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The Diversified Airway Management Model in Acute Exacerbation of Chronic Obstructive Pulmonary Disease (COPD) - A Review

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Abstract. Chronic obstructive pulmonary disease (COPD) is recognized as one of the three foremost causes of mortality among populations throughout the world. For patients diagnosed with acute exacerbation of COPD (AECOPD), three core clinical features are commonly observed: bronchial spasm, mucus accumulation-induced obstruction, and insufficient compensatory function of the lungs. In clinical practice, airway management measures must abide by a core principle – prioritizing non-invasive over invasive interventions while placing respiratory muscle protection at the core – a standard developed to reduce airway irritation and alleviate related tissue injury. Current clinical practice guidelines support evidence-based pharmacological treatment for AECOPD, yet traditional single-modal intervention methods only bring about temporary symptom relief. These conventional approaches cannot fully address the disease's underlying pathological mechanisms, a limitation that often leads to gradual respiratory function decline and marked impairment of patients' overall quality of life. This review collates cutting-edge clinical studies focusing on multimodal airway management for AECOPD, aiming to break the cycle of over-reliance on single therapies by implementing standardized patient assessments and stratified interventions. Beyond this primary aim, the review also seeks to provide practical clinical care guidance for frontline clinicians, optimize patients' short- and long-term prognosis, and clarify key directions for future research on personalized treatment strategies.

Keywords: chronic obstructive pulmonary disease, systematic review, airway management, MDT support

1. Introduction

Acute exacerbation of COPD speeds up the progressive decline in lung function. Such abnormal pathological changes can further disrupt the normal function of other body organs, even causing repeated hospital stays or fatal results in serious cases. Clinical treatment faces two core challenges: for one thing, airway obstruction in patients develops in a dynamic manner, and there are great differences in patient age and underlying disease profiles; for another, treatment across different care settings lacks consistent and sustainable execution plans.

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The traditional airway management evaluation method is relatively simple, using a single treatment plan and unified intervention measures: it is difficult to accurately judge the degree of airway obstruction by relying only on indicators such as pulmonary function (FEV1), and it is also difficult to provide targeted treatment, while dynamic parameters such as airway mucus secretion, sputum generation ability and inflammatory markers are often ignored [1].

Patients with different levels of disease severity often receive largely identical treatment regimens and have no access to hierarchical management approaches. This practice not only fails to reduce the burden on patients during acute episodes but also cannot prevent symptom recurrence in the stable phase. The multimodal airway management model takes the collaborative concept of "airway as the core" as its foundation and integrates the combined efforts of multidisciplinary treatment teams. By implementing standardised condition evaluations, symptom-based stratified interventions and seamless patient transfer processes, it aims to resolve the shortcomings in airway management for acute exacerbation of AECOPD patients across the entire continuum from acute treatment to stable-phase rehabilitation. Ultimately, this management model can reduce the occurrence of acute flares and readmission rates, while also improving the overall quality of life of these patients.

2. Background

2.1. Burden of COPD

COPD has emerged as one of the three major causes of death worldwide, with 90% of related mortalities reported in low- and middle-income nations. In 2012, more than 3 million individuals across the world lost their lives due to COPD, representing 6% of the global total deaths in that year [2]. Deficiencies in primary healthcare systems across underdeveloped and developing nations underpin a striking trend: some 90% of chronic obstructive pulmonary disease (COPD)-related deaths in those under 70 years of age occur in low- and middle-income regions. Beyond these demographic and geographic disparities, the financial burden of medical care for COPD patients has continued to mount over time. Current projections show that COPD will impose cumulative economic losses of 4.3 trillion US dollars on global macroeconomic development over the three decades from 2020 to 2050 [3].

Various inflammatory cell populations infiltrate the airway wall and lung parenchyma concurrently, inflicting lasting damage on airway tissues and amplifying active local inflammatory responses. These pathological processes induce airway mucosal thickening, epithelial shedding and ciliary dysfunction—changes that impede efficient mucus clearance along the entire airway tract. Proliferation and fibrosis of airway smooth muscle narrow the airway lumen, reduce tissue elasticity and ultimately lead to irreversible airflow limitation. Mucous glands and goblet cells undergo hyperplasia, resulting in excessive mucus secretion; this excess mucus then accumulates into obstructive plugs that block small peripheral airways. Rupture and fusion of alveolar walls, alongside the structural destruction characteristic of emphysema, further impair pulmonary ventilation efficiency and worsen airflow restriction severity [4].

Clinical practice guidelines advocate for the incorporation of inhaled bronchodilators and corticosteroids into standard medication protocols. That said, for patients with divergent baseline health conditions and age brackets, exclusive dependence on traditional therapeutic modalities—such as monotherapy with dexamethasone or alternative steroid formulations—might yield partial symptomatic relief, yet frequently falls short of resolving multiple clinical issues in a concurrent manner. Consequently, the majority of affected individuals either experience ongoing disease

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progression or exhibit a protracted recovery trajectory; this trend precipitates a gradual deterioration in respiratory function, which further erodes their overall quality of life.

2.2. Rationale for comprehensive airway management

Airway spasm, mucus buildup and impaired lung function are the main clinical features seen in patients with acute exacerbation of chronic obstructive pulmonary disease (AECOPD). When caring for these patients' airway needs, clinicians should prioritize non-invasive measures ahead of invasive procedures, with respiratory muscle protection as a central priority to cut down on airway irritation and avoid further harm to the respiratory tract. For AECOPD patients, multimodal airway management is geared toward optimizing ventilation efficiency, relieving airway obstruction and stopping respiratory failure from developing. Clinicians should choose airway management strategies in a step-by-step way, based on how severe a patient's respiratory distress is and a thorough review of their overall health — starting with gentle non-invasive interventions and moving to more intensive care only when clinical status calls for such changes. This tiered care approach avoids two problematic outcomes: the use of unnecessary aggressive therapies on one side, and dangerous lags in delivering essential medical care on the other. Usable interventions include basic airway support — such as oxygen therapy and inhaled bronchodilator use — as well as several multimodal airway clearance techniques like vibration-assisted chest physiotherapy, acupuncture-based care and personalized smoking cessation support.

The main benefit of multimodal airway management is that it does not depend on any single treatment method. By selecting and flexibly combining appropriate approaches to meet each patient's unique needs, this care model can be adjusted to fit individual clinical signs and treatment contexts. It targets the natural variability of chronic obstructive pulmonary disease (COPD), addresses complex clinical situations, manages challenging airway issues and adapts dynamically as a patient's condition changes. Its key objectives are to reduce airway-related risks, boost the safety of ventilation support, minimize the adverse effects of invasive procedures and stop life-threatening complications from occurring [5].

At present, several experimental and observational studies have demonstrated that diversified airway interventions can improve symptom control, reduce hospitalisation duration, enhance nutritional status, improve post-recovery quality of life, increase exercise capacity and lower re-hospitalisation rates in COPD patients.

2.3. Need for a systematic review

When conducting multimodal airway management for patients with acute exacerbation of AECOPD, heterogeneity in the evidence emerges as a frequent challenge. Three main factors contribute to this issue: differences in patients' baseline traits, including age, severity of airflow limitation, and concurrent diseases; unclear definitions of "multimodal" intervention measures, such as divergent choices of tools and different timings for intubation; and inconsistent use of outcome assessment indicators. In daily clinical practice, healthcare workers should select suitable intervention tools for tailored combinations based on each patient's unique circumstances, such as age, airflow restriction severity and comorbid conditions. At the same time, future research should adopt the framework of "hierarchical research paired with standardised trial design" to reduce such heterogeneity, thus providing more accurate evidence-based guidance for clinical practice.

For patients with chronic obstructive pulmonary disease who have developed acute exacerbation, the crux of clinical decision-making in multimodal airway management is to carry out hierarchical

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patient care. This care model centres on dynamic symptom evaluation and takes risk prediction as a core prerequisite. Medical workers need to flexibly choose appropriate intervention tools according to the patient's disease severity, airway characteristics, existing comorbidities, and available medical resources [6]. Dynamic assessment and risk prediction need to be integrated into every step of treatment decision-making. Drawing on the combined expertise of multidisciplinary care teams, clinicians can balance two key priorities: avoiding over-intervention and guarding against delayed ventilation implementation. This balance in turn helps achieve three core goals: reducing intubation rates, minimising complications, and improving overall patient outcomes.

Up to now, researches centered on multimodal airway care for acute COPD exacerbations have established a basic hierarchical decision-making framework. Even so, obvious research limitations exist in three crucial aspects: the appropriateness of matching varied intervention measures, supporting clinical evidence for special patient groups, and thorough analysis of outcome evaluation indicators. These drawbacks impede the optimization of evidence-based clinical practice guidelines and the standardized development of regular clinical work.

3. Method

3.1. Research question and scope

This study focus on assessing the efficacy of diverse airway management strategies—including chest physiotherapy for sputum clearance, pharmacologic interventions, oxygen therapy, and other symptomatic care combined with routine treatment measures—in caring for patients with acute COPD exacerbations.

Inclusion criteria:

1. Patients who meet the diagnostic criteria for COPD in the 'Guidelines for the Diagnosis and Treatment of Chronic Obstructive Pulmonary Disease (2021 Edition)' and are in the acute exacerbation phase

2. Aged18-60 years old

3. Patients may present with chronic diseases such as hypertension and diabetes

Exclusion criteria:

4. Patients with lung cancer, tuberculosis, severe heart failure (NYHA class IV), and acute respiratory distress syndrome (ARDS), which may affect respiratory function

Research type: limited to clinical trial studies published in the past 15 years (January 2010 to August 2025), including randomised controlled trials, quasi-experimental studies, cohort studies, and retrospective analyses.

Intervention measures: Studies were required to clearly adopt a diversified airway management plan combining conventional treatment with symptomatic treatment (such as conventional treatment + pulmonary rehabilitation, etc.).

3.2. Data collection

Using a standardised table specifically designed for this study, information was extracted, including article title, publication year, interventions beyond conventional treatment, intubation rate, length of hospital stay, lung function indicators, analysis of six-minute walk test results, and readmission rate within 30 days. The research conclusions were drawn by summarising, analysing, and comparing the above data.

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4. Result

A total of 1446 articles were identified in the search results, of which 126 were duplicate publications. After screening titles and abstracts according to the inclusion and exclusion criteria, seven eligible clinical studies were included in the final analysis.

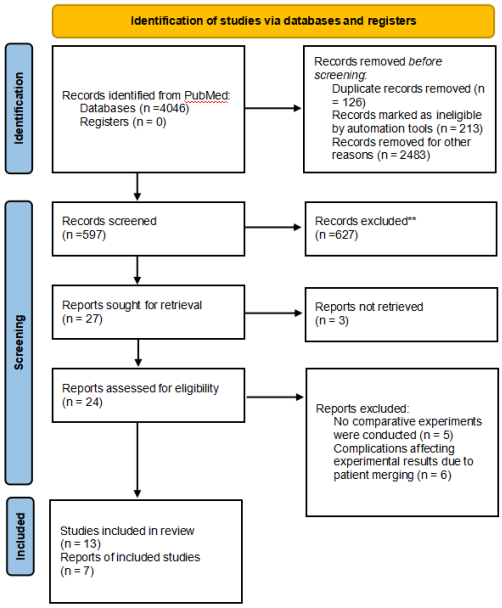

Figure 1. Flowchart of the different phases of the search strategy

Table 1. Characteristics of the included studies, with the main data extracted from the papers

Authors	Control group	Experimental group intervention measures	Intubation rate	Length of hospital stay	FEV1	6-minute walking distance	Probability of readmission within 30 days
McCarthy et al., 2015 [7]	Conventional therapy	Conventional treatment + pulmonary rehabilitation			Experimental group 39.2% Conventional treatment group 36.4%	MD43.93,95% CI 32.64 to 55.21; participants = 1879; studies = 38).	
Osadnik et al., 2017 [8]	Conventional therapy	Conventional treatment + NIV	Reduce by 64%	Decreased by more than three days			
H. Chen et al., 2023 [9]	Conventional therapy	Conventional treatment + N-acetylcysteine (NAC)	NAC group 3.1% Non NAC group 13.5%	The median length of hospital stay in the NAC group was 8.3 days (95% CI, 7.6 to 8.4 days) The non NAC group lasted for 9.1 days (95% CI, 8.5 to 9.5 days)			NAC group 2.1% Non NAC group 5.2%

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Table 1. (continued)

Del Sorbo et al., 2015 [10]	Conventional therapy	Conventional treatment + non-invasive ventilation combined with extracorporeal carbon dioxide removal	Experimental group 12% Conventional treatment group 33%		
Ralf et al., 2023 [11]	Conventional therapy	Conventional treatment + NIV		LT-NIV group 19 (12; 30) days, non-NIV group 12 (9; 17) days LT-NIV group 19 (12; 30) days, non-NIV group 12 (9; 17) days	
Levy et al., 2022 [12]	Conventional therapy	Conventional treatment + acupuncture treatment		5.5 ± 2.3 days in the acupuncture and moxibustion group, 6.0 ± 2.9 days in the sham acupuncture and moxibustion group, and 6.3 ± 2.9 days in the SOC group, p = 0.05	FEV1 < 50% 12 (46%) in the acupuncture and moxibustion group 15 (63%) in the sham acupuncture and moxibustion group SOC group is 13 (59%)
Cheng et al., 2022 [13]	Conventional therapy	Conventional treatment + high-frequency chest wall oscillation sputum evacuation		Experimental group (A) 10.61 ± 2.50 Control group (B) 15.56 ± 3.26	Experimental group (A) 48.03 ± 7.04 Control group (B) 43.81 ± 6.28

5. Conclusion

This review analyses the application of a variety of strategies in acute exacerbation of chronic obstructive pulmonary disease (AECOPD), including oxygen therapy, the combined use of bronchodilators, non-invasive ventilation (NIV), nebulisation inhalation, physical sputum discharge and artificial airway management. The analysis demonstrates that a single treatment method is insufficient to comprehensively address the various symptoms experienced by patients with AECOPD, such as airway spasm, sputum retention, and respiratory failure. In contrast, a diversified and combined treatment plan, based on patient stratification (e.g., mild, moderate or severe disease, with or without respiratory failure), can significantly improve the efficiency of airway clearance, reduce intubation rates and 30-day re-hospitalisation rates, improve lung function, and shorten the length of hospital stays. These benefits not only improve treatment success rates and delay disease progression, but also reduce the economic burden on patients and their families.

Multidisciplinary care strategies rely on close collaboration among varied healthcare providers, including physicians, nurses, rehabilitation therapists and pharmacists. Yet numerous primary care institutions currently have no access to well-trained multidisciplinary teams — a limitation that hinders the practical implementation of such care protocols. This is why research into multimodal airway management for elderly patients with multiple comorbidities remains limited, and the applicability of existing study findings requires cautious interpretation. In summary, AECOPD multimodal airway management is not just a basic combination of therapeutic methods, but precise, individualized collaborative care suited to the unique characteristics of each patient. Going forward, more high-quality studies are needed to identify optimal combined treatment strategies and support

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their shift into standardized clinical pathways, ultimately achieving core goals: reducing the risk of acute AECOPD exacerbation, treating or slowing disease progression, and improving patients' overall quality of life.

Conflicts of interest

The authors declare no conflicts of interest.

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