

Inhaled Drug Use in Elderly Patients and Limitations in Association With Geriatric Assessment Scores

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OBJECTIVE: The study of the association between geriatric profile and the use of inhaled respiratory drugs would help to identify age-related factors that might indicate poor inhaler use and technique.

PATIENTS AND METHODS: We selected 117 patients older than 74 years receiving chronic treatment with inhaled respiratory drugs to participate in this descriptive, cross-sectional, multicenter study. The following variables were analyzed: age, sex, institutionalization, carer assistance, inhaled drugs, prescribed regimen, actual regimen followed by the patient, initial indication, concomitant use of drugs that could exacerbate the underlying disease, adverse effects, basic geriatric assessment scores, treatment adherence, inhalation technique, and spirometric variables.

RESULTS: In all, 5.4% of the patients had moderate to severe cognitive impairment; 2.2%, considerable or total dependency in terms of activities of daily living; and, 14%, considerable or total dependency in terms of instrumental activities of daily living. Twenty-three percent had symptoms of depression and 5.4% (all men) were depressed. Forty percent of the patients analyzed were considered to be at psychosocial risk.

Inhalation technique scores were not correlated with any of the other variables analyzed. Higher scores were obtained when dry powder inhalers were used to administer anticholinergic agents and when capsule-based inhalers were used to administer corticosteroids concomitantly with long-acting β_2 -agonists.

CONCLUSIONS: Tests readily administered in daily practice to detect age-related deterioration may not accurately predict optimal use of inhaler devices.

Key words: *Inhaler use. Geriatric assessment. Inhaler technique.*

Uso de medicación inhalada en pacientes de edad avanzada y sus limitaciones según la evaluación geriátrica

OBJETIVO: El estudio de la asociación entre perfil geriátrico y uso de medicación respiratoria inhalada permitiría conocer qué factores relacionados con el envejecimiento pueden condicionar la utilización y la técnica de administración de estos fármacos.

PACIENTES Y MÉTODOS: Se ha realizado un estudio multicéntrico, descriptivo y transversal en que se incluyó a 117 pacientes mayores de 74 años, en tratamiento crónico con fármacos respiratorios por vía inhalada. Se analizaron las siguientes variables: edad, sexo, institucionalización, cuidador, fármacos inhalados de acción respiratoria, pauta prescrita y realizada por el paciente, diagnóstico que originó la prescripción, fármacos concomitantes que pudieran agravar la enfermedad de base, efectos adversos, valoración geriátrica básica, cumplimiento terapéutico, valoración de la técnica de inhalación y variables espirométricas.

RESULTADOS: El 5,4% de los pacientes presentaba un deterioro cognitivo moderado-grave, el 2,2% una dependencia funcional importante-total y el 14% una dependencia instrumental importante-total. El 23% tenía depresión leve y el 5,4% depresión establecida, siendo todos los pacientes varones. El 40% presentaba riesgo social.

La valoración de la técnica no se correlacionó con ninguna de las variables analizadas.

Los dispositivos Aerolizer-Handihaler mejoraban la valoración de la técnica en la aplicación de los anticolinérgicos y los dispositivos Accuhaler-Turbuhaler, la aplicación de la asociación de corticoides con agonistas adrenérgicos β_2 de acción larga.

CONCLUSIONES: Los tests de fácil aplicación en consulta para detectar el deterioro asociado al envejecimiento no parecen ser un buen elemento predictivo para determinar un mejor uso de los dispositivos de inhalación.

Palabras clave: *Uso de inhaladores. Evaluación geriátrica. Técnica de administración.*

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Introduction

Although inhalation is a highly effective drug delivery route¹ and associated with fewer systemic adverse effects than other routes,² efficacy can be compromised by poorer treatment adherence and incorrect inhaler use.^{3,4} It is therefore essential to train patients on optimal use when prescribing inhaled medication, but for training to be successful, patients must be capable of understanding instructions and willing to collaborate.⁵ This becomes complicated in the case of patients whose intellectual function and self-care skills have declined. Aging can seriously impair these functions and skills and is believed to affect treatment adherence and correct drug use.

Few studies have analyzed the association between inhaled drug use and aging,⁶ although poor inhaler use appears to be associated with cognitive impairment rather than actual age.⁷ While relevant guidelines and publications^{8,9} recommend talking to patients in order to choose an inhaler device that suits their situation and needs, they do not give clear indications on how to overcome age-related limitations or on which devices are most appropriate in situations of this type.

The study of the association between geriatric profile and the use of inhaled drugs in patients with chronic respiratory disease would help to identify age-related factors that might predict poor inhaler technique and treatment adherence.

Patients and Methods

Study Design

We performed a descriptive, cross-sectional, multicenter study in the health care area of Granollers-Mollet, Spain; this area has 15 primary care centers serving a population of 342 093 inhabitants, of whom 6.6% (n=22 517) are older than 74 years. The subjects selected for inclusion were informed of the purpose and characteristics of the study and its implications, and consent was obtained from all those who agreed to participate.

Patients

We included all patients over 74 years assigned to health care centers in the study area (including those living in nursing homes) who had been receiving inhaled drugs to treat a respiratory disorder for over 3 months. Excluded were patients who, at the beginning of the study, were hospitalized, had serious hearing problems, could not be located, or refused to participate.

Protocol

Patients were recruited by simple random selection and the following data were recorded from their medical history: age, sex, institutionalization, carer assistance, inhaled drugs and regimen, initial indication, and concomitant use of drugs which might exacerbate the underlying disease (β -blockers, angiotensin-converting enzyme [ACE] inhibitors, anxiolytics, and sedatives).

Patients were contacted by telephone and asked by a nurse if they would like to participate in the study; those who consented to do so were scheduled for an interview at their home. During this interview, the nurse noted the drug regimen followed by the patient and any adverse effects he/she reported to have experienced. Evaluations included a basic geriatric assessment and a study of adherence to treatment and inhaler technique.

Airway function was assessed by spirometry (including a bronchodilator test) performed in accordance with the recommendations of the Spanish Society of Pulmonology and Thoracic Surgery (SEPAR).¹⁰ Spirometry tests were not performed in patients whose medical history included spirometry results from the previous 6 months or if the nurse considered that the patient might have difficulty cooperating.

The following instruments were used for the basic geriatric assessment: the Pfeiffer test (cognitive function), the Barthel index (functional evaluation), the Lawton-Brody test (instrumental activities of daily living), the Yesavage test (depression), and the Gijon test (social evaluation).¹¹⁻¹⁶ Cognitive impairment was considered to be moderate or serious when patients made 5 or more errors in the Pfeiffer test and functional dependence was classified as considerable or total for patients with a Barthel index score of 45 or less. Women with a score of 3 or less in the Lawton-Brody test and men with a score of 0 or 1 were considered to be very or fully dependent in terms of instrumental activities of daily living. Using the Yesavage test, depression was classified as stable in patients with a score of 9 or more and mild in those with a score of between 6 and 9. Finally, patients were considered to be at social risk if they scored 10 or higher on the Gijon test.

Adherence to treatment was assessed using the Morisky-Green test,¹⁷ which indicates whether or not a patient is following the prescribed regimen correctly and if not, whether this is due to forgetfulness, an improvement in symptoms, or discomfort. The test consists of 4 questions on adherence and this is considered to be good if the patients answer all these items satisfactorily.¹⁷

To assess inhaler technique, we used the scoring system designed for different inhaler devices by the authors of the EDEN study.¹⁸ We used the EDEN scoring system for Turbuhaler and Accuhaler devices to design similar scales for Handihaler and Aerolizer devices; in other words, we applied the same score correlation system in the same steps and took into consideration SEPAR guidelines on inhaled drug use.¹⁹ All scores were expressed as percentages of the maximum attainable score for each device in order to facilitate comparison between devices. Inhaler technique was considered acceptable if a patient scored over 75%.

Statistical Analysis

Having determined that 8% of patients over 74 years of age in the study area were on long-term inhaled medication, a sample size of 117 patients was needed, assuming an α risk of 5% and a β risk of 5% in a 2-tailed comparison. For the descriptive analysis, qualitative variables were expressed as absolute numbers and percentages and quantitative variables as means (SD).

The χ^2 test was used to analyze the association between sex and type of respiratory disorder, treatment adherence, main drug prescribed, and type of inhaler device used. The *t* test for independent samples was used to study the association between age and type of respiratory disorder, geriatric assessment score, and treatment adherence. Finally, the association between type of inhaler device and both inhaler technique and age was analyzed using single-factor analysis of variance (ANOVA). When statistically significant differences were observed between groups, comparisons were done using the Gabriel test, which is appropriate for unequal group sizes. Inhaler technique was also analyzed by stratifying inhalers by the main drug prescribed; for cases which did not comply with ANOVA applicability hypotheses, we used the nonparametric Kruskal-Wallis test.

Statistical significance was set to a level of $P < .05$. All the variables analyzed were entered into a unified Microsoft Access database and data were analyzed using the Statistical Package for Social Sciences software package, version 11.5 (SPSS, Chicago, Illinois, USA).

Results

Study Population

We selected 117 patients, of whom 24 (21%) refused to participate in the study; the total number of subjects included was therefore 93. There were no significant differences in terms of age or sex between those who participated and those who refused to participate in the study.

The mean (SD) age of the participants was 81.8 (4.4) years; 26% (n=24) were women and 74% (n=69) men. Fourteen patients (15%) had a carer responsible for medication and only 2 (2%) were institutionalized. Table 1 shows the indication for which inhaled therapy was prescribed; this information was not available for 21 patients (23%).

Spirometry

Spirometric values were recorded for 86 patients (92%), of whom 75 (87%) had a respiratory abnormality; this was obstructive in 62 cases (72%) and restrictive in 13 (15%). The mean (SD) maximum forced expiratory volume in 1 second was 1147.4 (423.8) mL/s (52.1% [20.4%] of predicted). Analysis by sex revealed that restrictive disorders were more common in women (29%) than in men (11%) and that obstructive disorders were more common in men (82%) than in women (43%) ($P<.05$). Thirty seven percent of patients experienced an increase in lung function of over 11% compared to baseline during the bronchodilator test (36% of all men and 40% of all women).

Basic Geriatric Assessment

Five patients (5.4%) had moderate or severe cognitive impairment. Two patients (2.2%) had considerable or total functional dependence and 13 (14%) had considerable or total dependence in terms of instrumental activities of daily living. Those in the former group were, on average, 8.3 years older than the group as a whole (95% confidence interval [CI], 2.2-14.4 years) while those in the latter group were, on average, 5.3 years older (95% CI, 2.8-7.7 years).

Twenty patients (23%) had symptoms of mild depression and 5 (5.4%) (all men) had stable depression. Depression was the only factor in the basic geriatric assessment for which there was a significant difference between men and women ($P=.012$).

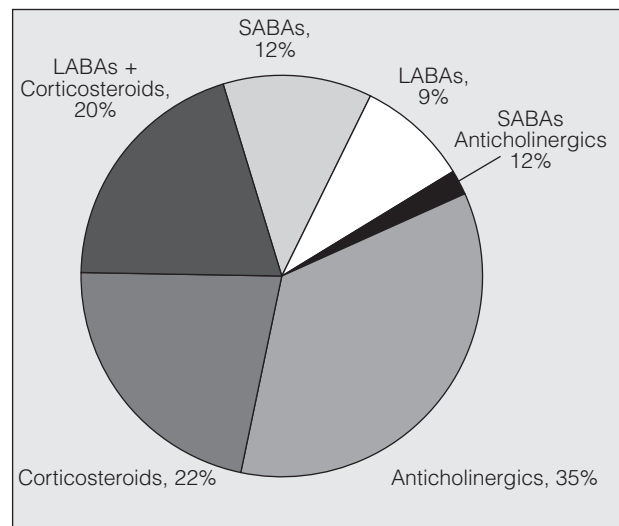


Figure. Drugs prescribed (n=171). SABAs indicate short-acting β -adrenergic agonists; LABAs, long-acting β -adrenergic agonists.

Forty percent of patients were found to be at psychosocial risk and these were, on average, 2.5 years older than the group as a whole (95% CI, 0.6-4.4 years).

Pharmacotherapy

The 93 patients included in the study had been prescribed 171 inhaled drug treatments (see the corresponding types of drug in the Figure). A third of the drugs prescribed were anticholinergic agents and almost a quarter were corticosteroids. The drugs prescribed and their frequency are shown in Table 2.

Adverse effects were reported by 12 patients (13%). The most common of these was irritation of the oral mucosa (n=5), followed by dysphonia (n=3), oral candidiasis (n=2), pharyngeal pruritus (n=1), and dryness of the mouth (n=1). All of these patients were taking inhaled corticosteroids, either alone or in combination with a β_2 adrenergic agonist.

Almost a quarter of all patients (24%, n=22) were receiving concomitant treatment with a drug capable of exacerbating their underlying disease. These were anxiolytics or sedatives in over half of the group (55%, n=22), ACE inhibitors in 36% of the group (n=8), and β -blockers in 9% (n=2).

TABLE 1
Diagnoses by Sex (n=72)^a

Men			Women		
Clinical Diagnosis	No. of Patients	%	Clinical Diagnosis	No. of Patients	%
COPD	42	77.8	Asthma	10	55.6
Asthma	7	13.0	COPD	4	22.2
Chronic bronchitis	3	4.3	Chronic bronchitis	2	11.1
Bronchiectasis	1	1.9	Bronchiectasis	1	5.6
Respiratory insufficiency	1	1.9	Bronchospasm	1	5.6
Total	54	100	Total	18	100

Abbreviation: COPD, chronic obstructive pulmonary disease.
^aData not available for 21 patients.

TABLE 2
Drugs Prescribed (Alone or in Combination)

Drug or Drug Combination	No.	%
Ipratropium	41	24
Budesonide	31	18.1
Fluticasone/salmeterol	21	12.3
Salbutamol	18	10.5
Tiotropium	18	10.5
Budesonide/formoterol	13	7.6
Salmeterol	10	5.8
Formoterol	6	3.5
Beclomethasone	4	2.3
Fluticasone	3	1.8
Salbutamol/ipratropium	3	1.8
Terbutaline	3	1.8
Total	171	100

Inhaler Devices

All the inhaler devices described in this study are standard devices that are readily available on the market; they include manually actuated pressurized metered-dose inhalers (pMDIs), which need to be activated by the patient, and breath-actuated pMDIs, which are automatically activated when the patient inspires. Also used were large-volume spacer devices, which are attached to pMDIs to facilitate use and improve drug delivery; dry powder inhalers (DPIs) such as Accuhaler or Turbuhaler, which release specific doses of drug to be inhaled by the patient; and capsule-based inhalers such as Aerolizer and Handihaler, which also release powder by piercing a capsule containing the drug.

The majority of inhaler devices used in the study were large-volume spacer devices (35%, n=60), followed by pMDIs (26%, n=45), DPIs (25%, n=42) and capsule-based devices (14%, n=24). We observed a significant association

between inhaler device and drug prescribed ($P<.001$). Table 3 shows the type of device used for each drug or drug combination and the frequency with which it was used. pMDIs were used for short-acting β_2 -adrenergic agonists in 52% of cases whereas spacer devices were preferred for long-acting β_2 -agonists (44% of cases). pMDIs and spacers were used to a similar degree for corticosteroids (40% and 34%, respectively) and DPIs were only used in 21% of cases. The most common inhaler devices for anticholinergic agents were spacer devices (44%), DPIs (32%), and pMDIs (24%). Finally, the most common device for combinations of corticosteroids and long-acting β -adrenergic agonists was the DPI (88%).

Treatment Adherence and Agreement Between Treatment Prescribed and Treatment Followed

Adherence to treatment, measured using the Morisky–Green test, was 44% (n=41) and there were no significant differences in terms of age, sex, or type of respiratory disorder. The level of agreement between treatment prescribed and treatment followed was 64% (n=109), with no significant differences when analyzed by sex, age, drug type, or inhaler device used.

Inhaler Technique Assessment

Because this was a descriptive study, participants received no prior training on inhaler use, although they may have received instructions on correct usage from nursing staff as this is common practice in primary care centers.

The lowest score obtained was 30 and the highest 100; a score of over 75 was recorded in 40% of cases. Inhaler technique scores were not found to be correlated with any of the variables analyzed (age, sex, type of respiratory disorder, carer assistance, basic geriatric score, treatment adherence, or level of agreement between treatment prescribed and treatment followed). Table 4 shows the

TABLE 3
Inhaler Device Used by Drug or Drug Combination

Drug	Total	Meter-Dosed Inhalers ^a		Spacer Devices		Dry Powder Inhalers		Capsule-Based Inhalers	
		No.	%	No.	%	No.	%	No.	%
Salbutamol	18	10	56	8	44	–	–	–	–
Terbutaline	3	1	33	–	–	2	67	–	–
SABAs (subtotal)	21	11	52	8	38	2	10	–	–
Formoterol	6	1	17	2	33	–	–	3	50
Salmeterol	10	3	30	5	50	2	20	–	–
LABAs (subtotal)	16	4	25	7	44	2	12	3	19
Beclomethasone	4	2	50	2	50	–	–	–	–
Budesonide	31	13	42	8	26	8	26	2	6
Fluticasone	3	–	–	3	100	–	–	–	–
Corticosteroids (subtotal)	38	15	40	13	34	8	21	2	5
Ipratropium	41	14	34	26	63	–	–	1	2
Tiotropium	18	–	–	–	–	–	–	18	100
Anticholinergics (subtotal)	59	14	24	26	44	–	–	19	32
Budesonide/formoterol	13	–	–	1	8	12	92	–	–
Fluticasone/salmeterol	21	–	–	3	14	18	86	–	–
Corticosteroids/LABAs (subtotal)	34	–	–	4	12	30	88	–	–
Salbutamol/ipratropium	3	1	33	2	67	–	–	–	–
Anticholinergics/SABAs (subtotal)	3	1	33	2	67	–	–	–	–
Total	171	45		60		42		24	

Abbreviations: LABAs, long-acting β -agonists; SABAs, short-acting β -agonists.
^aIncludes manually actuated and breath-actuated pressurized metered-dose inhalers.

mean score for each inhaler device. Statistically significant differences were observed when inhaler technique was analyzed by type of device ($P < .001$).

Analysis of inhaler technique by device (stratified by drug) showed that the highest scores were obtained when capsule-based inhalers were used to administer anticholinergic agents ($P = .001$) and when PDIs were used to administer corticosteroids concomitantly with long-acting β_2 -agonists ($P = .022$).

Discussion

According to the IBERPOC study, chronic obstructive pulmonary disease (COPD) is underdiagnosed in Spain in subjects aged 40 to 69 years.²⁰ Although we studied a different age group, COPD was also probably underdiagnosed and, consequently, undertreated in our patients. This would also explain why a high percentage of patients were on long-term inhaled medication even though there was no mention of COPD diagnosis in their medical records. Nonetheless, the most common diagnosis in our population was COPD, which affected more men than women. Asthma, in contrast, was more common in women. There were no differences between those who participated and those who refused to participate in the study in terms of age or sex.

When analyzing inhaler technique and treatment adherence in patients with carers, we recorded the final result with the carer as, although assistance with medication might have counteracted the possible impact of cognitive impairment, we considered it a truer reflection of actual drug use.

Geriatric assessment provides tools to determine whether or not age-related deterioration has occurred. Inhaler technique did not differ significantly according to the degree of deterioration measured by any of the tools used. While it has been reported that pMDI technique starts to deteriorate in patients when they develop moderate dementia,²¹ the overall level of cognitive impairment in our study was low. Furthermore, our patients also used other inhalers, possibly chosen in accordance with their particular needs. The tests used in our geriatric assessment are common and easy to implement in routine practice although more sophisticated tools might have yielded more accurate results. The screening tests used in this study (Pfeiffer¹¹⁻¹⁶ and Yesavage¹²), for example, are designed solely to detect disease. Other tools such as the mini-mental state test by Folstein^{22,23} or indeed other neuropsychological tests are required to reach a definitive diagnosis but these cannot be used in routine practice as they are complex and need to be administered by trained professionals. The simple, routine tests used in our study to detect age-related deterioration might not be a good means of predicting optimal use of inhaler devices.

It is interesting to note that many subjects in our group were taking drugs that were contraindicated for their condition and might have exacerbated their underlying disease. The most common drugs prescribed were anticholinergic agents, followed by, in descending order of frequency, corticosteroids alone and corticosteroids in combination with long-acting β -adrenergic agonists (corresponding to the diagnoses recorded in the patients'

TABLE 4
Inhaler Technique Scores by Inhaler Device

Device	No. of Devices	Mean Score ^a	95% CI	
Meter-dosed inhalers ^b	45	71.71	67.47	75.95
Spacer devices	60	67.64	64.03	71.25
Dry powder inhalers	42	78.33	73.14	83.53
Capsule-based inhalers	24	85.76	79.76	91.77
Total	171	73.88	71.48	76.28

Abbreviation: CI, confidence interval.

^aExpressed as percentage of maximum attainable score for each device.

^bIncludes manually actuated and breath-actuated pressurized metered-dose inhalers.

medical histories). Although it is generally recommended that pMDIs should be used with a spacer device, in our study, pMDIs alone were used more than pMDIs with a spacer for administering inhaled corticosteroids, in agreement with findings by Carrión et al.⁴

The most common inhaler device in our group was the large-volume spacer device, possibly indicating that physicians are taking patient limitations into consideration when prescribing inhaler devices. Nevertheless, our findings do not confirm reports that spacers have more advantages than pMDIs for elderly patients.²⁴ While spacer devices were more common in our group than any other inhaler device, we found that DPIs were easier to use, coinciding with findings by Allen and Zaman.²⁵ Finally, capsule-based devices provided the best results for administering anticholinergic agents and corticosteroids. In 2001, Lindsey et al²⁶ reported that DPIs were not often used in patients over 65 years, even though patient acceptance was higher than for other devices. In our study, we used a greater number and variety of devices.

Inhaler technique did not differ significantly from one device to another, except in the case of capsule-based devices, perhaps because they are easier to use.

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