Benefit of hospital pharmacy intervention on the current status of dry powder inhaler technique in patients with asthma and COPD: a study from the Central Development Region, Nepal

Ramesh Sharma Poudel1
Rano Mal Piryani2
Shakti Shrestha3
Aastha Prajapati1

1Hospital Pharmacy, 2Department of Internal Medicine, Chitwan Medical College Teaching Hospital, 3Department of Pharmacy, Shree Medical and Technical College, Chitwan, Nepal

Background: The majority of patients with asthma and chronic obstructive pulmonary disease (COPD) have been known to perform inhaler technique inadequately. We aimed to evaluate the benefit of hospital pharmacy intervention on the current status of dry powder inhaler (Rotahaler®) technique in such patients and the factors associated with the correct use.

Methods: A pre–post interventional study was conducted at the outpatient pharmacy in a teaching hospital of the Central Development Region, Nepal, in patients with asthma and COPD currently using a Rotahaler device. Patients’ demographics and Rotahaler technique were assessed before intervention. Those who failed to demonstrate the correct technique were educated and trained by the pharmacist, and their technique was reassessed after 2 weeks of intervention. Descriptive statistics, including Wilcoxon signed rank test, Mann–Whitney U test, Spearman’s correlations and Kruskal–Wallis test, were performed for statistical analysis.

Results: Before intervention, only 5.7% (10 of 174) of the patients demonstrated the correct Rotahaler technique and the most common errors observed were failure to breathe out gently before inhalation (98.8%) and failure to hold breath for about 10 seconds after inhalation (84.8%). After the intervention (n=164), 67.1% of the patients showed their technique correctly (p≤0.001) and failure to breathe out gently before inhalation was the most common error (27.44%). Age (p=0.003), previous instruction (p=0.007), patient’s education level (p=0.013) and source of instruction (p<0.001) were associated with an appropriate technique before intervention, while age (p=0.024), duration of therapy (p=0.010) and gender (p=0.008) were the factors correlated with correct usage after intervention.

Conclusion: The current status of Rotahaler technique is inadequate in patients with asthma and COPD attending the Chitwan Medical College Teaching Hospital in the Central Development Region, Nepal. However, a single hospital pharmacy intervention can significantly improve the correct use of the technique, highlighting the role of hospital pharmacies in the improvement of inhaler technique.

Keywords: asthma, COPD, intervention, Nepal, pharmacy, pharmacist, Rotahaler

Introduction
The prevalence of bronchial asthma and chronic obstructive pulmonary disease (COPD) is increasing worldwide.1 Nepal bears a burden of bronchial asthma of ~0.4% of total hospital admission and 1.0% of intensive care unit (ICU) admission,2 while COPD accounts for 12% of all admission cases.3 These groups of patients are mainly treated with inhaled medication using inhaler devices, preferentially pressurized metered dose inhalers (pMDIs) and dry powder inhalers (DPIs).4 The treatment outcomes of
these techniques rely on the ability of patients to correctly perform the technique. It has been reported that up to 94% of patients perform DPI technique incorrectly, resulting in diminished therapeutic effect, poor control of symptoms and therefore insufficient disease management. Patients are also seldom aware that they are performing their inhaler technique inadequately due to overestimation of their own abilities. However, studies have suggested that pharmacist-led interventions in asthma and COPD patients not only improve the inhaler technique but also improve the patients’ compliance, positive outcomes and quality of life. Improvement of inhaler technique also decreases the frequencies of total and nocturnal asthma symptoms and β2-agonist use and improves the peak expiratory flow rate and forced expiratory volume. In Nepal, pharmaceutical care is in a developing state due to limited health care facilities and qualified personnel and low economic status and education level of patients. Studies have shown that Nepalese patients as well as health care professionals (HCPs) have inadequate ability on the correct use of inhaler technique. A study in the capital city of Nepal demonstrated that the all of the COPD patients had an unsatisfactory inhaler technique and about one-third of them never received instruction on the correct use of an inhaler. Similarly, in another study, ~76% of the study population believed that their Rotahaler technique was correct; however, only 44% of the patients performed the technique correctly on assessment, showing significant differences between the patients’ self-reporting of technique and real practice. Furthermore, Nepalese patients living with COPD have been known to experience physical and psychosocial health problems in their daily life, which may be associated with inadequate disease control due to incorrect use of inhaler technique. Therefore, assessment of the inhaler technique and appropriate interventions are necessary in these patients, as majority of them perform the technique incorrectly. Our study aimed to evaluate the benefit of hospital pharmacy intervention on the current status of Rotahaler technique in patients with asthma and COPD and the factors associated with the correct use.

Methods

Study design

This study was conducted at the Medication Counseling Centre of Chitwan Medical College Teaching Hospital (CMCTH), Bharatpur, Nepal, from December 2014 to June 2015 after ethical approval was obtained from the Institutional Review Committee of the Chitwan Medical College. It was a single-group pre–post interventional study designed to evaluate the benefit of hospital pharmacy intervention on the current status of Rotahaler technique and the factors associated with the correct use. A pre-/post-intervention score comparison was used to evaluate the benefit of intervention. The hospital pharmacy intervention comprised individualized education and training on the correct use of Rotahaler technique by a registered pharmacist (successful completion of 4 years bachelor degree in pharmacy and registered in Nepal pharmacy council). The pharmacists were educated and trained in DPI technique by the Health Professionals Education and Research Centre of CMC. In addition, pharmacists were suggested to use drug information leaflets enclosed inside the rotacaps and Rotahaler device. We recruited two pharmacists for this study.

Study population

A total 174 patients with asthma and COPD using Rotahaler device (Cipla Pvt. Ltd., Mumbai, India) for >1 month and who were confident in the Rotahaler technique were recruited for this study. The confirmation of the patient confidence in the correct use of Rotahaler technique was based on their verbal agreement. Patients who demonstrated the technique through other DPI devices such as Instahaler and Rupihaler and were suffering from a mental disorder such as dementia were excluded.

Baseline assessments of technique and intervention

The first pharmacist made appointments with the patients and assessed their eligibility for the study using a predefined checklist (inclusion criteria). Patients who met the inclusion criteria of the study were requested to participate in the study. Patients were well informed about the study, and verbal informed consents were obtained from all patients before participation in the study. The Institutional Review Committee did not require that written consents be obtained due to the type of study, and as the majority of patients were formally uneducated. A structured interview was conducted by the pharmacist to obtain the sociodemographic information such as age, gender, duration of disease, duration of therapy, patient’s education level, residential area, previous instruction received and source of instruction. Subsequently, patients were asked to demonstrate their technique using the placebo (capsule without active ingredient), while the pharmacist observed the technique according to the Rotahaler-specific GINA guideline checklist (eight Rotahaler-specific checklist items, three items for preparation of medication and five items for inhalation of medication). Each correct step was scored “1” and incorrect or missed step was scored “0”. The patients who scored “8” were considered using a correct Rotahaler technique and were excluded from the intervention. Those who failed to demonstrate the correct technique (made at least one error)
were educated and trained (intervention) on the correct use of technique, which included verbal instruction, followed by demonstration of the technique (two times) using placebo, and were trained till no error was observed. During the pharmacist’s instruction, the patients were also allowed to ask questions for further clarification. The baseline assessments, education and training were carried out by the first pharmacist on the same day of visit to the hospital. Patients and their accompanying relatives were instructed to use leaflets as supplementary information. At the end of the first appointment, the pharmacist conducted an interview on the management of Rotahaler device (washing, storage and changing), provided instruction on the proper management and invited the patient for a second appointment after 2 weeks of intervention. On the second appointment, the second pharmacist reassessed the technique and marked each single step correct or incorrect according to the GINA guidelines checklist.20

Statistical analysis
Initially, numeric data were checked for normality using Shapiro–Wilk test; however, none of them followed the normal distribution. So, nonparametric tests were applied for statistical analysis. Wilcoxon signed rank test was used to evaluate the benefit of hospital pharmacy intervention (comparison of pre- and post-intervention scores). The scores (pre and post) were compared within dichotomous variables using Mann–Whitney U test. Spearman’s correlation was used to determine the relationship between two numeric variables, and Kruskal–Wallis test was performed for the analysis of variance. A p-value of <0.05 was considered as significant. Data were analyzed using SPSS 21.0.

Results
In our study, females were predominant (55.2%). The median (interquartile range [IQR]) age was 64 (55–71) years. The median (IQR) duration of disease and therapy was 4 (1.4–10.0) and 2 (0.3–5.0) years, respectively. Most of the patients (127, 73%) were living in the rural area. The majority (84, 50.6%) of patients reported that they had received the instructions from the physician, and eight (4.6%) patients claimed that they are not instructed on the use of Rotahaler device (Table 1).

Only 10 (5.7%) patients demonstrated the correct Rotahaler technique on the baseline assessment and were excluded from the intervention. The overall median score (IQR) before intervention was 6 (5–6), which increased to 8 (7–8) after the intervention, and 110 (67.1%) patients were able to perform the correct Rotahaler technique. This difference was statistically significant at p<0.001 (Table 2). Significant improvement was observed in step 4 (1.2%–72.6%) and step 8 (15.2%–92.7%) after the intervention (Table 3).

The Spearman’s correlation test showed a weak relationship between pre-intervention score and age (p=0.003; correlation coefficient −0.223); post-intervention score and age (p=0.024; correlation coefficient −0.178) and post-intervention score and duration of therapy (p=0.010; correlation coefficient −0.083). Similarly, Mann–Whitney U test showed that pre-intervention score was associated with

| Table 1 Demographic characteristics of the patients assessed for the intervention (n=174). |
|---|
| Variables | Category | n (%) |
| Gender | Male | 78 (44.8) |
| | Female | 96 (55.2) |
| Age (years)* | 64 (55–71) |
| Duration of disease (years)* | 4 (1.38–10) |
| Duration of therapy (years)* | 2 (0.34–5) |
| Education | Formally uneducated | 125 (71.8) |
| | Primary education | 18 (10.3) |
| | Secondary education | 23 (13.2) |
| | Intermediate level | 5 (2.9) |
| | Bachelor or above | 3 (1.7) |
| Residential area | Rural | 127 (73) |
| | Urban | 47 (27) |
| Pervious instruction on Rotahaler® technique | Yes | 166 (95.4) |
| | No | 8 (4.6) |
| Source of instruction (n=166) | Pharmacy personnel | 57 (34.3) |
| | Physician | 84 (50.6) |
| | Nurse | 25 (15.0) |
| Pre-intervention score (n=174)* | 2 | 7 (4.0) |
| | 3 | 8 (4.6) |
| | 4 | 9 (5.2) |
| | 5 | 39 (22.4) |
| | 6 | 76 (43.7) |
| | 7 | 25 (14.4) |
| | 8 | 10 (5.7) |
| Post-intervention score (n=164)** | 5 | 2 (1.2) |
| | 6 | 4 (2.4) |
| | 7 | 48 (29.3) |
| | 8 | 110 (67.1) |

Notes: *Median (IQR). **Ten patients were excluded from the intervention since they correctly performed the Rotahaler technique at baseline and were not included in the second assessment. *The possible scores were out of a total of 8; none of the patients scored 1 for the pre-intervention and none scored 1–4 for the post-intervention, so those values were not included in the table. Abbreviation: IQR, interquartile range.

| Table 2 Effect of hospital pharmacy-based educational intervention on correctness of Rotahaler® technique (n=164) |
|---|
| Assessment of Rotahaler® technique | Median (IQR) | p-value |
| | Before intervention | 6 (5–6) | <0.001* |
| | After intervention | 8 (7–8) |

Note: *Wilcoxon signed rank test. Abbreviation: IQR, interquartile range.
Step 8. Hold breath for 10 seconds

Step 7. Take Rotahaler out of mouth and deeply

Step 6. Breathe in the powder quickly

Step 5. Put mouthpiece between lips and teeth

Step 4. Breathe out gently

Step 3. Splits capsule into cap and body

Step 2. Put capsule into square hole

Step 1. Hold Rotahaler vertically

Gender* Male 6 (5–6.25) 17 (9.8) Female 6 (5–6)

Education** Formally uneducated 6 (5–6) 79 (45.4) Primary education 6 (6–6.25) 75 (45.6) Secondary education 6 (7–8) 149 (85.6) Intermediate level 6 (5.5–7) 80 (47.5) Bachelor or above 6 (6–7) 75 (45.4)

Abbreviation: *Mann–Whitney test, **Kruskal–Wallis test.

Notes: IQR, interquartile range.

Table 3 Comparison of correct Rotahaler® technique before and after intervention (n=164)

| Rotahaler checklist | Before intervention, patients, n (%) | After intervention, patients, n (%) |
|---------------------|-------------------------------------|-----------------------------------|
| Step 1. Hold Rotahaler vertically | 156 (95.1) 164 (100) |
| Step 2. Put capsule into square hole | 148 (90.2) 164 (100) |
| Step 3. Splits capsule into cap and body | 146 (89.0) 164 (100) |
| Step 4. Breathe out gently | 2 (1.2) 119 (72.56) |
| Step 5. Put mouthpiece between lips and teeth | 146 (89.0) 162 (98.78) |
| Step 6. Breathe in the powder quickly | 156 (95.1) 164 (100) |
| Step 7. Take Rotahaler out of mouth | 120 (73.2) 162 (98.78) |
| Step 8. Hold breath for –10 seconds | 25 (15.2) 152 (92.68) |

Table 4 Association of sociodemographic variables with pre-intervention score (n=174)

| Variables | Category | Median (IQR) score | p-value |
|-----------|----------|-------------------|---------|
| Gender*   | Male     | 6 (5–6.25)        | 0.170   |
|           | Female   | 6 (5–6)           |         |
| Previous  instruction on Rotahaler technique* | Yes | 6 (5–6) | 0.007 |
|           | No       | 4.50 (3.25–5.75)  |         |
| Residential area* | Urban | 6 (5–6) | 0.457 |
|               | Rural    | 6 (5–6)           |         |
| Source of instruction** | Pharmacy | 6 (6–7) | <0.001 |
|               | Physician | 6 (5–6) |         |
|               | Nurses   | 6 (5–6)           |         |
| Education*** | Formally uneducated | 6 (5–6) | 0.013 |
|               | Primary education | 6 (6–6.25) |       |
|               | Secondary education | 6 (5–7) |       |
|               | Intermediate level | 6 (5.5–7) |       |
|               | Bachelor or above | 6 (6–no value) |       |

Notes: *Mann–Whitney U test, **Kruskal–Wallis test. Abbreviation: IQR, interquartile range.

Table 5 Association of sociodemographic variables with post-intervention score (n=164)

| Variables | Category | Median (IQR) score | p-value |
|-----------|----------|-------------------|---------|
| Gender*   | Male     | 8 (8–8)           | 0.008   |
|           | Female   | 8 (7–8)           |         |
| Residential area* | Urban | 8 (7–8) | 0.622 |
|               | Rural    | 8 (7–8)           |         |
| Education*** | Formally uneducated | 8 (7–8) | 0.090 |
|               | Primary education | 8 (8–8) |       |
|               | Secondary education | 8 (7–8) |       |
|               | Intermediate level | 8 (8–8) |       |
|               | Bachelor or above | 8 (8–8) |       |

Notes: *Mann–Whitney U test, **Kruskal–Wallis test. Abbreviation: IQR, interquartile range.

Table 6 Reponses on the management of Rotahaler® device (n=174)

| Questions on Rotahaler management | Response | Patients, n (%) |
|-----------------------------------|----------|----------------|
| Did you wash the Rotahaler at least twice a week? | Yes | 95 (54.6) |
| Did you always store the Rotahaler in its box? | Yes | 149 (85.6) |
| Did you know that a new Rotahaler is to be used every 6 months? | Yes | 17 (9.8) |

Discussion

In our study, >94% of the patients demonstrated the incorrect Rotahaler technique on baseline assessment. Such improper inhaler technique has been associated with poor disease control, increased risk of hospitalization, emergency room visits, courses of oral steroids and antimicrobials.5,21 Our single hospital pharmacy intervention corrected the Rotahaler technique in 67.1% (110 of 164) of the patients. In contrast to this, a previous study by Shrestha et al showed that the combination of video and demonstration strategy corrected the technique in 33.6% of the intervened patients,16 suggesting that the verbal instruction followed by demonstration and training might be a better strategy in improving the Rotahaler technique. Evidence showed that individual coaching (observation, verbal instruction and physical demonstration) significantly improves the technique on a long-term basis.22 Moreover, educating patients on the correct use of inhaler technique (verbal training, demonstration movie and leaflet) also lowers the number of attacks, emergency visits and hospitalizations, together with improvement of quality of life of patients.10,23 Our study also showed that patients had inadequate knowledge on the management of the Rotahaler device, including cleaning and frequency of changing the Rotahaler, highlighting the need of an educational intervention not only on the correct use of the technique but also on the management of the Rotahaler device.
Data showed that illiterate patients, as in our study, made more errors than postgraduates and professionals while using a DPI, suggesting that drug information leaflets enclosed within DPIs might not be user-friendly to illiterate patients or patients with low literacy level. In our study, the majority of patients failed to exhale before inhalation (98.8%) followed by holding breath after inhalation (84.8%). Similar results were reported by Lavorini et al in their study. Failure to exhale before inhalation hinders the forceful and deep inhalation, particularly in children and those with severe airflow limitation, resulting in insufficient drug release and low lung deposition. Similarly, failure to hold breath after inhalation may decrease the chance of adequate lung deposition. Moreover, there were some patients in our study who were unaware about the process of breaking the capsule into body and cap, which might lead to the loss of medicine and therapeutic failure. Such errors ultimately decrease the effectiveness of the drug therapy and adequate disease control.

In our study, pre-intervention score was significantly associated with age, previous instruction, patient’s education level and source of instruction. This association indicates that younger patients, who received previous instruction on the Rotahaler technique and formally educated patients who received instruction from the pharmacy had better possibility of demonstrating the correct Rotahaler technique at baseline. The study by Aydemir also revealed that educational status, gender, living areas, duration of disease and being diagnosed and followed up by a specialist were associated with the correct use of inhaler technique at baseline. However, after the standard training, the correct use of the technique was associated with old age and the type of the pMDI devices. In our study, post-intervention score was significantly associated with age, duration of therapy and gender, suggesting that older patients, patients having longer duration of therapy and female patients might score poorly even after single intervention. Association of post-intervention score with age and gender suggests that reinforcement and re-assessment or additional interventions were needed in older and female patients in comparison to younger and male patients in our setting. Similarly, weak negative association between post-score and duration of therapy highlights the necessities of early intervention on the Rotahaler technique.

Incorrect use of inhaler devices by the patients may be a direct consequence of inadequate instruction by the health caregivers, and a 100% error has been seen in self-educated patients. In our study, 4.6% of the patients had not received instruction from HCPs. A systematic review has reported that about one-fourth of the patients had never received instruction, and for those who had received some instruction it was almost always <10 minutes duration with no follow-up evaluation in nearly half of the patients. Further, another study in Nepal had shown that 30% of patients had never been educated on the use of the inhaler. Studies showed that training improves the capability of patients to use established DPIs, however, repetitive training and assessment of technique were suggested for proper use of the technique, adherence to therapeutic regimen and improving health-related quality of life in COPD patients.

Patients can come across the HCPs to receive instructions on the correct use of inhaler devices. Therefore, the knowledge and skills of the HCPs on inhaler technique significantly affect patients’ education outcomes. There was a widespread ignorance of HCPs on educating the patients regarding inhaler technique, and up to 85% of them may fail to use inhalers correctly. In addition, they may have poor demonstrating skills of one type of inhaler device over another. Studies showed that HCPs have poor knowledge on the correct use of inhaler devices. Hence, to ensure that correct instruction and training have been provided to patients, HCPs should be well educated and trained regarding various inhaler devices. HCPs’ knowledge and skills can be significantly improved through educational intervention on a long-term basis.

This study had some limitations that may reduce the accuracy and generalizability of the results. First, the assessment was repeated after 2 weeks of intervention; hence, the long-term effectiveness of the intervention remains unidentified. The Hawthorne effect might have also affected the accuracy of our study results, whereby the patients might act in a different manner when they are aware of being observed. In this study, patients might have been motivated to demonstrate appropriate Rotahaler technique due to the unseen effect of them being observed. On the other hand, use of placebo (no real medication) might render some patients to be less motivated on the correct use of Rotahaler technique. In addition, all the patients were recruited from a single site, thus affecting the generalizability of these results. Finally, the study was limited by its design itself as the pre–post design might not be ideal for evaluating the effectiveness of an intervention. Besides these limitations, our results have a high practical relevance. Implementation of this service in every hospital pharmacy may upgrade the current status of inhaler technique in patients with asthma and COPD. Moreover, this study has been able to assess the current status of the Rotahaler technique among the patients with asthma and COPD in Nepal and will probably be one of the first studies to evaluate the effect of education and training on the current use of...
Rotahaler technique from this country and will certainly add to the body of literature in this area of practice.

Conclusion
The current status of Rotahaler technique is inadequate among patients with asthma and COPD attending the CMCTH of the Central Development Region, Nepal. However, a single hospital pharmacy intervention significantly improved the correct use of the technique. Our study suggests that single educational intervention and training might not be sufficient for elderly and female patients. There is also a need to routinely assess the Rotahaler technique of asthma and COPD patients during their visits to hospital pharmacies in accordance with published guideline recommendations. Additionally, the pharmacist should focus and insist on the two steps of the technique, ie, to breathe out gently before inhalation and to hold breath for ~10 seconds after inhalation, during education and training session.

Acknowledgments
The authors are grateful to Saroj Gyawali, Bina Adhikari, Nawaraj Chaudhary, Samjhana Adhikari Bhatta, Rajan Sapkota, Pariksha Devkota, Jyoti Koirala, clinicians from different departments and the patients and their relatives for their warm support and coordination throughout this study.

Disclosure
The authors report no conflicts of interest in this work.

References
1. Brocklebank D, Ram F, Wright J, et al. Comparison of the effectiveness of inhaler devices in asthma and chronic obstructive airways disease: a systematic review of the literature. Health Technol Assess. 2001;5(26):1–149.
2. Sayami A, Shrestha BR. Critical Care (Manual of ICU and CCU of TU Teaching Hospital). 1st ed. Chiyoda-ku: Japan International Cooperation Agency (JICA); 1995.
3. Bhandari GP, Anagdembe MR, Dhimal M, Neupane S, Bhusal C. State of non-communicable disease in Nepal. BMC Public Health. 2014;14(1):23.
4. Lavorini F, Corrigan CJ, Barnes PJ, et al. Retail sales of inhalation devices in European countries: so much for a global policy. Respir Med. 2011;105(7):1099–1103.
5. Melani AS, Bonavia M, Cilenti V, et al. Inhaler mishandling remains common in real life and is associated with reduced disease control. Respir Med. 2011;105(6):930–938.
6. Lavorini F, Magnan A, Dubus JC, et al. Effect of incorrect use of inhaler on management of patients with asthma and COPD. Respir Med. 2008;102(4):593–604.
7. Erickson SR, Horton A, Kierding DM. Assessing metered-dose inhaler technique: comparison of observation vs. patient self-report. J Asthma. 1998;35(7):575–583.
8. Hammerlein A, Muller U, Schulz M. Pharmacist-led intervention study to improve inhalation technique in asthma and COPD patients. J Eval Clin Pract. 2011;17(1):61–70.
9. Ottenbros S, Teichert M, de Groot R, et al. Pharmacist-led intervention study to improve drug therapy in asthma and COPD patients. Int J Clin Pharm. 2014;36(2):336–344.
10. Goris S, Tasci S, Elmali F. The effects of training on inhaler technique and quality of life in patients with COPD. J Aerosol Med Pulm Drug Deliv. 2013;26(6):336–344.
11. Diamond SA, Chapman KR. The impact of a nationally coordinated pharmacy-based asthma education intervention. Can Respir J. 2001;8(4):261–265.
12. Rahmati H, Ansarfard F, Ghodsbin F, Ghayumi MA, Sayadi M. The effect of training inhalation technique with or without spacer on maximum expiratory flow rate and inhaler usage skills in asthmatic patients: a randomized controlled trial. Int J Community Based Nurs Midwifery. 2014;2(4):211–219.
13. Pedersen S, Frost L, Arnfred T. Errors in inhalation technique and efficiency in inhaler use in asthmatic children. Allergy. 1986;41(2):118–124.
14. Kishore PV, Palajan 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(2):720–725.
15. Graham LE. The ineffective use of inhalers in chronic obstructive pulmonary disease. J Inst Med. 2001;23:22–24.
16. Shrestha S, Sapkota B, Ghimirey A, Shakya R. Impact of counselling in inhalation technique (rotahaler) in chronic obstructive pulmonary disease patients. Int J Pharm. 2013;3(3):442–449.
17. Sharma K, Joshi S. Lived experiences of patients with chronic obstructive pulmonary disease in Chitwan, Nepal. Int J Health Sci Res. 2015;5(8):390–400.
18. Cordinia M, McElnay JC, Hughes CM. Assessment of a community pharmacy-based program for patients with asthma. Pharmacotherapy. 2001;21(10):1196–1203.
19. Armour C, Bosnic-Anticevich S, Brillant M, et al. Pharmacy Asthma Care Program (PACP) improves outcomes for patients in the community. Thorax. 2007;62(6):496–502.
20. Global initiative for asthma (GINA). Instruction for Inhaler and Spacer Use. Available from: http://www.ginasthma.org/local/uploads/content/files/inhaler_charts_2011.pdf. Accessed June 13, 2014.
21. Al-Jahdali H, Ahmed A, Al-Harbi A, et al. Improper inhaler technique is associated with poor asthma control and frequent emergency department visits. Allergy Asthma Clin Immunol. 2013;9(1):8.
22. Crane MA, Jenkins CR, Goeman DP, Douglass JA. Inhaler device technique can be improved in older adults through tailored education: findings from a randomised controlled trial. NPJ Prim Care Respir Med. 2014;24:14034.
23. Liorini F, Usmani OS. Correct inhalation technique is critical in achieving good asthma control. Prim Care Respir J. 2013;22(4):385–386.
24. Arora P, Kumar L, Vohra V, et al. Evaluating the technique of using inhalation device in COPD and bronchial asthma patients. Respir Med. 2014;108(7):992–998.
25. Beatty CR, Flynn LA, Costello TJ. The impact of health literacy level on inhaler technique in patients with chronic obstructive pulmonary disease. J Pharm Pract. Epub 2015 Jun 1.
26. Newman SP, Busse WW. Evolution of dry powder inhaler design, formulation, and performance. Respir Med. 2002;96(5):293–304.
27. Aydemir Y. Assessment of the factors affecting the failure to use inhaler devices before and after training. Respir Med. 2015;109(4):451–458.
28. Goren A, Noviski N, Avital A, et al. Assessment of the ability of young children to use a powder inhaler device (Turbuhaler). Pediatr Pulmonol. 1994;18(2):77–80.
29. Brocklebank D, Ram F, Wright J, et al. Comparison of the effectiveness of inhaler devices in asthma and chronic obstructive airways disease: a systematic review of the literature. Health Technol Assess. 2001;5(26):1–149.
30. Giner J, Macian V, Hernandez C. Multicenter prospective study of respiratory patient education and instruction in the use of inhalers (EDEN Study). Arch Bronconeumol. 2002;38(7):300–305.
31. Takemura M, Mitsui K, Iotani R, et al. Relationships between repeated instruction on inhalation therapy, medication adherence, and health status in chronic obstructive pulmonary disease. Int J Chron Obstruct Pulmon Dis. 2011;6:97–104.
32. Keeley D. Ignorance about teaching inhaler technique is widespread among healthcare professionals. *BMJ*. 2014;348:g3452.

33. Basheti IA, Armour CL, Reddel HK, Bosnic-Anticevich SZ. Long-term maintenance of pharmacists’ inhaler technique demonstration skills. *Am J Pharm Educ*. 2009;73(2):32.

34. Valarmathi S, Parajulee S. Knowledge of nursing practitioners towards use of meter dose inhaler in a tertiary care teaching hospital in Nepal. *Rawal Med J*. 2011;36(3):186–189.

35. Kim SH, Kwak HJ, Kim TB, et al. Inappropriate techniques used by internal medicine residents with three kinds of inhalers (a metered dose inhaler, Diskus, and Turbuhaler): changes after a single teaching session. *J Asthma*. 2009;46(9):944–950.

36. McCarney R, Warner J, Iliffe S, van Haselen R, Griffin M, Fisher P. The Hawthorne effect: a randomised, controlled trial. *BMC Med Res Methodol*. 2007;7:30.