Research Article

ASSESSMENT OF INHALATION TECHNIQUES IN COPD PATIENTS USING METERED-DOSE INHALER AND ROTAHALER AT A TERTIARY CARE HOSPITAL IN NEPAL

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ABSTRACT

Inhalation technique is main therapy of chronic obstructive pulmonary disease (COPD). Incorrect usage of inhaler devices might have a major influence on the clinical effectiveness of the delivered drug. This issue is poorly addressed in management guidelines. The present study was carried out with an objective to assess the inhalation techniques in hospitalized patients with COPD using Metered Dose Inhalers (MDI) and rothaler. The study consists of all hospitalized patients diagnosed with COPD above 40 years who are using MDI and rothaler. The study was an institution based prospective and descriptive study done for 8 weeks. The data of the study was analysed using SPSS 20.0 version and Microsoft Excel 2007. Of 100 patients with COPD (mean age 68 years), most of the patients were illiterate (75%) with smoking habit (36%) and smoking history (48%). 84% patients do not use their inhalers correctly, the most common errors being "not exhaling to residual volume" and "not holding breath for 5 seconds". While using MDI, apart from above mentioned errors, the other frequent errors were not continuing slow and deep inhalation, not shaking the inhaler and not inhaling slowly and pressing canister. While using rothaler, the other common errors apart from afore mentioned errors were not inhaling powder forcefully and deeply and not exhaling away from mouth piece. From the present study it can be concluded that incorrect inhalation techniques is common among COPD patients. The success of COPD management is highly dependent on correct use of inhalers. Thus, trainings, verbal instruction and technique assessment and reassessment are considered necessary to make patients use their inhalers correctly.

Key words: COPD, inhalation techniques, inpatients, Metered-dose inhaler, Rothaler

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) defines a group of diseases that includes chronic bronchitis and emphysema, and patients are prone to frequent exacerbations of symptoms that range from chronic cough and sputum production to severe disabling shortness of breath, leading to significant impairment of quality of life. COPD is a highly prevalent disease and has a large impact on quality of life for patients. COPD is defined as a disease state characterized by progressive airflow limitation that is not fully reversible and is associated with an abnormal inflammatory response of the lungs to noxious particles or gases, primarily cigarette smoke. Bronchodilators like β_2 -sympathomimetics, methylxanthines, anticholinergics and inhaled corticosteroids are used in treatment of COPD.¹

Two types of inhaler are in common use: metered dose inhalers (MDIs) and dry powder inhalers (DPIs). Both have their advantages and disadvantages. MDIs are small, easy to carry, and deliver at least 100 doses, but they require good hand lung coordination to achieve the best results. DPIs, being breath actuated, are unaffected by hand-lung coordination, but patients need an inspiratory flow of more than 30 L/minute which might prove difficult to achieve for patients with severe COPD.²

The use of inhaled therapy has a number of advantages over systemic (oral or intravenous) administration. The inherent advantages of aerosol drug delivery are faster onset of pharmacological action, since the drug is being delivered to the site needing therapeutic effect, and a lower systemic bioavailability, which decreases potential adverse effects.³ A survey conducted by Palen *et al* in inhalation technique in 123 patients with COPD

revealed that one third failed to use their inhaler effectively.² Numerous studies in Outpatient settings have documented the misuse of MDIs. Misuse of MDI is also prevalent among healthcare workers and may be in part responsible for MDI misuse among hospitalized patients.⁴ A large proportion of patients prescribed inhaled medications do not use their inhalers correctly. Overall, up to 90% of patients show incorrect technique in clinical studies with either standard pressurized metered dose inhalers (pMDIs) or dry-powder inhalers (DPIs). Incorrect use of inhalers is associated with poorer asthma control. With short-acting beta2 agonists (relievers), poor inhaler technique results in loss of bronchodilator effect. Among patients using standard pMDIs without a spacer, failure to coordinate inspiration with actuation has been shown to result in reduced lung deposition of medication. Incorrect use of pMDIs for inhaled corticosteroids (ICS) has been associated with increased reliever use, increased use of emergency medical services, worsening asthma and higher rates of asthma instability as assessed by a general practitioner. These outcomes are most pronounced among patients with poor inspiration-actuation coordination. Inefficient technique with DPIs may also lead to insufficient drug delivery and therefore insufficient lung deposition.⁵ Thus, this study acts as baseline information for planning an appropriate intervention at this area in order to minimize the incidence of problems related with incorrect inhalation. The present study was carried out with an objective to assess the inhalation techniques in hospitalized COPD patients using Metered Dose Inhalers and Rothaler.

MATERIALS AND METHODS

An institution based prospective descriptive study was carried out in patients in the inpatient ward of Respiratory Unit of Tribhuvan University Teaching Hospital (TUTH), a tertiary health care centre

of Nepal. The study population included the patients who were diagnosed with COPD (age above 40 years) and those who were using either MDIs or rotahalers. The study was carried out for a period of 6 months (May 2014 to October 2014). Semi-structured interview was applied to collect data from the patients. Incorrect inhalation technique was defined as one or more mistakes on preparation or breathing steps.⁶ Inhalation technique was assessed using a standardised inhaler-specific checklist. The checklist was adapted from Dutch Asthma Foundation.⁷ Data analysis was done in 20.0 version of Statistical Package for Social Sciences (SPSS) software and Microsoft Excel 2007. Association of age and sex with inhaler type was done by using Chi-square test. Similarly, association of age, occupation, education status, inhaler type, experience with MDI and experience with rotahaler with correctness of inhalation technique was analysed by using Chi-square test. A p -value < 0.05 was considered at a level of significance. Ethical clearance was taken from the Institution Review Board (IRB) of Institute of Medicine, Tribhuvan University, Kathmandu, Nepal. Verbal consent was taken from the respondents before the interview. At any point, the respondents were permitted to terminate the interview.

RESULT

Altogether 100 patients were enrolled in the study.

Demographic studies

Table 1: Age of patients

Age (Years)	Frequency (N=100)	Percent (%)
41-50	5	5
51-60	18	18
61-70	29	29
>70	48	48

The mean age of patients was 68 years. Among these patients, the greatest number was in the age group of above 70 years i.e 48%, followed by 61-70 age group with 29 %. 18% patients were admitted in age group 51-60 and 5% in 41- 50 age group (Table 1).

Education Status of patients

Table 2: Education status

Characteristics	Frequency (N=100)	Percent (%)
Uneducated	75	75
Primary	21	21
Secondary	2	2
Graduate	2	2

Most of the patients were uneducated 75(75%) while only 21(21%) patients had received primary education. Patients with secondary and graduate level of education were each 2(2%) and 2(2%) respectively (Table 2).

Smoking status of patients

Table 3: Smoking status

Characteristics	Frequency	Percent (%)
Smoker	36	36
Ex-smoker	48	48
Non smoker	16	16

The smoking habits of the enrolled patients are presented in Table 3. It showed that 36% of total enrolled patients were smoker, 48% were ex-smoker and 16% were non smoker.

Occupation of patients

Table 4: Occupation status

Characteristics	Frequency	Percent (%)
Agriculture	20	20
House wife	53	53
Employ	12	12
Business	15	15

Among the study population, 53% were house wife, 20% were farmer followed by 15% and 12% as businessman and employee respectively (Table 4).

Co-morbidities

Table 5: Co-morbidities status

Patients with underlying diseases	Frequency	Percent (%)
Yes	84	84
No	16	16

Figure 1: Underlying diseases

Figure 2: Medications prescribed

NOTE, SABA: Short acting Beta-2 agonists; Mx: Methylxanthines; Ac: Anticholinergics; Cs: Corticosteroids; CsSABA: Corticosteroids with Short acting Beta-2 agonists; CsLABA: Corticosteroids with Long acting Beta-2 agonists; SABAMx: Short acting Beta-2 agonists with Methylxanthines

Among drugs for COPD, SABA and Ac were prescribed most frequently i.e 24% each followed by CsLABA 20% and Cs 18%. Mx was prescribed for 11%. The least prescribed drugs were LABA, CsSABA and SABAMx each with 1% respectively (Figure 2).

Inhaler specific check list with item score

Table 6: Inhaler specific checklist

Item No.	MDI (22)	Item score (%)
1	Remove cap and shake the inhaler*	8
2	Hold inhaler upright	23
3	Exhale to residual volume	3
4	Keep head upright or slightly tilted	26
5	Mouth piece between teeth and lips	26
6	Inhale slowly and press canister*	14
7	Continue slow and deep inhalation*	6
8	Hold breath for 5seconds	2
Rotahaler (78)		
1	Keep the rotahaler upright*	79
2	Insert rota cap with transparent end down	73
3	Keep rotahaler horizontal	74
4	Rotate both ends to open capsule*	71
5	Exhale to residual volume	16
6	Keep rotahaler level and put mouth piece between teeth and lips	68
7	Inhale powder forcefully and deeply*	58
8	Remove rotahaler from mouth and hold breath for 5 seconds	31
9	Exhale away from the mouth piece	62
10	If any powder is left, repeat steps from e-i	77
11	Open rotahaler and discard the empty capsules	77

Note, * Essential checklist items, Dutch Asthma Foundation⁷

Table 6 shows Inhaler Specific Check list with item score of admitted patients. The most common errors were "not exhaling to

residual volume" and "not holding breath for 5 seconds" i.e item no.3 (97%) and item no.8 (98%) incase of MDI and item no.5 (84%) and item no.8 (69%) incase of rotahaler. The most correctly performed step while using MDI were item no.4 (26%) and item no.5 (26%) whereas item no.1 was the most correctly performed step in using rotahaler with 79%. In case of MDI, the essential checklist items- item no.1, item no.6 and item no. 7 were correctly performed by 8%, 14% and 6% of admitted patients, respectively. While in case of rotahaler, the essential checklist items- item no.1, item no.4 and item no.7 were correctly performed by 79% , 71% and 58% respectively.

Table 7: Experience with MDI and Experience with Rotahaler (%)

Experience with MDI (years)	Percent (%)	Experience with Rotahaler (years)	Percent (%)
< 1	8	< 1	30
1-5	12	1-5	38
6-10	3	6-10	8
>10	5	>10	5

Table 7 shows that patients having experience with MDI less than 1 year was 8%, 1-5 years was 12 %, 6-10 years was 3% and more than 10 years was 5%. Whereas the highest percentage of patients having experience with rotahaler was 38% in group 1-5 years and the least percentage was 5% in group of patients having experience with rotahaler for more than 10 years.

Table 8: Patient Characteristics with Inhaler Type

Patient Characteristics	MDI	Rotahaler	P value
Age(yrs)			
41-50	2	6	0.450
51-60	7	18	
61-70	10	23	
>70	3	31	
Sex			
Male	9	35	0.358
Female	13	43	

Table 8 shows that both age and sex has no significant effect on inhaler types used. It also depicts that maximum patients (39.7%) were given rotahaler in age group above 70 while MDI was given in age group 61-70(45.4%).

Table 9: Association of Inhaler correctness with patient characteristics

Patient Characteristics	Rotahaler Characteristics	P value	MDI Correctness	P value
Age (yrs)				
41-50	0(0.0%)	0.049*	0(0.0%)	0.080
51-60	6(7.6%)		0(0.0%)	
61-70	5(6.4%)		2(9.0%)	
>70	3(3.8%)		0(0.0%)	
Occupation				
Agriculture	0(0.0%)	0.032*	2(9%)	0.189
Housewife	6(7.6%)		0(0.0%)	
Employ	4(5.1%)		0(0.0%)	
Business	4(5.1%)		0(0.0%)	
Education Status				
Uneducated	6(7.6%)	0.002*	1(4.5%)	0.204
Primary	5(6.4%)		1(4.5%)	
Secondary	2(2.5%)		0(0.0%)	
Graduate	1(1.28%)		0(0.0%)	
Inhaler Type				
MDI			2(9%)	0.288
Rotahaler	14(17.9%)	0.718		
Experience with MDI (yrs)				
<1			0(0.0%)	0.019*
1-5			0(0.0%)	
6-10			0(0.0%)	
>10			2(9%)	
Experience with rotahaler (yrs)				
<1	3(3.8%)	0.048*		
1-5	6(7.6%)			
6-10	2(2.5%)			
>10	3(3.8%)			

The correctness of different kinds of inhalers used in the patients are shown in Table 9. It depicted that the correct use of rotahaler was significantly associated with age ($p=0.049$), education status ($p=0.002$), occupation ($p=0.018$) and experience with rotahaler ($p=0.048$). However, in case of MDI, there was only significant relation between the correct use of MDI and experience with MDI ($p=0.019$). It showed that only 2(9.09%) patients out of 22 patients using MDI and 14(17.9%) patients out of 78 patients use rotahaler correctly. It depicted that 84% of patients use inhalers incorrectly.

It was found that maximum patients of age group 51-60(7.6%) use their rotahaler correctly while patients of age group 61-70(9.0%) use their MDI correctly. Mostly, male patients 10.2% and 9.0% respectively use their rotahaler and MDI correctly. Mostly, uneducated patients (7.6%) used their rotahaler correctly and uneducated(4.5%) and patient with primary education(4.5%) used their MDI correctly. Regarding occupation, maximum housewives (7.6%) use their rotahaler correctly and maximum farmers(9.0%) use their MDI correctly. Mostly, patients having experience with rotahaler for 1-5 years(7.6%) and patients having experience with MDI for more than 10 years(9.0%) use their rotahaler and MDI correctly.

DISCUSSION

The current study shows that the greatest number of patients were in age group above 70 years (48%). This is because prevalence of COPD gradually increases with age.⁷ However, in the study conducted by Bhandari *et al.*, the greater incidence of COPD was reported in age group 60-69 years.⁸

The result shows that 75% of total admitted patients were illiterate and 25% were literate which is in accordance with study conducted by Ansari *et al.* The higher percentage of illiteracy was found to be associated with lower socio economic status of patients. Literature shows that according to the study conducted in UK in 1950's and 1960's, there is clear social class gradient for COPD with it being more prevalent in the lower socio economic strata.⁹

The study reveals that 36% were smokers, 48% ex smokers and 16% non smokers which is in accordance with study of Ansari *et al.*⁹ Tobacco smoking is established as primary cause of COPD. Studies have shown that smokers in Nepal have 70% greater chance of developing COPD.⁸ The odds of developing COPD are 1.7 times more among smoking group than those who do not smoke.¹⁰ The present study shows that 53% of patients were housewives. These housewives were involved in cooking food using wood along with other household work because they were mostly from poor family in lower socioeconomic strata and studies also correlate that woman who cooks over a biomass fire has between two to four times more chances of suffering from COPD than a woman who remains unexposed. WHO estimates that 22% of all COPD is caused by exposure to indoor smoke from biomass fires so the above study supports the findings of higher prevalence of COPD in females.⁹ It was found that the highest percentage of underlying disease along with COPD was cor-pulmonale (36%), followed by pneumonia (23%), heart failure (19%), Diabetes mellitus and hypertension each (9%) and respiratory failure (4%). The highest number of COPD with cor-pulmonale was found due to the higher numbers of COPD because COPD is one of the main risk factors for developing cor-pulmonale. According to Gale Encyclopedia of Medicine, cor-pulmonale, or pulmonary heart disease, occurs in 25% of patients with COPD. In fact, about 85% of patients diagnosed with cor-pulmonale have COPD and pulmonary hypertension, which develops late in the course of COPD (Stage IV: Very Severe COPD), is the major cardiovascular complication of COPD and is associated with the development of cor-pulmonale and a poor prognosis.^{11,12}

Bronchodilators like β_2 -sympathomimetics, methylxanthines, anticholinergics and inhaled corticosteroids are used in treatment of COPD.¹³ In present study, the most commonly prescribed drugs were short acting beta agonists (24%), anticholinergics(24%) and combination of corticosteroids with long acting beta agonists(20%). In the study conducted by Bolton *et al.*, the most prescribed drugs were short acting beta agonists followed by inhaled corticosteroids, long acting beta agonists and anticholinergics.¹⁴ Short acting beta

agonists may have been prescribed most frequently due to its rapid onset of action. Anticholinergics may have been prescribed frequently due to its maximum bronchodilation effect. It is found that combination therapy of corticosteroids with long acting beta agonists reduced the frequency of exacerbations in patients, as well as, the need for rescue medication when compared with outcomes in patients receiving monotherapy so it may have been prescribed frequently.¹⁵

Regarding inhalation techniques, the most common errors patients made while using MDI and rotahaler were 'not exhaling to residual volume' and 'not holding breath for 5 seconds'. The study conducted by Palen *et al.* support our result.² However, van Beerendonk *et al.* in their study found that 'not continuing to inhale slowly after actuation of the inhaler' and 'exhaling before the inhalation' to be the most common errors.¹⁶ Also, according to study by Lavorini *et al.*, the most common errors made included 'failure to exhale before actuation of inhaler', 'failure to breath-hold after inhalation', 'incorrect positioning of inhaler', 'incorrect rotation sequence' and 'failure to execute a forceful and deep inhalation'.¹⁷ While using MDI, apart from above mentioned errors, the other frequent errors were not continuing slow and deep inhalation, not shaking the inhaler and not inhaling slowly and pressing canister. While using rotahaler, the other common errors apart from afore mentioned errors were not inhaling powder forcefully and deeply and not exhaling away from mouth piece. Self *et al.* in their study also found the similar result.¹⁸

The present study shows that most of the patients had 1 to 5 years of experience with MDI and/ or rotahaler. This study depicts that age and sex had no significant effect on type of inhaler but not any study has stated about it.

Regarding correct use of inhalers, present study shows that 84% of patients did not use inhalers correctly which is consistent with previous studies.^{2,17} Present study shows that only 9% (out of 22 patients) used their MDI correctly while 14% (out of 78 patients) used their rotahaler correctly which is supported by findings of Molimard *et al.* highlighting the fact that pMDIs are more difficult to use than DPIs.¹⁹

It shows that age, education status, occupation and experience with rotahaler had significant association with correct use of rotahaler but only experience with MDI had significant effect on correct use of MDI. This might be due to very small number of patients (9%) performing inhalation technique correctly while using MDI. Current study shows that there was no association of inhalation technique with sex and type of inhaler. However, studies have found no association between inhalation technique and age, sex, ethnicity, education, comorbidity and smoking.^{2,9}

But, De Blaquiére *et al.* concluded that the patient's age and education had little influence on correct inhaler use and patients with most experience with inhalers produced best results²⁰ while Appel found this to be true for age and sex.²¹ Studies have found that type of inhaler is determinant of incorrect inhalation technique¹⁹ but the current study did not find association of inhalation technique with type of inhaler. However, this study is supported by finding of National Asthma Council which states that regardless of the type of inhaler device prescribed, patients are unlikely to use inhalers correctly.⁵

CONCLUSION

From the current study it can be concluded that 84% of patients used their inhalers incorrectly which ultimately leads decreased efficacy, insufficient drug delivery, increased side effects and increased economic burden resulting patient non-compliance. The most common errors while using inhalers were 'not exhaling to residual

volume' and 'not holding breath for 5 seconds'. Inhalation technique was found to be associated with age, occupation, education status, experience with MDI and rotahaler but not with sex and type of inhaler.

The mean age of patients was 68 years with majority of patients more than 70 years. Most of the patients were illiterate and have history of smoking. Most of the females were housewives who have to use biomass fuel. Cor-pulmonale was the major associated disease with COPD. Short acting beta agonists, anticholinergics and corticosteroids with long acting beta agonists were mostly prescribed drugs.

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