INHALED PHARMACOLOGICAL TREATMENT AND CRITICAL ERRORS IN INHALATION TECHNIQUE IN PATIENTS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE

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Abstract

Introduction: Chronic obstructive pulmonary disease (COPD) is a fairly common disease characterized by airflow limitation in the lungs that is not fully reversible. The main cause in developed countries is exposure to tobacco smoke. The aim of this study is the analysis and evaluation of inhaled pharmacological treatment and critical errors in inhalation technique in patients with chronic obstructive pulmonary disease (COPD). Material and methods: This is a prospective, observational, transversal study carried out in outpatient primary and secondary care patients with COPD in the city of Struga, in the period from 12.07.2024 to 24.09.2024, where a total of 68 patients were evaluated. Results: From the total of 68 patients with COPD included in the study, 39 or 57.4% of them, are female patients. The average age is 57.87±13.34. About 60 % of patients had two or more exacerbations of COPD symptoms. In total, 82.3% of patients used treatment containing inhaled corticosteroids. The largest percentage of patients (45.6%) declared to use metered dose inhalers, despite 22.1% of them using dry powder inhalers. Treatment with ≥1 type of device was initiated in 32.4% of patients in the study. Conclusion: To improve COPD results, all inhalation steps should be followed to eliminate as many (critical) errors as possible. This research aims to contribute to reducing critical errors in inhalation technique and advancing pharmacological inhaler treatment in COPD patients. By increasing the quality of COPD management, the efficiency and effectiveness of disease treatment can be increased.

Keywords: Chronic obstructive pulmonary disease (COPD), inhalation technique, inhaled pharmacological treatment, critical errors.

Introduction

Chronic Obstructive Pulmonary Disease (COPD) is a lung disease caused by exposure to harmful particles or gases (Agarwal et al., 2023). It is a preventable and treatable disease characterized by irreversible or partially reversible narrowing of the airways, leading to restriction of airflow (Celli et al., 2022; Gupta et al., 2013). It is a major public health issue globally, contributing significantly to morbidity and mortality (Mathers & Loncar, 2006). Some of the risk factors that increase the likelihood of COPD include smoking, passive smoking, exposure to dust and fumes, exposure to air pollutants, genetic factors, and socio-economic status (Agustí et al., 2022; Ezzati, 2005; Agarwal et al., 2023). COPD includes Chronic Obstructive Bronchitis and Pulmonary Emphysema (Widysanto & Mathew, 2022; Pahal et al., 2023). Although these two diseases do not initially develop in the same way, they are grouped because they are characterized by respiratory obstruction, or airflow obstruction, in the bronchial passages (Pahal et al., 2023; Widysanto & Mathew, 2022). Clinically, the most common symptoms of chronic bronchitis are chronic cough, excessive sputum production, dyspnea, wheezing, and cyanosis of the lips and fingernails (Widysanto & Mathew, 2022; NHS, 2024). COPD exacerbations are defined as an acute worsening of respiratory symptoms (Ritchie & Wedzicha, 2020). They are classified as mild (treated with short-acting bronchodilators alone), moderate (treated with short-acting bronchodilators plus antibiotics and/or oral corticosteroids), and severe symptoms (requiring hospitalization or an emergency room visit) (Gupta et al., 2013). Severe exacerbations may also be associated with acute respiratory failure (Ritchie & Wedzicha, 2020). Complications may include acute complications such as acute respiratory failure, pneumothorax, and recurrent and prolonged

lower respiratory tract infections, such as pneumonia, bronchitis, and other bacterial or viral infections, and chronic complications such as cardiopulmonary diseases, osteoporosis, depression and anxiety, sleep disorders, weight loss, and muscle loss (Agarwal et al., 2023).
Pharmacological therapy includes bronchodilators (short-acting and long-acting), antimuscarinics (inhaled), methylxanthines (oral), PDE4 inhibitors, antibiotics, and anti-inflammatory agents (Gupta et al., 2013). The primary goals of inhaled pharmacotherapy are to alleviate symptoms, improve lung function, reduce exacerbation frequency and severity, and enhance overall health status (Jones et al., 2016; van Dijk et al., 2023).
Despite the proven efficacy of inhaled therapies, optimal disease control is often not achieved in clinical practice. One of the major contributing factors is incorrect inhalation technique (Usmani et al., 2018; Sulku et al., 2022). Evidence indicates that a substantial proportion of COPD patients commit critical errors when using inhalation devices, significantly reducing drug deposition in the lower airways and thereby diminishing therapeutic effectiveness (Kocks et al., 2023; Ahn et al., 2019). Common errors include failure to follow these techniques: holding the breath for 10 seconds while inhaling, exhaling slowly through the mouth after inhaling, correctly sealing the lips around the inhaler, shaking the device before use, and breathing slowly and deeply while inhaling (Sulku et al., 2022; Usmani et al., 2018). Factors that influence errors in inhalation technique are age, educational level, lack of information from healthcare workers, and the variety and complexity of inhalation devices (Kocks et al., 2023; Usmani et al., 2018). The persistence of these errors highlights the importance of proper patient education and healthcare professional support to avoid errors in inhalation technique (Ahn et al., 2019; Sulku et al., 2022). Therefore, this study aims to analyze and evaluate pharmacological treatment with inhalers and critical errors in inhalation technique in patients with chronic obstructive pulmonary disease.

Materials and methods

This is a prospective, observational, cross-sectional study conducted in primary and secondary care outpatients with COPD in the city of Struga and its surroundings. The group included in the study are patients diagnosed with COPD in the city of Struga, in the period from 12.07.2024 to 24.09.2024. The instrument that will be used for data collection is a self-administered questionnaire, using trusted online reference databases. This questionnaire provides data on age, gender, current smoking, educational level (primary, secondary, or higher education), and the health status of patients with COPD assessed according to the CAT table and through the number of exacerbations within 12 months. The GOLD A–D categorization of COPD (A (low risk, fewer symptoms), B (low risk, more symptoms), C (high risk, fewer symptoms), and D (high risk, more symptoms)) in the patients included in the study was based on the patient's CAT score and history of exacerbations (GOLD2017).
Pharmacological treatment was categorized into long-acting beta-2-agonists (LABA), long-acting muscarinic antagonists (LAMA), LABA + LAMA, inhaled corticosteroids (ICS), ICS + LABA, ICS + LAMA and ICS + LABA + LAMA. Inhaler device models included were categorized into Dry Powder Inhalers (DPI), Metered Dose Inhalers (MDI or pMDI), Soft Mist Inhalers and more than one device type.
The steps for the correct technique that the patient should follow during inhalation, in the form of a checklist, were determined by consulting the patient information leaflets for each device and previous studies. If a patient's technique deviated from the six defined steps, even in just one of them, it would be judged as a critical error.
The data collected were expressed as frequencies and percentages, and as means and standard deviations (SD) for continuous and categorical variables. The CAT asks questions about eight domains, with a score range of 0 to 5 for each domain, with a total score ranging from 0 to 40.

Higher scores indicate that COPD has a greater impact on the patient's overall health and well-being. Table 1 presents the impact of COPD on the patient's overall health and well-being according to CAT (https://www.healthline.com/health/cat-score-for-copd?utm_source).

Table 1. Impact of COPD on the patient's overall health and well-being according to CAT

CAT results	Impact	Meaning
0-9	Low	You may not experience many symptoms of COPD, or at least not enough to affect your daily activities. Most days are fine, but you cough regularly and get tired easily.
10-20	Medium	COPD symptoms regularly affect your life. You have some good days, but you get short of breath easily and cough up phlegm regularly. You have 1 or 2 flare-ups each year.
21-30	High	Your symptoms regularly prevent you from doing the things you want to do. Regular daily activities like getting dressed are tiring. You don't feel in control of your chest problem.
31-40	Very high	Your symptoms regularly prevent you from doing the things you want to do. Regular daily activities like getting dressed are tiring. You don't feel in control of your chest problem.

Results

A total of 68 patients with chronic obstructive pulmonary disease (COPD) from the city of Struga were included in this study, in the period from 12.07.2024 to 24.09.2024, who voluntarily expressed their willingness to participate in the study. From the data analyzed and presented in
Table 2, it results that out of the total of 68 patients with
COPD included in the study, 39 or 57.4% of them, are female patients. The average age is 57.87±13.34. According to the level of education, 57.4% of the patients declared having completed only primary education. According to the data collected, the majority of COPD patients 49 (72.1%) included in the study were found to have been smokers in the past, despite 25 (36.8%) of them continuing to be current smokers.

Table 2. Sociodemographic charactersitics of the patients in the study

Variable	Frequency	Percentage
Gender		
Male	29	42.6
Female	39	57.4
Age	57.87±13.34	
Educational level		
Primary school	39	57.4
Secondary school	18	26.5
University	11	16.2
Current smoker		
Yes	25	36.8
No	43	63.2
Former smoker		
Yes	49	72.1
No	19	27.9

During the data analysis, it is noted that about 58.0% of patients have had two or more exacerbations of COPD symptoms. In a significant percentage of them (47.1% and 39.7%), COPD have a medium, respectively high impact on the patient's overall health and well-being. Thus, the categorization of COPD according to GOLD A–D in the patients included in the study was based on the patient's CAT score and history of exacerbations (GOLD 2017).

Table 3. Distribution of exacerbation frequency and CAT scores among COPD patients

Variable	Frequency	Percentage
Number of exacerbations		
≤ 1	29	42.6
≥ 2	39	57.4
CAT Score	19.8±7.4	
0-9 (low impact)	4	5.9
10-20 (moderate impact)	32	47.1
21-30 (high impact)	27	39.7
31-40 (very high impact)	5	7.4

Based on the findings of this study, 55.9% of patients were classified as GOLD stage D COPD (≥2 exacerbations and CAT score ≥10), while 38.2% were classified as GOLD stage B COPD (≤1 exacerbation and CAT score ≥10) according to the GOLD A–D classification.

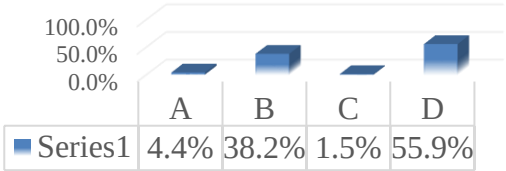

Figure 1. Distribution of patients according to GOLD A–D COPD classification

In our study, a total of 82.3% of patients were using treatment containing inhaled corticosteroids. Dual ICS+LABA treatment (52.9%) was the most common treatment among patients with COPD. The largest proportion of patients (45.6%) reported using metered dose

inhalers compared to 22.1% using dry powder inhalers. Treatment with ≥1 type of device was initiated in 32.4% of patients in the study (Table 4).

Table 4. Distribution of COPD treatment regimens and inhaler device types among study participants

Variable	Percentage (%)
Treatment	
No treatment	10.3%
LABA	1.5%
LAMA	5.9%
ICS	14.7%
ICS + LABA	52.9%
ICS + LAMA	1.5%
ICS + LABA + LAMA	13.2%
Inhaler Type	
Dry powder inhaler	22.1%
Metered-dose inhaler	45.6%
More than one type of device	32.4%

In total, 95.6% of patients included in the study made one or more critical errors while using a currently prescribed inhaler device. A very small percentage, only 4.4% of patients reported "Always" performing all six steps of the inhalation technique, compared to 7.4% of them who did not report "Always" performing any step. Holding the breath for at least 10 seconds after use and exhaling slowly after use were the most common types of critical error identified, contributing to 67.6% of the total critical errors. Exhaling completely before use was the second most common type of critical error identified (66.2%). Shaking the device before use was the only error type with a significantly lower prevalence (22.1%). A significant percentage of COPD patients included in the study (59.0%) considered that healthcare personnel had instructed and taught them on the correct use of an inhaler, despite a small percentage (9.0%) stating the opposite (Table 5).

Table 5. Critical errors in inhalation technique and instructions received from healthcare professionals

Variables	Percentage (%)
Number of Critical Errors	
0	4.4%
1	20.6%
2	23.5%
3	22.1%
4	14.7%
5	7.4%
6	7.4%
Types of critical errors in inhalation technique	
Shakes the device before use	22.1
Exhales completely before use	66.2
Closes lips tightly around the mouthpiece	45.6
Breathes in deeply and slowly through the mouthpiece	54.4
Holds breath for at least 10 seconds	67.6
Breathes out slowly after use	67.6
Healthcare professionals' instructions regarding inhalation technique	
More details	59.0%
Not at all	9.0%
In general	32.0%

Discussion

This study aims to analyze and evaluate pharmacological treatment with inhalers and critical errors in inhalation technique in patients with Chronic Obstructive Pulmonary Disease (COPD). A total of 68 patients with COPD from the city of Struga, in the period from 12.07.2024 to 24.09.2024, voluntarily expressed their willingness to participate in this study. When comparing the findings of the present study with those of a one-year follow-up study conducted in Sweden by Johanna Sulku in 2022, it was observed that 82.3% of the 68 COPD patients included in our study were receiving treatment containing inhaled corticosteroids. Similarly, in the Swedish study, 310 out of 360 patients who completed the one-year follow-up were using inhaled therapy at both study visits. The distribution of COPD patients according to the GOLD A–D classification was 6% in stage A, 56% in stage B, 29% in stage C, and 8% in stage D. Regarding treatment patterns, triple therapy consisting of ICS + LABA + LAMA was the most frequently prescribed regimen (50%). Other therapeutic approaches included as-needed therapy (7%), LABA monotherapy (2%), LAMA monotherapy (16%), LABA + LAMA (6%), ICS monotherapy (3%), ICS + LABA (12%), and ICS + LAMA (4%).

The findings of the present study demonstrated that inhaler misuse and critical inhalation technique errors remain highly prevalent among COPD patients. More than 90% of the patients included in our study made at least one critical error while using their prescribed inhaler device, whereas only 4.4% performed all inhalation steps correctly. The most frequently identified errors were failure to hold the breath for at least 10 seconds after inhalation (67.6%), failure to breathe out slowly after use (67.6%), failure to exhale completely before inhalation (66.2%), and failure to inhale deeply and slowly through the mouthpiece (54.4%). In addition, nearly half of the patients did not close their lips tightly around the mouthpiece (45.6%). These findings indicate substantial deficiencies in inhalation technique that may negatively affect drug delivery and disease control. Similar findings were reported in the multi-country cross-sectional observational PIFotal study conducted by Janwillem Kocks, which included 1,434 COPD patients using dry powder inhalers. In that study, 81.3% of patients made at least one critical inhalation error. Errors related to inhalation manoeuvre, breath holding, and exhalation after inhalation were significantly associated with worse health status and higher CAT scores, while errors involving inhaler preparation and inhalation technique were associated with more severe exacerbations. The authors also demonstrated that an increasing number of inhalation errors was associated with poorer health status and a higher rate of COPD exacerbations. Our findings are consistent with these observations, particularly regarding the high frequency of errors involving exhalation before inhalation, breath holding, and post-inhalation breathing technique. Comparable results were also observed in the prospective cross-sectional case-control study conducted by June Hong Ahn among 189 COPD patients. The study reported that 42.9% of patients made at least one critical inhaler error, with the highest proportion of errors observed among users of pressurized metered-dose inhalers. The authors identified associations between inhaler misuse and frequent exacerbations, while factors such as lower educational level, use of multiple inhaler devices, and inadequate inhalation technique contributed to poorer disease control. In contrast to that study, our results demonstrated an even higher prevalence of inhalation technique errors, suggesting that inhaler misuse remains a major challenge in routine clinical practice.

An important finding of our study was that only 59.0% of patients reported receiving detailed instructions regarding inhaler technique from healthcare professionals, while 9.0% reported not receiving any instructions at all. This finding may partly explain the high prevalence of inhalation errors observed in our population and underscores the importance of repeated patient education and regular reassessment of inhaler technique in clinical practice.

Conclusion

Inhaler therapy is very important in the pharmacological treatment of patients with COPD, providing a variety of medications that can significantly improve respiratory function and quality of life. Therefore, this research attempts to contribute to the reduction of critical errors in inhalation technique and the advancement of pharmacological treatment with inhalers in patients with COPD. By increasing the quality of adequate management of COPD, the efficiency and effectiveness of the treatment of the disease can be increased, and thus the quality of life of millions of individuals worldwide can be significantly improved, considering that COPD is the third leading cause of death in the world.
Therefore, in conclusion, these results will help identify areas where improvements can be made, which will contribute to the advancement of inhaler treatment and improvements in inhalation technique that lead to symptom relief and improved general well-being.

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