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ORIGINAL RESEARCH ARTICLE

Inhaler Technique and Self-reported Adherence to Medications Among Hospitalised People with Asthma and COPD

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Abstract

Background Metered dose inhalers (MDIs) and dry powder inhalers (DPIs) are devices used for the treatment of asthma and chronic obstructive pulmonary disease (COPD). Inhaler technique is important since incorrect technique can lead to a poorer prognosis and hospitalization.

Objective The objective of this study was to investigate the inhaler technique and overall adherence to medications in an adult population with asthma and COPD.

Patients and Methods Those invited to participate were people admitted to Umeå University Hospital in northern Sweden in October, November and December 2018, with inhaled medication prescribed prior to admission. Inhaler technique was assessed using checklists and observations with placebo-inhalers were conducted. The Medication Adherence Report Scale (MARS)-5 was used to measure self-reported overall adherence to drug medication.

Results Of the 23 people included in the study, 26.1% had one or more critical errors in inhaler technique and 30.4% were considered overall non-adherent to drug medication. Among the 23 participants, the mean age, and the number of regularly prescribed medications were higher among those with poor inhaler technique than among people with no error in their inhaler technique.

Conclusion This study indicates that poor inhaler technique and overall non-adherence to medications occur among hospitalised people with asthma and COPD living in northern Sweden. Interventions to improve inhaler technique and adherence to drugs are needed.

Key Points

Incorrect inhaler technique among people with asthma and COPD has been a problem for many years, and it does not seem to have been resolved.

There are currently a variety of medication inhaler devices with different critical steps involved. This might be confusing for the users, and requires knowledge and skills among the medical professionals who will teach inhaler techniques to the users.

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1 Introduction

Asthma and chronic obstructive pulmonary disease (COPD) are chronic inflammatory diseases that affect the airways. Asthma is common in all age groups while COPD is more common in older people [1, 2]. The prevalence of asthma varies between different age groups, but according to WHO, 339.4 million people worldwide were affected by asthma in 2016, corresponding to a prevalence of about 4.6% [1]. According to one meta-analysis, the global prevalence of COPD is 11.7% [3]. In Sweden, the reported prevalence of asthma and COPD among adults is estimated to 10% and 8.5%, respectively [4]. The use of an inhaler is the main administration method for medication in the treatment of asthma and COPD. The two main types of inhaler used are metered dose inhalers (MDIs) and dry powder inhalers (DPIs). MDIs are driven by an aerosol and DPIs are driven by the user's own inhalation and breath. In general, when using an MDI, the user needs to coordinate their breathing and actuation to ensure the effectiveness of the inhaled drug. In contrast, DPIs are breath-actuated, and the user

needs to inhale in a rapid and powerful way to ensure drug delivery [5]. However, all inhalers require several steps in order for the user to receive adequate medication. Some steps are more important than others and are termed critical steps. If these steps are not performed correctly, i.e. the user makes critical errors, some or all drug substances will not reach the lungs and their site of action [5, 6].

Inhaler technique is important, since incorrect technique can lead to a poorer prognosis for both asthma and COPD and an increased risk of hospitalization [5, 7, 8]. Further, poor inhaler technique contributes to avoidable costs associated with the management of asthma and COPD [9]. Extensive research has found that errors in inhaler technique are common [8, 10, 11]. Several factors have been associated with high inhaler error frequency, such as age, educational status, and lack of previous inhaler instruction [12]. As well as correct inhaler technique, another critical component in treating asthma and COPD people is adherence to medication. Non-adherence to inhaled medication has been associated with a higher morbidity and mortality risk among people with COPD [13]. However, non-adherence to inhaled medication and to medications overall is common among COPD and asthma people according to several studies [14–17]. It has also been found that adherence to treatment of COPD is lower than to other diseases [18].

In Sweden, mostly community pharmacists inform people using inhalers technique, but also other health professionals are involved in training, for example COPD nurses in hospital wards. Although many studies have been performed regarding inhaler technique in other countries, less is known about the relationship between overall adherence to medications, different factors such as gender, age, number of medications, and poor inhaler technique in elderly with comorbidities, and especially in a Swedish population. The aim of this descriptive study is therefore to investigate inhaler technique and overall adherence to medication in a cohort of people with asthma and COPD admitted to a hospital in northern Sweden. Specific objectives were to (1) assess inhaler technique (frequency and type of critical errors), (2) assess self-reported overall adherence to medications and (3) describe people with and without poor inhaler technique in persons with asthma and COPD admitted to a hospital in northern Sweden.

2 Materials and Methods

2.1 Study Design and Study Population

The study design is a prospective cross-sectional convenience sample. Those invited to participate were people admitted to the orthopaedic, geriatric and medical wards at Umeå University hospital in October, November and December 2018, with inhaled medication prescribed before admission. People using inhalers were identified by clinical pharmacists or by nurses working on the different wards. The persons were then asked if they would like to participate in the study. Persons were invited to participate the days when the pharmacist who did the observations was present, which was two days a week. All people, 18 years or older, except those with a dementia diagnosis were invited to participate. The orthopaedic, geriatric and medical wards were chosen because there were clinical pharmacists working in these specific wards. In order to fulfil the aim of this study observations regarding inhaler technique were performed and the persons were asked questions regarding their medication.

2.2 Definition of Poor Inhaler Technique

Checklists for each inhaler type were developed. These checklists and the definition of critical errors were based on previous research and manufacturer developed checklists (Online Appendix 1). The checklists were developed together with the COPD nurse and COPD physician working at the specific hospital. The checklists include critical and non-critical steps for each inhaler. A participant was defined as having poor inhaler technique if one or more critical steps was not correctly performed. Placebo-inhalers were used in the observations. No instructions were given beforehand. Only one observation per inhaler type was performed. For example, if a person had two turbuhalers, only one observation was performed. If one person had different type of inhalers, one observation per inhaler were performed, resulting in more observations than number of people.

2.3 Definition of Overall Non-adherence to Medication

The Medication Adherence Report Scale (MARS)-5, a validated scale that has been translated into Swedish, was used to measure self-reported overall adherence to medication [19, 20]. MARS-5 consists of five general statements about nonadherent behaviour. The five statements are; I forget to take my medicines, I alter the dose of my medicines, I stop taking my medicines for a while, I decide to miss out a dose, I take less than instructed. These are answered on a 5-point Likert scale (1 = always, 2 = often, 3 = sometimes, 4 = rarely, 5 = never). The scores were summed with a possible range of 5–25. A score of 5–22 was considered non-adherent and a score of 23–25 was considered adherent, according to previous research [19].

2.4 Background Data and Questions Asked

If the persons agreed to participate, background information about the person and about the type of inhaler used was collected from their electronic medical record. Background data collected from the electronic medical record were information about gender, age, living situation, diagnoses, number of medications, and years of using inhalers.

In addition, the participants were asked some questions concerning their general medications and their inhalation devices. The following questions were asked;

- Have you previously received instruction on how to use your inhaler?
- Do you find your inhaler easy or difficult to handle?
- Do you have someone to help you with your medications?

Further, to assess self-reported overall adherence, the persons were asked the questions included in MARS-5.

These questions as well as observations regarding inhaler technique were performed on the wards at the persons' bedside. All observations were made and assessed by one community pharmacist with experience from informing users about inhaler technique.

2.5 Statistical Analysis

Descriptive statistics were used to summarize the data. Frequencies and proportions were calculated for dichotomous variables, and continuous variables are presented as mean values with standard deviations.

SPSS 25 for MacOS X was used for data handling.

3 Results

A total of 38 people were asked to participate in the study. Of these, seven women and five men declined to participate in the study, while three persons were excluded since their ability to talk and understand was impaired due to disease. In total, 23 individuals were included in the study. Of these individuals patients, 78.3% were women and their mean age was 65 (±16.2), range 22 to 86 years old. Asthma was the most common reason for using an inhaler. The average number of medications was 7.2 (±4.2), range 1 to 17 and the mean number of years of using an inhaler was 9.0 (±11.1), range between 0 and 48 years. For more background data, see Table 1.

Out of 34 observations (29 DPIs and 5 MDIs) in 23 participants, a total of 14 critical errors were observed. Six of the 23 participants (26.1%) were found to have one or more critical errors in inhaler technique. The most common critical errors were regarding charging and positioning of the inhaler (5 out of 14 critical errors) and regarding inhaling/breathing through the inhaler (5 out of 14 critical errors). Other critical errors observed were errors regarding placing the lips and teeth around the moutpiece (2 out of 14 critical errors). In the 29 observations with DPI there were a total of ten critical errors, and in the five observations with MDI there were four critical errors. See Online Appendix 2 for more details. The most frequent non-critical error in inhaler technique was that the participants did not check that there were doses in the inhaler before inhalation.

When describing participants with no errors and those with one or more critical errors in their inhaler technique, the number of regularly prescribed medications was higher among those with poor inhaler technique (Table 1). The mean age in this group was more than ten years higher compared to the group with no error in their inhaler technique.

There were more adherent people (69.6%) than non-adherent participants (30.4%) concerning the general use of medications according to MARS-5 among the 23 participants (Table 1). Table 2 presents responses to all five statements included in MARS-5.

4 Discussion

This study found that 26.1% of participants included had one or more critical errors in their inhaler technique, and 30.4% were non-adherent according to the MARS-5 scale. Among the 23 participants, the mean age, and the number of regularly prescribed medications were higher among those with poor inhaler technique than among participants with no error in their inhaler technique.

The prevalence of people with poor inhaler technique is in line with or lower compared to other studies, where ranges from 24 to 40% have been found [21, 22]. In these studies, one or more critical steps not correctly performed is defined as having poor inhaler technique, as in the present study. As can be expected, in studies measuring total errors in inhaler technique, where a distinction between critical and non-critical steps is not made, a higher prevalence ranging from 71 to 82% [23–25] has been found. Since critical errors can be defined as errors that significantly impair the delivery of adequate medication to the lungs [12], using critical errors as a definition is likely to provide a more clinically relevant picture, presuming that there are evidence that the critical errors are critical. Although Price et al. did identify critical errors associated with asthma outcomes among some devices [26], there is a wide variety in how critical errors are defined [12]. Nevertheless, the results from the majority of studies, including the present one, conclude that incorrect use of inhalers is a common problem. In addition, studies

Table 1 Description of people with and without errors in inhaler technique

	Patients with no error in their inhaler technique ($n=17$)	Patients with one or more error in their inhaler technique ($n=6$)	Total, $N=23$
Gender *n* (%)			
Women	12 (70.6)	6 (100.0)	18 (78.3)
Age Mean (SD)			
Years	62.1 (±17.0)	73.2 (±11.1)	65.0 (±16.2)
Age *n* (%)			
<65	9 (52.9)	1 (16.7)	10 (43.5)
65–75	6 (35.3)	2 (33.3)	8 (34.8)
>75	2 (11.8)	3 (50.0)	5 (21.7)
Diagnoses related to inhaler *n* (%)			
COPD	1 (5.9)	3 (66.7)	4 (26.1)
Asthma	14 (82.3)	2 (50.0)	16 (73.9)
COPD and asthma	1 (5.9)	1 (16.7)	2 (8.7)
Other	1 (5.9)	0 (0.0)	1 (4.3)
Other diagnoses *n* (%)			
Heart failure	2 (11.8)	1 (16.7)	3 (13.0)
Hypertension	8 (47.1)	1 (16.7)	9 (39.1)
Atrial fibrillation	1 (5.9)	2 (33.3)	3 (13.0)
Diabetes mellitus	1 (5.9)	2 (33.3)	3 (13.0)
Cancer	4 (23.5)	0 (0.0)	4 (17.4)
Myocardial infarction, past	1 (5.9)	2 (33.3)	3 (13.0)
Stroke, past	1 (5.9)	0 (0.0)	1 (4.3)
Living situation* *n* (%)			
Living alone	7 (41.2)	4 (66.7)	11 (47.8)
Living at home with a relative	9 (52.9)	2 (33.3)	11 (47.8)
Number of medications Mean (SD)			
	6.1 (±4.2)	10.5 (±1.9)	7.2 (±4.2)
Type of inhaler *n***			
MDI	2	3	5
DPI	23	6	29
Years of using an inhaler Mean (SD)			
Years	8.7 (±11.7)	9.8 (±10.3)	9.0 (±11.1)
Have received instruction about use of inhalers *n* (%)			
Yes	15 (88.2)	5 (83.3)	20 (87.0)
No	2 (11.8)	1 (16.7)	3 (13.0)
Have someone who helps them with their medications *n* (%)			
Yes	1 (5.9)	0 (0.0)	1 (4.4)
No	16 (94.1)	6 (100.0)	22 (95.6)
Find their inhaler difficult to handle *n* (%)			
Yes	3 (17.6)	1 (16.7)	4 (17.4)
No	14 (82.4)	5 (83.3)	19 (82.6)
MARS-5			
Non-adherent participants (5–22 p) *n* (%)	5 (29.4)	2 (33.3)	7 (30.4)
Adherent participants (23–25 p) *n* (%)	12 (70.6)	4 (66.7)	16 (69.6)

MARS-5 Medication Adherence Report Scale, *p* points, *SD* standard deviation

*Data is missing for one person

**No percentages are presented since one person could have demonstrated inhaler technique in more than one MDI or DPI. The total number of observations were 34

Table 2 Prevalence of MARS-5

MARS-5	1 = Always	2 = Often	3 = Sometimes	4 = Rarely	5 = Never
I forget to take my medicines	0 (0.0)	0 (0.0)	4 (17.4)	12 (52.2)	7 (30.4)
I alter the dose of my medicines	0 (0.0)	0 (0.0)	1 (4.3)	1 (4.3)	21 (91.3)
I stop taking my medicines for a while	0 (0.0)	0 (0.0)	4 (17.4)	4 (17.4)	15 (65.2)
I decide to miss out a dose	0 (0.0)	0 (0.0)	1 (4.3)	2 (8.7)	20 (87.0)
I take less than instructed	0 (0.0)	0 (0.0)	0 (0.0)	1 (4.3)	22 (95.7)

MARS-5 Medication Adherence Report Scale

from as early as 1990 suggest that there is a problem with inhaler technique in people with asthma and COPD [27, 28]. This indicates that incorrect use of inhalers has been a problem for many years, and it does not seem to have been resolved.

Regarding which were the most common mistakes when using an inhaler, almost all of the participants failed to check how many doses were left in the inhaler before using it. This can result in users inhaling from empty inhalers, which may lead to a deterioration of the disease due to lack of effective treatment. This result is similar to a previous study investigating turbuhalers and accuhalers [11]. This step was not applied as a critical error in the checklists in the present study. However, the participants might intentionally have skipped this step, since they knew they were using placebo inhalers and therefore did not think they needed to check the dose counter. Concerning the distribution of critical steps, two of four critical errors for MDIs were related to breathing, a common mistake also found in other studies [29]. Nevertheless, no clear pattern could be seen overall. This result probably reflects the variety of devices, with different critical steps for different devices.

Another factor that was investigated in the present study was the prevalence of self-reported overall non-adherence to medications. The prevalence of overall non-adherence to medications was 30.4%. This is lower than in other studies, where prevalence up to 58% have been found [11, 15]. However, non-adherence specifically to COPD-medications was measured in these studies, not to medications in general as in the present study. Further, there were 29.5% self-reported non-adherent participants according to MARS-5 among those who performed critical errors in inhaler technique, and 33.3% self-reported non-adherent participants among those who did not. One study found a predictive relationship between inhaler technique maintenance and self-reported adherence among people with asthma [30]. One reason that the distribution of self-reported non-adherent people were quite similar between the two groups in the present study may be the low number of participants or possibly because MARS-5 might not be a good method for measuring adherence in patients with COPD, as found in other studies [31]. Besides, self-reported questionnaires generally tend to overestimate adherence [32].

When describing the groups with and without critical errors in inhaler technique, this study found that among the 23 participants, it was more common to have a higher number of medications in the group with poor inhaler technique compared to the group with no critical errors. Also, the mean age was more than ten years higher in the group with critical errors in inhaler technique. Previous research has indicated that increased age is associated with poor inhaler technique [8]. Further, other studies have found an association between people with poor inhaler technique and lack of instruction about inhaler technique [8, 21]. According to one study, many participants did not carefully read the instructions for use provided, even for an unfamiliar device [33]. It is, therefore suggested that all people should be given a thorough instruction in how to use the inhalers and time to practice in order to minimize the risk of their disease becoming worse, possibly leading to hospitalization, as a result of poor inhaler technique [5, 7, 8].

Other factors previously found associated with poor inhaler technique are for example lower schooling and severity of obstruction [8, 21]. Cognitive impairment has also been identified as a factor related to poor adherence and frequent errors in technique among people with COPD [34]. These factors are all interesting, however, these were not investigated in the present study.

This study has some limitations to consider. First, and most important, the number of people included in the study was limited. Besides, this is a single-center experience and the results may not extend to all hospitalized people. Due to the small sample size results may be over or under-stated, and they may not be generalizable. The results should be interpreted with caution. People from orthopaedic, medical and geriatric wards were recruited. If people admitted for respiratory conditions had been recruited, the results regarding poor technique may have been different. Further, people who are in hospital and unwell may perform poorly with regard to inhaler technique because they are not feeling well. Another limitation in this study is that for many of the errors defined as critical in this study, there is no evidence that

these are critical in terms of for example increased exacerbation rate. Also, whether the participants inhaled the DPIs with enough force was not taken into consideration in this study. The observations were not video-recorded and therefore assessed only by the pharmacist who met the patient. Regarding the results of the MARS-5 scale, most of the participants were lying in a room together with other people, which might have affected their answers. Nevertheless, our main results are in line with the published literature and indicate poor inhaler technique and a suboptimal general adherence among this group of people. Further, as far as we know, not many studies regarding inhaler technique have been performed in a Swedish setting. The results indicate that there is a problem with inhaler technique also in Sweden, and the study might be served as a pilot to a larger study. More research is also needed as to how adherence can be improved.

5 Conclusions

This study indicates that poor inhaler technique and overall non-adherence to medications occur among hospitalised people with asthma and COPD living in northern Sweden. In this small single-center study, people with poor inhaler technique have a higher number of medications compared with those with correct inhaler technique. However, to confirm the results of this study, a study with a higher number of participants is needed.

Declarations

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Conflict of interest The authors declare no conflict of interest.

Ethical approval This study has been approved by the Regional Ethical Review Board in Umeå (registration number 2018-165-31M). People participating in the study were given written and orally presented information about the research. Informed consent was obtained from all individual participants included in the study before the observations and the interviews were conducted.

Consent for publication Not applicable.

Consent to participate Not applicable.

Code availability (software application or custom code) Not applicable.

Data availability All data generated or analysed during this study are included in the paper or its supplementary files.

Author contributions Astrid Elander and Maria Gustafsson contributed to the study design; Maria Gustafsson analysed the data and Astrid Elander prepared the manuscript. All authors critically revised, contributed with comments and approved the final version of the manuscript.

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