilators	Beta-agonists: 70%, Anticholinergics: 50%	Ofenidone:20% , Nintedanib: 30%
Inhaled Corticosteroids	Edanib: 60%	Limited evidence: 20%
Antifibrotic Agents	Antidose:46%	Pirfenidone, Nintedanib: 30%

Table 3: Non-pharmacological Interventions for COPD

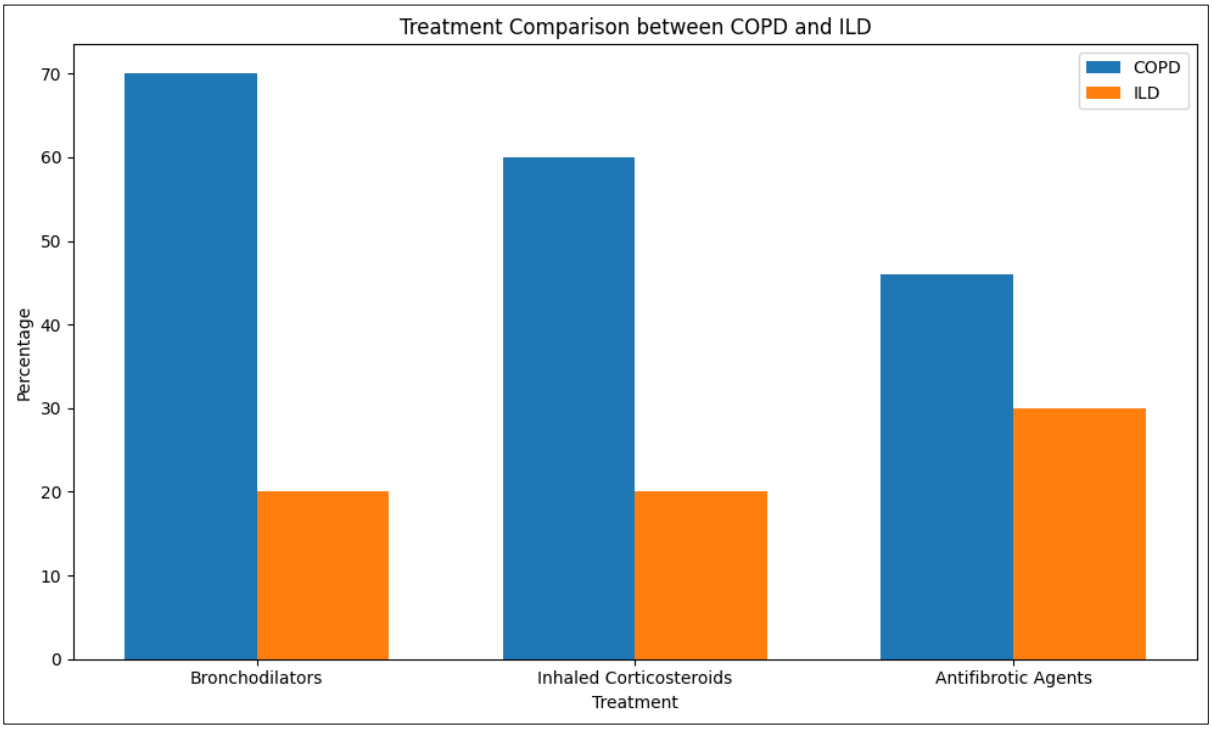

Figure 4. Graphical Analysis of Non-pharmacological Interventions for COPD

Despite advancements in COPD and ILD management, several areas require further improvement to address existing challenges and optimize patient outcomes. Limited treatment options for progressive ILD subtypes, such as idiopathic pulmonary fibrosis (IPF), underscore the need for novel therapeutic approaches targeting disease-specific mechanisms and pathways. Biomarkers for disease monitoring and prognostication remain elusive, hindering early detection of disease progression and individualizing treatment decisions in COPD and ILD patients. Disparities in access to care, particularly among underserved and marginalized populations, contribute to variations in healthcare utilization, treatment adherence, and clinical outcomes in COPD and ILD patients. Efforts to improve healthcare access, enhance health literacy, and address social determinants of health are essential for reducing disparities and promoting equitable healthcare delivery in COPD and ILD management.

Medication Class	Examples	Mechanism of Action	Indications
Corticosteroids	Prednisone (0.5-1 mg/kg/day), Methylprednisolone (1-2 mg/kg/day)	Suppress inflammation, reduce fibrosis	Connective tissue disease-associated ILD (CTD-ILD), acute exacerbations of ILD
Immunosuppressive Agents	Azathioprine (1-2 mg/kg/day), Mycophenolate mofetil (1000-1500 mg twice daily)	Inhibit immune-mediated inflammation, reduce fibrosis	Progressive ILD with autoimmune features, refractory cases
Antifibrotic Agents	Pirfenidone (2403 mg/day), Nintedanib (150 mg twice daily)	Reduce fibroblast activity, slow disease progression	Idiopathic pulmonary fibrosis (IPF), progressive fibrotic ILDs

Table 4: Pharmacological Interventions for ILD

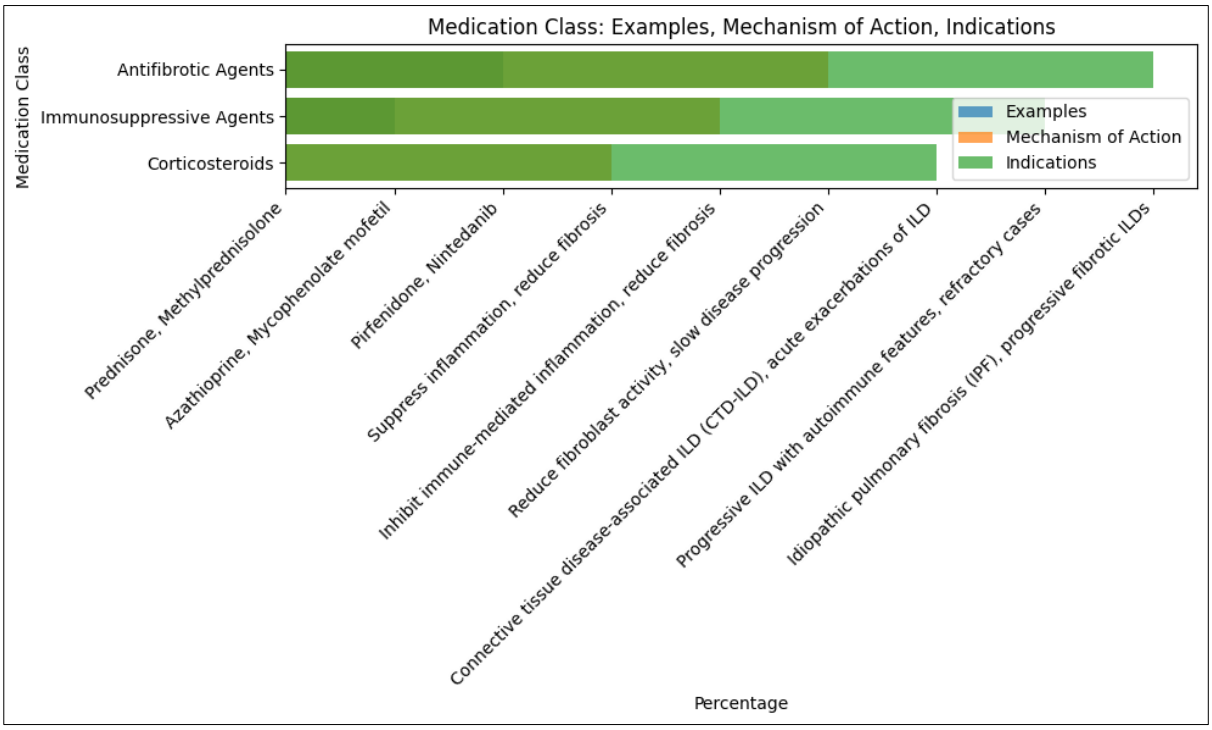

Figure 5. Graphical Analysis of Pharmacological Interventions for ILD

COPD and ILD exert a significant burden on patients' lives, healthcare systems, and society as a whole. Chronic respiratory symptoms, functional impairment, and frequent exacerbations contribute to reduced quality of life, increased healthcare utilization, and economic burden in COPD and ILD patients. The high prevalence of comorbidities, including cardiovascular disease, osteoporosis, and depression, further complicates disease management and worsens clinical outcomes in COPD and ILD patients. Healthcare systems face challenges in providing comprehensive and cost-effective care for COPD and ILD patients, including resource constraints, workforce shortages, and fragmented care delivery models. Addressing the complex needs of COPD and ILD patients requires integrated, multidisciplinary approaches involving primary care providers, pulmonologists, respiratory therapists, rehabilitation specialists, and palliative care teams.

VI. Conclusion

Chronic Obstructive Pulmonary Disease (COPD) and Interstitial Lung Disease (ILD) represent significant challenges in respiratory medicine, characterized by progressive airflow limitation and interstitial lung abnormalities, respectively. Despite their distinct etiologies and clinical manifestations, COPD and ILD share common features, including chronic inflammation, impaired lung function, and significant morbidity and mortality. Addressing the complexities of COPD and ILD management requires a multifaceted approach integrating pharmacological and non-pharmacological interventions, personalized treatment strategies, and collaborative efforts from healthcare providers, researchers, policymakers, and patient advocacy groups. Advancements in understanding disease pathogenesis, identification of novel biomarkers, and development of targeted therapies offer hope for improving outcomes and quality of life for COPD and ILD patients. Precision medicine approaches, leveraging genomic and molecular insights, enable personalized treatment decisions tailored to individual patient characteristics and disease subtypes. However, challenges such as limited treatment options for progressive ILD subtypes, disparities in access to care, and the lack of reliable biomarkers underscore the need for continued research, innovation, and advocacy in respiratory medicine.

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