

Original Article

Knowledge of spacer device, peak flow meter and inhaler technique (MDIs) among health care providers: an evaluation of doctors and nurses

Bamidele O Adeniyi¹, Ayodeji M Adebayo², Olayinka S Ilesanmi³, Daniel O Obaseki⁴, Olubukola O Akinwalere¹ and Gregory E Erhabor⁴

Ghana Med J 2018; 52(4): 15-21 DOI: <http://dx.doi.org/10.4314/gmj.v52i1.4>

¹Department of Medicine, Respiratory Unit, Federal Medical Centre, Owo, Ondo State, Nigeria, ²Department of Community Medicine, University of Ibadan, Oyo State, Nigeria, ³Department of Community Health, Federal Medical Centre, Owo, Ondo State, Nigeria, ⁴Department of Medicine, Respiratory Unit, Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria.

Corresponding author: Dr Bamidele O Adeniyi

E-mail: delbis2003@yahoo.com

Conflict of interest: None declared

SUMMARY

Background: Metered dose inhalers are cornerstone in effective management of bronchial asthma when correctly used. Most studies hitherto have focused on assessing patient's knowledge of inhaler technique. We sought to assess the knowledge of inhaler technique, spacer device and peak flow meter among doctors and nurses in a tertiary healthcare institution in Nigeria.

Method: A cross sectional survey of nurses and doctors from emergency department, family and internal medicine; who were attending a continuous professional development lecture, was carried out. From a total of 100 questionnaires administered, we retrieved 87 of which 75 were completed, giving a response rate of 75%. It was a self-administered questionnaire. Data was analysed with SPSS version 21.0. Descriptive statistics were done. Association was examined using chi-square test.

Result: Mean age of respondent was 35.8 years \pm 8.7, 47(62.7%) were < 40 years, 33(44%) were male, nurses were 30(40.0%). Only 28(37.3%) had ever used a peak flow meter. Only 4(14.3%) used peak flow meter frequently, while 12(26.7%) checked patient's inhaler technique often. Only 9 out of the 75 (12%) participants all of who are doctors knew at least 3 essential steps of the techniques in using the metered dose inhaler correctly. None of the participants got all the steps for the use of pMDI totally correct.

Conclusion: Knowledge regarding the use of the metered dose inhaler and spacer device was poor. Health practitioners should have constant reminders in the form of continuous medical education to update their knowledge regarding correct inhaler technique.

Funding: self-funded

Keywords: asthma, inhalers, knowledge, doctors, nurses

INTRODUCTION

The inhalational route is often the preferred choice when administering medications in patients with asthma and chronic obstructive pulmonary disease (COPD).¹ This route results in better delivery to the airways which is the site of action and is associated with less side effects. There are several types of inhalational devices ranging from metered-dose inhalers, disk inhalers, turbo inhalers etc.² Pressurized Metered dose inhalers (pMDIs) are the commonest devices in the management of obstructive lung diseases.³ Metered dose inhalers consist of a pressurized canister containing the medication.

When the inhaler is activated by pressing on the canister, it releases a measured aerosol dose of drug.⁴ Most pMDI involves coordinating correct timing and appropriate inspiratory flow rate.⁴ In order to increase drug delivery and overcome the problem of hand-breath coordination, a spacer device can be used alongside the inhaler.⁵ Spacer devices have also been found useful even during acute severe asthma management as a cost-effective alternative to nebulizers particularly in children.^{6,7}

A large randomized study comparing the use of spacers and nebulizers in children with moderate and severe acute asthma found out that the spacer was as effective as the nebulizer for clinical score, respiratory rate, and oxygen saturation and produced a greater reduction in wheezing among children age 1 to 4 years.⁸

Spacers are cheaper, handy and can even be fabricated at home.⁹ This is particularly important in middle and low-income countries where sometimes there may be unavailability of nebulizers or lack of electricity to power the nebulizers where it is available. Incorrect technique when taking inhaled medication frequently prevents patients from receiving the maximal benefit from their medication.^{10,11} For instance, in asthma care, incorrect inhaler technique could result in suboptimal control and patients could be subjected to unnecessary increases in medication dosage and its adverse effects.¹⁰ Additionally, the Global Initiative for Asthma (GINA) guideline for the management of asthma recommends routine inhaler technique check and adherence at every clinic visit. This must be put into consideration before adjusting the medications of the patients.¹² It has been observed that even brief inhaler technique training improves asthma control.¹³ Similarly, Peak flow meters are very important tools in the diagnosis and monitoring of treatment in asthma.¹¹ The peak flow meter is a small hand-held device that measures how fast a person can blow air out of the lungs when there is forceful exhalation, after maximum inhalation. They help in objectively assessing the level of asthma control by measuring and documenting the diurnal variability of the lung function of the asthmatic. It is helpful in monitoring the response to treatment during acute asthma episodes and can further be used in making a diagnosis of asthma by measuring pre and post bronchodilator readings.^{11,14}

Previous attention has been largely on assessing patients' knowledge of inhaler technique,^{10,15,16,17} in the management of asthma and achieving optimal asthma control, however there are few studies in Nigeria that evaluated the care givers' knowledge of inhaler technique.^{18,19} The effectiveness of inhalers in the care of asthma and other airway disease is often dependent on proper knowledge and communication of the correct technique by the health care giver. The purpose of this study was to assess the knowledge of doctors and nurses in a tertiary hospital in south-west Nigeria regarding spacer devices, peak flow meters and inhaler techniques.

METHODS

We conducted a cross sectional survey among health workers attending a continuous professional development (CPD) course.

Participants included doctors and nurses working in the departments of Internal Medicine, Family Medicine and the hospital staff clinic. These are the sections of the hospital involved in asthma care.

Respondents completed a self-administered questionnaire that elicited information on socio-demographics and their typical approach to managing asthma patients including proper inhaler techniques, knowledge of spacer device and peak flow meter. They were required to outline the steps in the correct use of a pressurized metered dose inhaler. We described the correct steps as written below:

Steps in using metered dose inhaler device adapted from the National Asthma Education and Prevention Programmes of America (NAEPP).²⁰

1. Shake the inhaler*
2. Take the cap off the inhaler mouthpiece*
3. Hold the inhaler upright
4. Breathe out
5. Place the inhaler mouthpiece between the lips and the teeth; keep the tongue from obstructing the mouthpiece*
6. Trigger the inhaler while breathing in deeply and slowly*
7. Continue to inhale until the lungs are full*
8. Hold the breath while counting to 10*
9. Breathe out slowly

*Essential steps

Adequacy of inhalational techniques was defined based on the ability of the respondents to identify at least 3 of the essential steps (steps One, Two, Five, Six, Seven and Eight) in MDI use and these were categorized as having good knowledge. Those who had less than 3 of the essential steps were categorized as having poor knowledge. Regarding the knowledge of spacer device, those who were able to indicate that the use of spacer was to; administer asthma drugs and increase delivery of salbutamol aerosol to the lungs were recorded as having good knowledge of its use while those who failed to indicate these as correct responses were scored as having poor knowledge of spacer device.

Data Analysis

Data was entered and analysed with SPSS version 21.0. Age was summarised using mean and standard deviation. Socio demographic characteristics and other categorical variables were presented in frequency and percent. Bivariate analysis using Fisher's Exact Test was conducted between socio demographic characteristics (independent variables) and knowledge of at least 3 essential techniques in using inhaler (outcome).

Chi square test was used to explore the relationship between socio demographic characteristics (independent variables) and adequate knowledge of spacer device (outcome). Level of statistical significance was $p < 0.05$.

Ethical approval was obtained from the Health Research Ethics Committee of the Federal Medical Centre, Owo. We sought and obtained informed consent from all the participants.

RESULTS

From a total of 100 questionnaires administered, we retrieved 87 of which 75 were completed, giving a response rate of 75%. Table 1 shows the sociodemographic characteristics of respondents. Mean age was 35.8 ± 8.7 years. Forty-seven (62.7%) were under 40 years, 33 (44%) were male. Doctors were 45 (60%) and nurses 30 (40%), in number. The results also indicate that 69 (92%) have been involved in managing Asthma. Although 51 (68%) had seen a peak flow meter, only 28 (37.3%) had ever used it.

Table 1 Sociodemographic characteristics of respondents

Characteristics (n=75)	Frequency	Percent
Recorded age in years		
< 40 years	47	62.7
40 years and above	28	37.3
Sex		
Male	33	44.0
Female	42	56.0
Religion		
Christian	70	93.3
Muslim	5	6.7
Marital Status		
Single	24	32.0
Married	51	68.0
Job type		
Medical Doctor	45	60.0
Nursing	30	40.0
Doctors (n=45)		
Junior*	18	40
Senior**	27	60
Nurses (n=30)		
Junior*	8	26.7
Senior**	22	73.3

* Nursing Officer/Medical Officer, Registrar, and House Officers
 **Senior Nursing Officer, Chief Nursing Officer/Senior Medical Officer, Senior Registrar, Consultant

As shown in Figure 1, over a third of the participants (40.0%), check the inhaler technique of their patients very often or often, while about a fifth of them (21.3%) does so occasionally. None of the respondents got the complete (nine steps) step-wise inhaler technique correctly. Only 9 out of 75 (12%) knew at least 3 essential steps in using pMDI correctly.

Table 2 shows sociodemographic characteristics and knowledge of spacer device. Adequate knowledge of spacer device was demonstrated by 13 (46.4%) of male participants (who were all doctors) and 7 (21.9%) of the female participants.

While adequate knowledge on spacers was demonstrated by 12 (50.0%) of senior doctors and 4 (25%) junior doctors, only 4 (26.7%) of the senior nurses and none of the junior nurses had adequate knowledge.

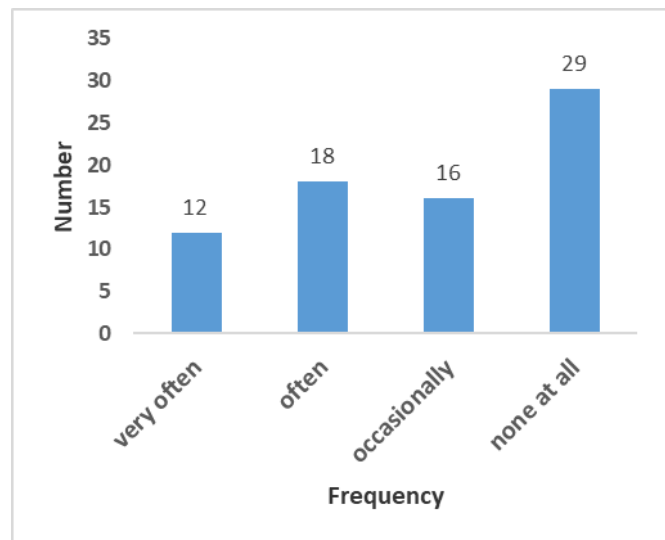


Figure 1 Frequency of checking the patient's inhaler technique among respondents

Table 2 Sociodemographic characteristics and adequate knowledge of spacer device

Socio-demographic characteristics	Adequate Knowledge of spacer device		Chi square	p-value
	Yes n(%)	No n(%)		
Recorded age in years				
< 40 years	15(38.5)	24(61.5)	1.319	0.251
40 years and above	5(23.8)	16(76.2)		
Sex				
Male	13(46.4)	15(53.6)	4.051	0.044
Female	7(21.9)	25(78.1%)		
Marital Status				
Single	11(52.4)	10(47.6)	5.275	0.022
Married	9(23.1)	30(76.9)		
Doctor (n=40)				
Junior*	4(25.0)	12(75.0)	2.500	0.114
Senior**	12(50.0)	12(50.0)		
Nurses (n=20)				
Junior*	0(0.0)	5(100)	Fisher's Test	Exact
Senior**	4(26.7)	11(73.3)	0.530	

As shown in Table 3, a slightly higher proportion 6(22.2%) of the senior medical doctors knew at least three essential steps in using inhaler compared to 3(16.7%) of junior doctors. This difference was not statistically significant. None of the nurses knew at least 3 of the essential steps in using the metered dose inhaler. Sixty of the respondents reported ever seeing a spacer device, of these; adequate knowledge of spacer device was demonstrated by 20, representing 26.7% of the total respondents.

Table 3 Socio-demographic characteristics and the technique of inhaler use

Socio-demographic characteristics	Knew at least 3 essential steps in using inhaler		Fisher's Exact Test
	Yes n (%)	No n (%)	
Age group (years)			
< 40 years	6(12.8)	41(87.2)	1.00
40 years and above	3(10.7)	25(89.3)	
Sex			
Male	5(15.2)	28(84.8)	0.495
Female	4(9.5)	38(90.5)	
Marital Status			
Single	3(12.5)	21(87.5)	1.000
Married	6(11.8)	45(88.2)	
Doctor			
Junior*	3(16.7)	15(83.7)	0.721
Senior**	6(22.2)	21(77.8)	

As shown in Table 4, most of the respondents were more likely to get step one and two correctly (34.7% and 37.3% respectively), while they were least likely to get correctly, the last two steps which involved “hold breath as long as you can tolerate and remove inhaler and breathe out slowly (2.7% and 2.7% respectively).None of the participants indicated step 3, which is to hold the inhaler in an upright position.

Table 4 Knowledge of steps involved in meter dose inhaler user

Steps	Frequency	Percent
*Step 1. Hold the inhaler and shake	26	34.7
*Step 2. Remove cap	28	37.3
Step 3. Hold the inhaler upright	0	0
Steps 4. Breathe out gently	26	34.7
*Step 5. Put the inhaler mouth-piece between the lips and the teeth	19	25.3
*Step 6. Trigger the inhaler while breathing in deeply and slowly	3	4.0
*Step 7. Continue to inhale until the lungs are full	6	8.0
*Step 8. Hold breaths as long as you can tolerate	2	2.7
Step 9. Remove inhaler and breathe out slowly	2	2.7

*Essential steps

DISCUSSION

Regarding the use of spacer device in asthma care, majority of asthma patients’ care givers in our study do not have adequate knowledge of spacer device. Adequate knowledge of spacer devices was demonstrated by only 26.7% of the participants. Onyedum et al²⁴in south-eastern Nigeria in a systematic review of challenges in asthma management, identified unavailability of spacer devices as one of the reasons practitioners may not be familiar with its use. Another probable explanation is the poor adherence to asthma guidelines by physicians.²⁵The Global Initiative for Asthma (GINA) guideline which is currently used as the standard of practice for asthma care in Nigeria, recommends the use of spacer device with pMDIs for improved delivery of aerosol to the airways.¹²

Our study identified that out of 92% that had been involved in managing asthma, only 37.3% had ever used a peak flow meter in asthma care while only 14.3% used peak flow meter frequently in their practice. The finding in this study agrees with that by Desalu et al²⁵ where the use of peak flow meter was shown to be very poor among health practitioners in Nigeria.

The reason for this low level of use could range from unavailability, the relative high cost of the device to the cost of asthma treatment in our local setting and the fact that many Physicians appeared not to be skilled in its use. It however contrasts with what obtains in the developed economies like the UK where peak flow meter use is readily available and frequently used in the monitoring of asthma thus leading to better levels of asthma control among such population.²⁶

Only 40.0% of the respondents check patients’ inhaler technique often during clinic visits similar to a 2012 study from Spain where only 27.7% of the physicians involved in asthma management stated that they always checked the patient's inhalation technique when prescribing a new inhaler.²⁷ This level is rather poor as the GINA guideline¹² has recommended that patients’ inhalational technique should be checked at every clinic attendance in order to reinforce their knowledge, improve use, encourage adherence and improve drug delivery.

The reason for this could be the fact that many of the health practitioners themselves are not conversant with the standard inhaler techniques as shown in this study. In addition, the clinics in Nigeria²⁸ as in many other low and middle-income countries are usually overcrowded²⁹ and not conducive, which may not allow the physicians or nurses to be able to spare the time to check the inhaler techniques of their patients.

In our hospital where this study was conducted, a doctor sees an average of 25 to 30 patients during medical outpatient clinic that runs for about 4 hours; spending an average of 8 minutes or less with each patient. The clinic area is often shared with other specialties running clinics on the same day. Due to lack of human capacity, asthma patients are mostly seen as part of the general medical clinic and there are no special asthma clinics. This situation is not peculiar to our hospital alone. There is thus pressure for time and space which often limit the available time to interact with the asthma patient. This is however not enough excuse to preclude them from carrying out this essential aspect of asthma and COPD management.

In developed economies, this problem has been reduced by the use of other care givers such as specialty nurses and respiratory therapists who spend more time interacting with the patient and help to implement the doctors' recommendations regarding asthma therapy. This could be a potential area of intervention that could help improve asthma care in Nigeria and other low-income countries. Significantly, bivariate analysis showed that more male (46.4%) than female (21.9%) participants had adequate knowledge of spacer device. This is probably explained by the fact that more of the male participants were physicians while more of the female participants were nurses. This is confirmed by the fact that knowledge of spacer device was generally better among the physicians. In Nigeria, specialized practice among the nurses is still largely rudimentary hence more of the nurses are general practice nurses. This could explain why most are not conversant with spacer devices.

The participants were least likely to get the last two steps correct, which involved the instruction "hold breath as long as you can tolerate" and "remove inhaler and breathe out slowly" (2.7 and 2.7% respectively) and only 3 (4%) wrote correctly the most significant step of the inhalational procedure which is to inhale deeply and slowly (step 6). Among the participants in the Spanish study²⁷ many more (46.1%) identified "inhale deeply and forcefully" as the most significant step in the inhalation manoeuvre, far better than what we obtained in our study. It is important to note that the Spanish study involved physicians who had recently received education on various aspects of asthma care including inhalational technique prior to the study; the impact of the education would be expected to still be fresh even though the result was still below what was expected. It has been demonstrated that even among physicians,³⁰ carers and patients³¹ who have initially demonstrated good inhaler technique, there is a progressive loss of knowledge over time.

This emphasizes the need for continuous reminders at every opportunity for both carers and asthmatics.

CONCLUSION

Majority of asthma patient caregivers themselves do not know how to use pMDI devices correctly. Knowledge regarding the use of spacer devices and peak flow meters was also poor. This indicates the need for establishing regular education programs for health care providers with constant reminders in the form of videos and pictorial representation in the clinics. This will enable the asthma care givers provide correct information to their patients which in turn will help improve asthma care. There is the need to train and engage the services of respiratory therapists and asthma nurses who can focus on various aspects of asthma care and help to implement the physicians' treatment plans for effective care of the asthmatics.

LIMITATIONS

Other studies have used another approach which is to ask the participants to demonstrate the use of the pMDI while a checklist is ticked for correct or wrong steps. We could not do this due to the fact we would require dummy pMDIs and this would be expensive and beyond our budget. Within this limitation however, we believe that the information provided by the participants is a fair reflection of what they know and practice.

ACKNOWLEDGEMENT

The authors acknowledge all the house officers and residents from internal medicine department, Federal Medical Centre, Owo who assisted in the gathering of data.

REFERENCES

1. Beveridge RC, Grunfeld AF, Hodder RV, Verbeek PR. Guidelines for the emergency management of asthma in adults. CAEP/CTS Asthma Advisory Committee. Canadian Association of Emergency Physicians and the Canadian Thoracic Society. *CMAJ: Can Med Assoc J.* 1996 ;155(1):25.
2. Cochrane MG, Bala MV, Downs KE, Mauskopf J, Ben-Joseph RH. Inhaled corticosteroids for asthma therapy: patient compliance, devices, and inhalation technique. *Chest.* 2000 ;117(2):542-50.
3. Virchow JC, Crompton GK, Dal Negro R, Pedersen S, Magnan A, Seidenberg J, Barnes PJ. Importance of inhaler devices in the management of airway disease. *Respir Med.* 2008 Jan 31;102(1):10-9.
4. Dekhuijzen PN, Vincken W, Virchow JC, Roche N, Agusti A, Lavorini F, van Aalderen WM, Price D. Prescription of inhalers in asthma and COPD: towards a rational, rapid and effective approach. *Respir med.* 2013;107(12):1817-21

5. Newman SP, Millar AB, Lennard-Jones TR, Morén FO, Clarke SW. Improvement of pressurised aerosol deposition with Nebuhaler spacer device. *Thorax*. 1984 ;39(12):935-41.
6. Bowton DL, Goldsmith WM, Haponik EF. Substitution of metered-dose inhalers for hand-held nebulizers: success and cost savings in a large, acute-care hospital. *Chest*. 1992;101(2):305-8.
7. Leversha AM, Campanella SG, Aickin RP, Asher MI. Costs and effectiveness of spacer versus nebulizer in young children with moderate and severe acute asthma. *J.Pediatrics*. 2000 ;136(4):497-502.
8. Zar HJ, Brown G, Donson H, Brathwaite N, Mann MD, Weinberg EG. Home-made spacers for bronchodilator therapy in children with acute asthma: a randomised trial. *The Lancet*. 1999;354(9183):979-82.
9. Mazur LJ. Spacers made from sealed cold-drink bottles were as effective as conventional spacers in children with acute asthma. *ACP J Club*. 2000;132(3):102-.
10. Onyedum C, Desalu O, Nwosu N, Chukwuka C, Ukwaja K, Ezeudo C. Evaluation of inhaler techniques among asthma patients seen in Nigeria: an observational cross sectional study. *Ann Med Health Sci Res*. 2014 ;4(1):67-73.
11. Adeniyi A, Erhabor G. The peak flow meter and its use in clinical practice. *Afr J Respir Med*. 2011 ;6(2):5-7.
12. www.ginasthma.org. Global strategy for asthma management and prevention,2017. (Accessed September 27,2017)
13. Foster JM, Usherwood T, Smith L, Sawyer SM, Xuan W, Rand CS, Reddel HK. Inhaler reminders improve adherence with controller treatment in primary care patients with asthma. *J Allergy Clin Immunol*. 2014 ;134(6):1260-8.
14. Nowak RM, Pensler MI, Sarkar DD, Anderson JA, Kvale PA, Ortiz AE, Tomlanovich MC. Comparison of peak expiratory flow and FEV1 admission criteria for acute bronchial asthma. *Ann. Emerg. Med* 1982;11(2):64-9.
15. Raw LJ. Practical problems with aerosol therapy in COPD. *Respir Care*. 2006; 51(2), 158-72.
16. Hamdan AJ, Ahmed A, Abdullah AH, Khan M, Baharoon S, Salih SB, Halwani R, Al-Muhsen S. Improper inhaler technique is associated with poor asthma control and frequent emergency department visits. *Allergy, Asthma & Clin Immunol*. 2013 ;9(1):1.
17. Souza ML, Meneghini AC, Vianna EO, Borges MC. Knowledge of and technique for using inhalation devices among asthma patients and COPD patients. *J bras Pneumol*. 2009 ;35(9):824-31.
18. Nduka SO, Anetoh MU, Amorha KC, Henry OO, Okonta MJ. Use of simulated patient approach to assess the community pharmacists' knowledge of appropriate use of metered dose inhaler. *J Basic Clin Phar*. 2016 ;7(4):116.
19. Adeyeye OO, Kuyinu YA, Bamisile RT, Oghama CI. A preliminary assessment of nurses' asthma education needs and the effect of a training programme in an urban tertiary healthcare facility. *Afri J RespirMed* . 2015 ;10(2):13-17
20. National Asthma Education and Prevention Program: Expert Panel Report III: Guidelines for the diagnosis and management of asthma. Bethesda, MD: National Heart, Lung and Blood Institute; 2007. NIH publication no 08 – 4051). Full text available online: www.nhlbi.nih.gov/guidelines/asthma/asthgdln.htm (Assessed September 27, 2017).
21. Kishore PV, Palaian S, Alam K, Shankar PR, Bajracharya B, Den Ende JV. A correct use of a metered dose inhaler: a prospective interventional study among healthcare professionals in a Nepalese teaching hospital. *J Clin Diagn Res*. 2008;2:720-5.
22. Hanania NA, Wittman R, Kesten S, Chapman KR. Medical personnel's knowledge of and ability to use inhaling devices. Metered-dose inhalers, spacing chambers, and breath-actuated dry powder inhalers. *Chest*. 1994 ;105(1):111-6.
23. Dolovich MB, Ahrens RC, Hess DR, Anderson P, Dhand R, Rau JL: Device selection and outcomes of aerosol therapy: evidence-based guidelines: American college of chest physicians/American college of asthma, allergy, and immunology. *Chest*. 2005, 127 (1): 335-71.
24. Onyedum CC, Ukwaja KN, Desalu OO, Ezeudo C. Challenges in the management of bronchial asthma among adults in Nigeria: A systematic review. *Ann Med Health Sci Res*. 2013 ;3(3):324-9
25. Desalu OO, Onyedum CC, Iseh KR, Salawu FK, Salami AK. Asthma in Nigeria: Are the facilities and resources available to support internationally endorsed standards of care?. *Health policy*. 2011 ;99(3):250-4.
26. Cross D, Nelson HS. The role of the peak flow meter in the diagnosis and management of asthma. *J Allergy Clin Immunol*. 1991 ;87(1):120-8.
27. Plaza V, Sanchis J, Roura P, Molina J, Calle M, Quirce S, Viejo JL, Caballero F, Murio C. Physicians' knowledge of inhaler devices and inhalation techniques remains poor in Spain. *J Aerosol Med Pulm Drug Deliv*. 2012 ;25(1):16-22
28. Iliyasu Z, Abubakar IS, Abubakar S, Lawan UM, Gajida AU. Patients' satisfaction with services obtained from Aminu Kano Teaching Hospital, Kano,

- Northern Nigeria. *Niger J Clin Pract.* 2010 Oct 1;13(4).
29. Joseph C, Nichols S. Patient satisfaction and quality of life among persons attending chronic disease clinics in South Trinidad. *West Indian med. j.* 2007;56(2):108-114
30. G.K. Crompton Problems patients have using pressurized aerosol inhalers *Eur J Respir Dis*, 63 (Suppl 119) (1982), pp. 101-104
31. Press VG, Arora VM, Trela KC, Adhikari R, Zadravec FJ, Liao C, Naureckas E, White SR, Meltzer DO, Krishnan JA. Effectiveness of interventions to teach metered-dose and Diskus inhaler techniques. a randomized t *Ann Am Thorac Soc.* 2016 Jun;13(6):816-24