Print ISSN: 2321-6379
Online ISSN: 2321-595X

Original Article

Assessment of Cognitive Function Status in Chronic Obstructive Pulmonary Disease and Its Association with Understanding Inhaler Technique

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Abstract

Background: Chronic obstructive pulmonary disease (COPD) is a treatable disorder wherein technique of inhalational medication plays a major role in adequate management of the patients in which cognitive impairment may have an adverse effect.

Materials and Methods: A descriptive study was conducted among 150 COPD patients attending chest clinic and medicine OPD in University College of Medical Sciences, GTB hospital, Delhi to assess the cognitive function status in COPD and its association with the ability to understand the inhaler technique.

Results: The mean age of the study group 54.52 ± 5.99 with 18.7% (28) females and 81.3% males. About 7.3% were having diabetes, 7.3% were being treated for hypertension, 2.7% had a history of stroke, 16.0% had asthma, and 1.3% were currently being treated for tuberculosis. About 94% did not have a graduation degree. About 82.7% patients out of 150 were using an inhaler. The inhaler demonstration was seen in only 20% (30) of the participants. An average Montreal cognitive assessment score was 19.73 ± 2.55. About 92.7% patients had score <26. The total score for correctly using the inhaler technique was 6.78 ± 0.77 at baseline and 6.01 ± 0.79 after a follow-up period of 15 days. An error in at least one step of the inhalation technique was seen in 96.7% of participants. There was statistical significant association (P = 0.003) of MOCA with increase in age.

Conclusion: Cognitive dysfunction should be part of the routine diagnostic procedures in COPD patients to grade the overall impact of patients' respiratory conditions and to decide the most effective therapeutic actions and strategies.

Key words: Chronic obstructive pulmonary diseases, Inhaler technique, MOCA, Montreal cognitive assessment

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is an important public health challenge that is both preventable and treatable. By the year 2030, it is expected that it will be the third leading cause of death from the current status of the fifth.[1] According to estimates from the Global Burden of Disease Study, COPD was prevalent in more than 300 million people in 2013. In European adult populations over 40 years, the prevalence of COPD ranges between 15–20% and is higher in men than in women.[2]

The main risk factor for the development of COPD is tobacco smoking but only around 20% of smokers develop the disease. The other risk factors contributing to increased risk of this disease are indoor and outdoor air pollution,[3] occupational exposure, second-hand smoke, genetic factors, lung growth, and development. Socioeconomic status, age, and sex are the other factors that are also related to the development of COPD.

Mild cognitive impairment refers to impairment in cognition above that which is seen with normal age-related cognitive decline, but not severe enough to cause significantly impaired daily function.[4] The Diagnostic and Statistical Manual of Mental Disorders 5th Edition (DSM-V) classifies MCI as a "mild neurocognitive disorder," and specifies that there must be

Access this article online

www.ijss-sn.com

Month of Submission : 02-2022
Month of Peer Review : 03-2022
Month of Acceptance : 03-2022
Month of Publishing : 04-2022

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both a subjective and objective decline from the previous level of functioning in one or more of the six cognitive domains, not substantially interfering with instrumental activities of daily living, and not occurring in the context of delirium or other psychological disorders.[5] The mechanism proposed for cognitive impairment in patients of COPD is neuronal damage mediated by hypoxia as a result of pulmonary disease or the comorbidities or risk factors that adversely affect the brain. Mayo Clinic Study of Ageing has demonstrated that patients of COPD have increased the risk of mild cognitive impairment. The various other screening tests that are being used for the cognitive impairment are Mini-Mental State Examination (MMSE), Functional Activities Questionnaire, NIH Toolbox Cognition Batteries, and AD8 Dementia Screening Interview, Memory Impairment Screen (MIS), Animal Naming, General Practitioner Assessment of Cognition Screening Test (CPCoG), The Saint Louis University Mental Status (SLUMS) Examination, and MiniCog.[6]

Inhaled medications play a key role in the treatment of COPD. This method of application has the advantage to deliver the drug directly into the airways. Therefore, high local concentrations can be achieved with a reduced risk of systemic side effects. Different sequential steps are necessary to achieve the correct application of these devices. Incorrect performance of one or more steps can substantially reduce the delivery of the administrated substance and consequently the effectiveness and safety of the medication. Various studies have shown that 50–80% of the investigated patients do not use their inhaler devices correctly.[7]

Cognitive impairment may have a bearing on the technique of inhalation.[8] This study was conducted to assess the cognitive function status in COPD and its association with the ability to understand the inhaler technique at an outpatient clinic of a tertiary care hospital.

MATERIALS AND METHODS

Study Site

The study was conducted at the Department of Medicine, UCMS and GTB Hospital, Delhi.

Study Design

It was a descriptive study.

Study Duration

The study duration wasSeptember 2018–April 2020.

Study Participants

Inclusion criteria

The following criteria were included in the study:

- Diagnosed cases of COPD as per GOLD Staging I, II, and III.
- Age: 40–60years
- Literate (As per Census, a person aged seven and above who can both read and write with understanding in any language, is treated as literate).

Exclusion criteria

The following criteria were excluded from the study:

- Patients presenting with acute exacerbation of COPD
- History of head injury, brain tumors, epilepsy, and dementia
- History of neurological or neuropsychiatric symptoms
- Use of sedatives and antipsychotics
- Any visual or hearing impairment.

Methodology

Following approval from the Institutional Ethics Committee (IEC), 150 patients were recruited serially in the Chest and Medicine OPD of UCMS and GTB Hospital. These patients were then subjected to undergo pulmonary function tests and were classified as per GOLD Staging I, II, and III. Among these, patients fulfilling inclusion and exclusion criteria were taken as the study population.

These diagnosed cases of COPD were then subjected to detailed history. The history included demographic data for age, literacy, and occupation. History was obtained relating to the duration of COPD and the use of an inhaler, exposure to industrial smoke, pollution, smoking, comorbid conditions, and previous or current history of pulmonary tuberculosis or any other lower respiratory tract infection. The participants were enquired in detail about the use of inhalers if any previous demonstration has been given regarding its use, previous pulmonary function tests if any, and drugs they were taking for COPD. The patients were also enquired about any previous psychiatric conditions, addictions such as alcohol, smoking, tobacco chewing, and any history of stroke or brain injury in the past. The participants were asked about the most common presenting symptom that they were having at the time of presentation to the hospital. The clinical examination incorporated the measurement of physical parameters such as height, weight, blood pressure (both systolic and diastolic), clinical signs such as clubbing, lymphadenopathy, pallor, edema, and icterus. The respiratory system was examined to look for any significant findings. The chest X-ray was also examined to look for the common findings among different participants of COPD.

Five milliliters of blood were withdrawn from the patients with their due consent for routine investigation (Liver function tests, Kidney function tests, complete blood counts, and blood Sugar) to rule out coexisting comorbidities which may, later on, confound the cognitive assessment.

At the first visit after clinical examination patients were given complete demonstration and training to use pressurized metered-dose inhalers using ten steps of inhaler technique given by National Asthma Council Australia.[9] The subjects were then asked to repeat these ten steps of inhaler technique after an interval of 5 min and scores were given as´ 1´ for each correctly performed step and ´0´ for incorrectly performed step. Inhaler technique scoring was based on the number of steps performed correctly out of 10.

During this same visit, patients were assessed for cognitive function using Montreal Cognitive Assessment scoring using MOCA Hindi Version. MOCA is a rapid screening instrument for mild cognitive dysfunction. It assesses different cognitive domains: attention and concentration, executive functions, memory, language, visuoconstructional skills, conceptual thinking, calculations, and orientation. There are eight domains and each domain was tested among the study participants using the Hindi version of MOCA. The total possible score is 30 points; a score of 26 or above is considered normal.[10]

All the subjects were then followed by a gap of 15 days for the inhaler technique and were again asked to repeat ten steps of inhaler technique and were given scores out of ten. At the follow-up visit difference in the score from the baseline score was also obtained. The inhaler technique score was then compared with the MOCA score to assess cognitive function and its association with an understanding of the inhaler technique.

Data Management and Statistical Analysis

Statistical analysis

Data were entered into MS Excel and cleaned. SPSS 20.0 Software has been used for statistical analysis. Categorical value like cognitive status impairment, gender, and so on was presented as a proportion. Continuous variables such as MOCA (Montreal Cognitive Assessment) scoring, inhaler technique scoring, and age etcetera were presented as a mean and standard deviation.

The continuous variables such as inhaler technique score, and age etcetera were compared in the two groups, that is, MOCA <26 and MOCA >26 by Student's t-test. The categorical variables such as gender were compared using the Chi-square test. $P < 0.05$ was considered statistically significant.

Ethical Consideration

Approval from the Institutional Ethical Committee of UCMS was taken for conducting the study. Informed written consent was taken from the patients.

RESULTS

The total number of patients who participated in the study was 150. The age of the participants ranged from 40 to 60 years. The mean age of the study group was 54.52 ± 5.99. There were 18.7% (28) females and 81.3% (122) males. Among all the study participants cough and shortness of breath were the most common symptoms 79.3% (119) followed by chest pain 41.3% (62) and palpitations 8% (12). 20 (30%) had pulmonary TB at presentation or had taken treatment for it in the past. About 4.7% (7) had lower respiratory tract infection at presentation.

About 7.3% (11) were having diabetes, 7.3% (11) were being treated for hypertension, 2.7% (4) had a history of stroke, 16.0% (24) had asthma, and 1.3% (2) were currently being treated for TB. About 74.7% (112) had a history of exposure to biomass fuel, 19.3% (29) had exposure to industrial smoke, and 3.3% (5) had increased exposure to air pollution. About 68% (102) had a history of smoking, 19.3% (29) had a history of tobacco chewing, and 12.66 (19) had other addictions (paan, ganja).

About 2.7% (4) were educated up to primary school 48% (72) have passed the middle school, 43.3% (65) high school, and only 6% (9) have a graduation degree. About 11.3% (17) were carpenters or involved in wood-related factories, 24% (36) were manual laborers, 9.3% (14) were farmers, 8.7% (13) were employed in government jobs, 36% (54) were working in private firms or running their businesses, and 10.7% (16) were either housewives or unemployed.

Among the patient, total duration of COPD ranged from 0.00 to 40 (years) and the mean duration was 5.38 ± 6.40 (years). The duration of inhaler ranged from 0.00 to 12 (years) and the mean duration for the study group was 2.12 ± 2.57 (years). About 82.7% (124) patients out of 150 were using an inhaler. The inhaler demonstration was seen in only 20% (30) of the participants and only 6.7% (10) participants have performed pulmonary function tests previously. The FEV_1 ranged from 36 to 70 and the mean FEV_1 of the study group was 51.9 ± 7.63. The FVC ranged from 052 to 102 and the mean FVC was 83.11 ± 10.2. The FEV_1/FVC ratio ranged from 50 to 69.5 and the mean ratio for the study group was 62.12 ± 6.86.

Cognitive Impairment and MOCA Scoring

Montreal cognitive assessment score was used to measure cognitive impairment in the study participants. Six different dimensions are used to measure cognitive function such as execution, naming, memory, attention, language, abstract, delayed recall, and orientation. The mean value obtained in each dimensions in this study is shown in Table 1. The different domains of MOCA with the frequency

of participants having different scores are given in the following Table 2. The total MOCA score was 30 and it ranged from 12 to 27 with an average score of 19.73 ± 2.55. The cutoff score was 26. 92.7% (139) patients had score <26 and 7.3% (11) had score ≥26 as shown in Table 3.

The study participants followed ten steps for using an inhaler. As shown in Table 4, step 1 was correctly done by all 100% (150) participants followed by step 2 and step 10 by 96.7% (145) participants and step 5 by 88.7% (133) participants, step 9 by 77.3% (116), and step 8 by 69.3% (104) participants. Step 6 was done correctly done by only 28% (42) participants. The mean value and range for different domains of MOCA are listed in the following Table 5. Among the different domains, language and abstract were the most commonly affected among those with MOCA score <26.

The study participants were divided into two groups, one with MOCA score <26 and the other with MOCA score ≥26. In participants with MOCA score<26, the average baseline inhaler score was 6.79 ± 0.75 and in participants with MOCA score ≥26 the baseline score 6.64 ± 1.0. $P = 0.521$ and it was not statistically significant. The mean total score at follow-up in participants with MOCA <26 was 6.00 ± 0.77 and in MOCA score ≥26 was 6.09 and was not statistically significant with $P = 0.19$ as shown in Table 6. In this study, as shown in Table 7, there was statistical significant association of MOCA with age with $P = 0.003$.

Table 1: The mean value in each domains of MOCA scoring

Domains	Mean (*n*=150)	Standard deviation	Range
Execution	2.91	0.61	0.00–4.00
Naming	1.94	0.59	0.00–3.00
Memory	2.19	0.75	0.00–4.00
Attention	2.42	0.85	0.00–4.00
Language	1.09	0.58	0.00–3.00
Abstract	1.18	0.64	0.00–3.00
Delayed recall	2.34	0.65	0.00–4.00
Orientation	5.67	0.55	3.00–6.00
Total score	19.73	2.55	12.00–27.00

DISCUSSION

Cognition is an ability that allows learning and correctly processing information from the environment for its subsequent retrieval and use. Cognitive impairment is defined as a moderate decline in function from baseline performance in one or more of six cognitive domains, where the deficits are insufficient to impair independent functioning. It can present as mild or severe form. It can present with memory loss, difficulty in judgment, recognizing the familiar persons and places, planning and carrying out tasks, frequent changes in mood and behavior. Risk factors for the development of mild cognitive impairment are age being the most important, hypertension, hyperlipidemia, coronary artery disease, stroke, family history of cognitive impairment, COPD, diabetes mellitus, depression, and other lifestyle factors.[11]

This study was conducted among COPD outpatients attending Medicine OPD of GTB hospital for a regular check-up and follow-up. The purpose of this study was to assess cognitive impairment in COPD patients (using MOCA) and to study the association of cognitive impairment with the understanding of inhaler technique. MOCA score was used for the screening of cognitive impairment which is a rapid screening test and can be easily administered on an OPD basis with minimal resources and has better sensitivity than other methods like MMSE.

In this study, out of 150 patients enrolled in the study, the mean age of the patients was 54.52 ± 5.99 years and 51.3% (77) of the participants were in the age group of 55–60 years. Males comprised 81.3% (122) and females comprised 18.7% (28). About 48% (72) had completed middle school, 43.3% (65) completed high school, and only 6% (9) have completed graduation. 102 (68%) had a history of smoking as the most common risk factor for the disease followed by tobacco chewing seen in 19.3%. The exposure to biomass fuel was seen in 74.7% (112), followed by industrial smoke in 19.3% (29), and air pollution in 3.3% (5). The mean FEV_1 was 51.99 ± 7.63, FVC being 83.11 ± 10.22, and the FEV_1/FVC ratio was 62.12 ± 6.86. The

Table 2: Distribution of the patients with respect to the scores in various domains of MOCA

Score	Execution		Naming		Memory		Attention		Language		Abstract		Delayed recall		orientation	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
0	1	0.7	2	1.3	2	1.3	2	1.3	17	11.3	11	7.3	1	0.7	0	0
1	1	0.7	25	16.7	20	10.7	16	10.7	105	70.0	109	72.7	7	4.7	0	0
2	26	17.3	103	68.7	79	52.7	63	42.0	26	17.3	22	14.7	87	58	0	0
3	105	70.0	20	13.3	45	30.0	55	36.7	2	1.3	8	5.3	50	33.3	1	0.7
4	17	11.3	-	-	4	2.7	14	9.3	-	-	-	-	5	3.3	3	2.0
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	41	27.3
6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	105	70.0

mean duration of the disease was 5.38 ± 6.40 years and the average duration for use of inhaler was 2.12 ± 2.57 years. The mean total MOCA score was 19.73 ± 2.55 with a score ranging from 12 to 27.

Among the various domains of MOCA, it was observed that in this study, "language," "abstract," and "naming" were the most commonly affected among those with cognitive impairment (score<26) and there was statistically significant ($P < 0.001$) association.

The total score for correctly using the inhaler technique was 6.78 ± 0.77 at baseline and 6.01 ± 0.79 after a follow-up period of 15 days. The difference in the inhalation score at the follow-up was observed to be 1.08 ± 0.76. An error in at least one step of the inhalation technique was seen in 96.7% of participants. Cognitive impairment as defined in our study as MOCA scores <26 was observed in 92.7% (139) and a score of ≥26 was seen in 7.3% (11).

In a cross-sectional study by Dal Negro *et al*., the extent and prevalence of cognitive dysfunction in COPD the study group comprised 402 participants out of which 229 were of COPD. The mean age for the study was 70 ± 12.9 years ranging from 40 to 79 years and males were 158 (68.9%) and females were 71 (31.0%) in number. About 82.1% were current or active smokers. The mean FEV_1 was 54.9 ± 23.6 and mean FEV_1/FVC ratio was 52.7 ± 11.9. They used MMSE, Clock drawing test, and Trail making test for assessing the cognitive impairment out of which trail making test and MMSE positively correlated with FEV_1 severity. Memory, attention, symbolic representation and visual processing, reproduction of numeric sequences, cognition flexibility, and shifting capacity were the most affected cognitive functions.[12] The mean FEV_1 was comparable to our study and they also observed cognitive impairment starting in the earlier stages of COPD.

Thakur *et al*. published in their study that the role of hypoxemia on cognitive impairment in COPD on 1202 participants. The mean age for the study was 58.2 ± 6.2 years (45–65 years) and females comprised 57.4% ($n = 691$). Current and ex-smokers were 87% ($n = 1027$). About 29% of the total participants have completed high school. MMSE was used as the screening tool for cognitive impairment and risk for cognitive impairment was seen with a positive odds ratio of 2.86 (1.34–7.46) and confidence interval of 95%.[13] Their study also observed a high prevalence of smoking as a risk factor similar to this study. The age of their study group was comparable to ours but they did also find an association between comorbidities and risk of cognitive impairment.

Turan *et al*. conducted a study to evaluate parameters affecting inhalation therapy adherence in elderly patients with COPD and asthma. Out of the total 121 participants recruited, 88 were of COPD. The mean age group was 70.24 ± 5.85 years. Females comprised 13.6% ($n = 12$) and males comprised 86.4% ($n = 76$). The male and female ratio of their study was similar to our study. A majority of their study group had completed only primary education (63.6%) and the average duration of their disease was 4.77 years which was very similar to 5.38 year seen in our study. The mean FEV_1 was 53.70 ± 16.85 and FEV_1/FVC ratio was 64.92 similar to seen in our study. They used MMSE as the tool for cognitive impairment and cognitive impairment was observed in 40.2%. The average inhaler device score was 7.01 ± 1.96.[14] The higher cognitive impairment observed in our study could be because of better sensitivity of MOCA to detect cognitive impairment.

Table 3: Distribution of patients according to total MOCA score

Score	Frequency (*n*=150)	Percentage (%)
<26	139	92.7
>26	11	7.3

Table 4: Distribution of participants according to correct inhaler technique for various steps of using the inhaler at baseline and at follow-up

Steps of inhaler technique	Frequency (*n*=150)	Percentage (%)	Frequency (follow-up)	Percentage (follow up)
Step 1 (remove cap)	150	100	144	96
Step 2 (hold the inhaler and shake it well)	145	96.7	75	50.0
Step 3 (breathe out gently)	69	46	107	71.3
Step 4 (put mouthpiece between teeth without biting)	133	88.7	126	84.0
Step 5 (start to breathe in slowly through the mouth and press down firmly on the canister)	56	37.3	59	39.3
Step 6 (continue to breathe in slowly and deeply)	42	28.0	38	25.3
Step 7 (hold breath for about 10 s)	57	38	39	26.0
Step 8 (while holding breath , remove the inhaler from the mouth)	104	69.3	73	48.7
Step 9 (breathe out gently away from the mouthpiece)	116	77.3	96	64.0
Step10 (replace cap)	145	96.7	144	96.0

Table 5: Comparisons of domains of MOCA scores

Domains	MOCA				*P*-value
	<26 (*n*=139)		>26 (*n*=11)		
	Mean	SD	Mean	SD	
Execution	2.84	0.57	3.73	0.47	<0.001
Naming	1.89	0.57	2.55	0.52	<0.001
Memory	2.13	0.71	3.00	0.77	<0.001
Attention	2.34	0.81	3.45	0.69	<0.001
Language	1.01	0.52	2.00	0.45	<0.001
Abstract	1.10	0.56	2.18	0.75	<0.001
Delayed recall	2.25	0.58	3.45	0.52	<0.001
Orientation	5.64	0.56	6.00	0.00	<0.037

Table 6: Difference in inhaler technique scores with respect to MOCA score

	MOCA				*P*-value
	<26 (*n*=139)		>26 (*n*=11)		
	Mean	SD	Mean	SD	
Baseline total score	6.79	0.75	6.64	1.03	0.521
Follow-up total score	6.00	0.77	6.09	1.04	0.715
Difference	1.06	0.76	1.36	0.67	0.197

Table 7: Distribution of participants with respect to MOCA status among different age groups

Age (years)	MOCA				*P*-value
	MOCA<26 (*n*=139)		MOCA>26 (*n*=11)		
	No.	Percentage	No	Percentage	
40–45	18	90	2	10	0.003
46–50	27	100	0	0	
51–55	23	88.5	3	11.5	
56–60	71	92.2	6	7.8	

A similar cross-sectional observation study was done by Mourad *et al.* to study cognitive profile in patients of COPD and asthma. Out of a total of 100 study participants, 40 were of COPD and the mean age was 60 ± 19.85 years, and males comprised 75% (n = 30) and females 25% (n = 10). The average duration of the disease was 13.2 ± 5.62 years. The mean FEV_1/FVC was 61.25 ± 17.51. They also used MOCA as the screening tool and the average MOCA score was 16.4 ± 6.30. The occurrence of cognitive impairment was observed in 85% of the COPD participants. They observed a significant association of age with cognitive impairment but did not found any association of gender, duration of disease, FEV1 with cognitive impairment.[15] This study had results similar to ours and observed a high occurrence of cognitive impairment.

In a cohort study done by Ersel Dag *et al.* in 2013, the study participants were in the age group of 43–79 years with a mean age of 64.9 ± 9.4 years and had 47 males and five females of the total 52 participants. The mean FEV_1 was 50.5 ± 17.5 in their study. For cognitive dysfunction, they used MOCA and MMSE and the proportion of subjects with COPD with cognitive impairment as measured by MOCA was 12% and they also found a significant association of age with cognitive impairment.[16] The huge difference in cognitive impairment from our study could be attributed to the difference in the sample size and literacy.

In a prospective cross-sectional study conducted by Hung *et al.* among 103 outpatients of COPD to evaluate the use of inhaler devices, 77 patients (74.8%) performed at least one essential step incorrectly for all devices. For the pMDI, the steps "breathe out gently to residual volume" and "shake inhaler thoroughly" were most frequently performed incorrectly.[17] In this study, at least one error was done by 96.7% which could be because of higher cognitive dysfunction observed. The step which was most incorrectly performed was "to continue to breathe in slowly and deeply" followed by "start to breathe in slowly through the mouth and press down firmly on the canister" and "holding the breath for about 10 s or as long as comfortable." These same errors were observed at follow-up also.

CONCLUSION

Prompt identification and management of cognitive impairment can have an effective bearing on the management and clinical outcome. Screening of cognitive dysfunction should be part of the routine diagnostic procedures in COPD patients to grade the overall impact of patients' respiratory conditions and to decide the most effective therapeutic actions and strategies.

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How to cite this article: Verma AK, Kumari L, Gupta A, Narang S. Assessment of Cognitive Function Status in Chronic Obstructive Pulmonary Disease and Its Association with Understanding Inhaler Technique. Int J Sci Stud 2022;10(1):33-39.

Source of Support: Nil, **Conflicts of Interest:** None declared.