

Original Research

A specialized training program on inhaler technique delivered by pharmacists to nurses: a study from the United Arab Emirates

Iman Basheti , Laila Salameh , Bassam Mahboub , Mohammad Abed Sakarneh , Basema Saddik , Mena Al-Ani , Mohamed Al-Hajjaj , Eman Abu-Gharbieh 

Received (first version): 09-Aug-2022

Accepted: 27-Aug-2022

Published online: 09-Sep-2022

Abstract

Background: Inhaled drug delivery has been hailed as a major advancement in respiratory therapeutics. However, a major limitation to use the inhaled medications effectively is the inability of patients and nurses to use and demonstrate the proper use of these devices correctly. Being the drug experts, pharmacists are in a pivotal position to delivered tailored education to their peers, the nurses. **Aim:** This study aims to examine nurses' knowledge of asthma management, their ability to demonstrate proper inhaler technique, and the impact of a specialized workshop training program delivered by skilled pharmacists on improving their performance. **Methods:** This is a pre- and post-cross-sectional study design in hospital setting where nurses were recruited from the respiratory and emergency departments within a healthcare facility in the United Arab Emirates (UAE). The nurses attended a training workshop prepared and delivered by skilled pharmacists on inhaler technique demonstration skills. Nurses' inhaler technique demonstration skills for Diskus, Turbuhaler, and pMDI were assessed at baseline, immediately after the workshop, and after four weeks. The nurses completed the demographic and Asthma Knowledge Questionnaire (AKQ). **Results:** A random convenience sample of registered nurses (n=20) from the respiratory and emergency departments was recruited from a tertiary hospital in Sharjah, UAE, with a mean age of 35.25 (SD=6.96) years, of whom 90% were females. The mean number of years of experience was 12.00 years (SD=5.81). Inhaler technique assessment revealed low inhaler technique scores for all the three study inhalers at baseline (mean score for Diskus=3.85 (SD=2.87); Turbuhaler=3.70 (SD=3.20); pMDI=4.50 (SD=2.65)). Significant improvements in inhaler technique scores were noted after the workshop (Diskus=8.9 (SD=0.31); Turbuhaler=8.9 (SD=0.31); pMDI=8.0 (SD=0.00), P<0.001). A significant difference in AKQ scores was found before (mean=4.85 (SD=1.27)) and after (mean=7.50 (SD=0.95)) the workshop training session (P<0.001), and four weeks after the workshop training session (mean=7.55 (SD=0.76), P<0.001). **Conclusion:** The UAE nurses' inhaler technique and AKQ scores were suboptimal at baseline. The specialized training program prepared and delivered by the skilled pharmacists improved nurses' inhaler technique demonstration skills and AKQ scores. Such improvements would reflect positively on patients' asthma management outcomes as nurses are the health care professionals who interact the most with the patients during hospitalization.

Keywords: asthma; inhaler technique; training; United Arab Emirates; nursing

Iman BASHETI. Department of Clinical Pharmacy and Therapeutics, Faculty of Pharmacy, Applied Science Private University, P.O. Box 166, Amman 11931, Jordan. dr_iman@asu.edu.jo

Laila SALAMEH. Sharjah Institute for Medical Research, University of Sharjah, Sharjah 27272, Rashid Hospital, Dubai Health Authority, Dubai 4545, United Arab Emirates. lisalameh@dha.gov.ae

Bassam MAHBOUB. Rashid Hospital, Dubai Health Authority, Dubai 4545, United Arab Emirates. BHMahboub@dha.gov.ae

Mohammad Abed SAKARNEH. Department of Special Education, Princess Rahama University College, Al-Balqa Applied University, Al Salt 19117, Jordan. msakarneh@bau.edu.jo

Basema SADDIK. Sharjah Institute for Medical Research, University of Sharjah, Sharjah 27272, Department of Family and Community Medicine and Behavioral Sciences, College of Medicine, University of Sharjah, Sharjah 27272, United Arab Emirates. bsaddik@sharjah.ac.ae

Mena AL-ANI. Sharjah Institute for Medical Research, University of Sharjah, Sharjah 27272, United Arab Emirates, UCL Great Ormond Street Institute of Child Health,

Developmental Biology and Cancer Department, London WC1N 1EH, United Kingdom. m.alani@ucl.ac.uk

Mohamed AL-HAJJAJ. Department of Clinical Sciences, College of Medicine, University of Sharjah, Sharjah 27272, University Hospital Sharjah, Sharjah, Sharjah 72772, United Arab Emirates. malhajjaj@sharjah.ac.ae

Eman ABU-GHARBIEH*. Sharjah Institute for Medical Research, University of Sharjah, Sharjah 27272, Department of Clinical Sciences, College of Medicine, University of Sharjah, Sharjah 27272, United Arab Emirates. eabugharbieh@sharjah.ac.ae

INTRODUCTION

In the United Arab Emirates (UAE), asthma is one of the most predominant diseases, affecting 8-10% of adults.¹ In the UAE, 53% of children with asthma and 17% of adults miss work or school.² Inhaled drug delivery has been hailed as a major advancement in respiratory therapeutics. As a result, drug delivery devices for various respiratory conditions have been developed. Inhaled asthma therapy is now widely available, ranging from traditional nebulizers to more modern dry-



powder inhalers (DPIs).

Whilst quite evolutionary in design and concept, a major limitation to use inhaled medications effectively is the inability of patients (28-68%),³⁻⁵ and healthcare professionals (HCPs), including nurses (15-69%)⁶⁻¹⁰ to use and demonstrate the proper use of these devices. In turn, incorrect patient device usage defeats the purpose of therapy and leads to low medication lung deposition.¹¹ Bronchodilator inhalers can significantly lose their effects, which eventually can be life-threatening.^{12,13} For controller inhalers, incorrect use can lead to poor asthma control, increased emergency visits,¹⁴ and eventually higher asthma management costs.^{15,16}

An effective counselling intervention on asthma device use prepared and delivered by pharmacists, the drug experts, has recently been shown to have positive clinical outcomes, including improved asthma control and reduced severity.¹⁷⁻²⁰ Progressive, humanistic outcomes, including better asthma-related quality of life and better-perceived control over asthma for patients with asthma, were also reported. Many other DPI-targeted inhaler technique education interventions reported similar outcomes, with significant improvements in inhaler technique, asthma control, beliefs about medicines, quality of life, and patient satisfaction.^{21,22} Similarly, with Pressurized Metered Dose Inhalers (pMDIs), interventional studies improved asthmatics patients' inhaler technique demonstration skills.²³

Not all HCPs are competent in assessing and teaching inhaler techniques.²⁴ Nurses are often the primary caregivers for patients with chronic diseases in hospitals.²⁵ Nurses provide much of the primary, secondary, and tertiary care for asthma patients and are essential in most care programs. In collaboration with the patient and physician, nurses are often the frontline providers of patient care in asthma.²⁶ Patients' satisfaction with nursing care is considered important in explaining hospital service quality perceptions.²⁷

A strong relationship with patients is encouraged by the National Asthma Education Prevention Plan (NAEPP) guidelines.²⁶ These collaborations enable nurses to identify high-risk patients, provide enhanced care or specialist referrals and educate patients, including inhaler technique.²⁶ No previous study in the UAE examined nurses' asthma knowledge and inhaler technique, nor the effect of the specialized educational program in this area previously prepared, trialed successfully, and published by expert pharmacists in the field.^{20,28}

This study aimed to examine the nurses' knowledge about asthma management, their demonstration skills of correct inhaler technique, and the effect of a training program prepared and delivered by skilled pharmacists on their performance.

METHODOLOGY

Study participants

A random convenience sample of registered nurses from the

respiratory and emergency departments was recruited from a tertiary hospital in Sharjah. The researchers (a group of clinical pharmacists expert in the field of inhaler technique education) approached nurses just before starting their working round or during their break time. All nurses who agreed to participate in the study after reading the informed consent form were included. Inclusion criteria included nurses having experience not less than one year and attending a three-hour workshop on asthma management guidelines.

The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the University Hospital Sharjah Ethics and Research Committee (UHS-HERC-040 -09042018) and the Research Ethics Committee of the University of Sharjah (REC-17-01-29-04, 8 May 2017).

The workshop

Participants were invited to a three-hour asthma management workshop in June 2020 from 5:00 to 8:00 pm. Figure 1 summarizes the three-hour workshop, its time, and content. First, the participants had to demonstrate inhaler techniques before presenting asthma management information. Three different assessors (expert clinical pharmacists in the field, one for each device) sat in three different rooms, and only

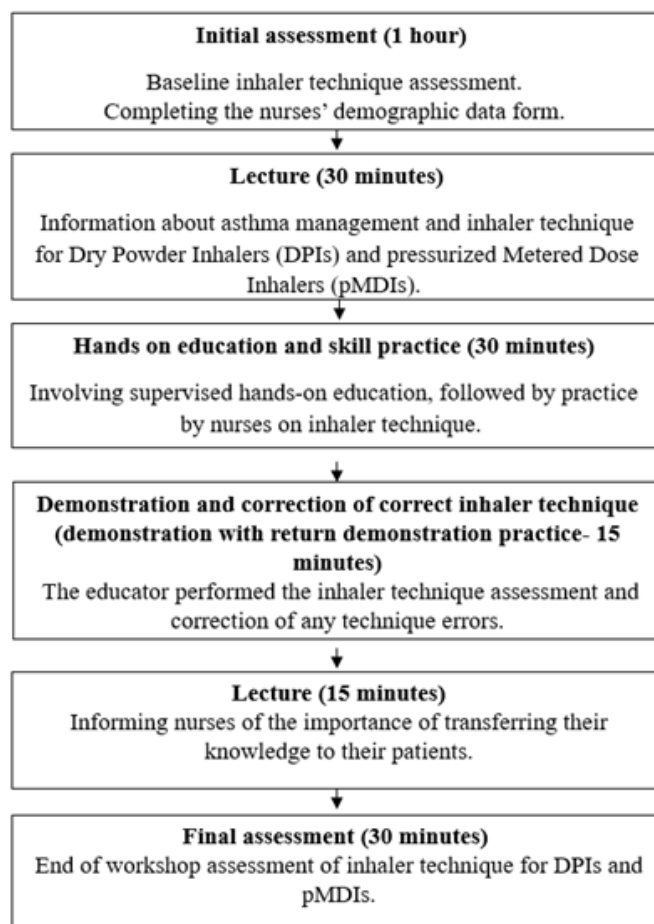


Figure 1. Summary of the three-hour workshop, time, and content of each segment of the workshop



one participant entered at a time (according to a randomized prepared list). Participants were asked to complete the demographic and Asthma Knowledge Questionnaire (AKQ). They were then educated on asthma knowledge via a presentation by a specialist in the area of asthma management and then educated on correct inhaler technique using previously published methods, including verbal information on the technique and a physical demonstration of the steps involved in the technique checklist for each study inhaler (Diskus, Turbuhaler, and pMDI). All participants were then assessed again on their inhaler technique demonstration skills for the three devices in random order by the same assessors as the pre-workshop assessment.

Data collection tools

Two separate study instruments were used to assess the knowledge of asthma and inhaler technique competence for data collection. In order to evaluate nurses' knowledge of asthma symptoms and management, participants completed a pre-published questionnaire,²⁸ which comprised of questions regarding their demographic characteristics (age, gender, and years in practice) and their knowledge of asthma devices (Diskus, Turbuhaler, and pMDI). The AKQ comprised 8 true/false questions about asthma and its treatment;²⁹ the AKQ score was calculated and presented as a mean score (standard deviation, SD) out of 8. All questionnaires were administered in English.

To evaluate the competence of participants on correct inhaler technique, each participant was asked to demonstrate the inhaler technique skill by using the placebo inhaler device provided by AstraZeneca, (AstraZeneca Pharmaceuticals, Wilmington, DE, USA; Amman, Jordan) and GlaxoSmithKline (GSK), (Philadelphia, PA, USA; Amman, Jordan) to one trained observer (a clinical pharmacist with extensive involvement in the assessment and teaching of inhaler technique).

Published checklists for the study inhalers (Diskus, Turbuhaler, and pMDI) were used.^{30,31} The checklists for each device consist of 9 steps (for Diskus and Turbuhaler) or 8 steps (for pMDI), with three essential steps (without these steps, little or no medication would reach the airway) for the Diskus and pMDI, and four essential steps for the Turbuhaler.

After the trials, all participants were educated on proper inhaler techniques. The steps were based on the Diskus,³⁰ Turbuhaler,¹⁷ and pMDI technique manufacturer's instructions.³² The assessment was done at three points: baseline, immediately after the workshop's teaching sessions, and four weeks later. Nurses' knowledge and skills in demonstrating inhaler techniques were compared.

Data analysis

The nurses' responses were coded and analysed using IBM Statistical Package for the Social Sciences (IBM SPSS, version 21, Chicago, IL, US). Descriptive analysis and Chi-square test were used to identify any significant associations among the nurse's knowledge responses with significance defined as a P-value of

≤ 0.05 . Inhaler technique assessment among the participants before and immediately after the workshop session and four weeks after the workshop was compared using the paired sample t-test, $p < 0.05$ was considered significant.

RESULTS

Figure 2 shows participants' recruitment and retention into the study. The study participants ($n=20$) had a mean age of 35.25 (SD=6.96) years, of whom 90% were females. The mean number of years of experience was 12.00 years (SD=5.81).

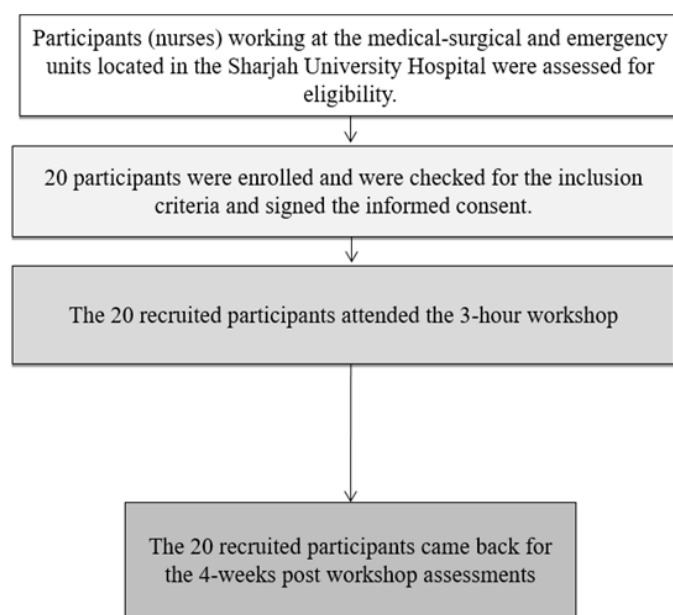


Figure 2. CONSORT diagram showing participants' recruitment and retention during the study four-week period

Inhaler technique demonstration skills

Inhaler technique assessment revealed low inhaler technique scores for all the three study inhalers at baseline (mean score for Diskus=3.85 (SD=2.87); Turbuhaler=3.70 (SD= 3.20); pMDI=4.50 (SD= 2.65)). Significant improvements in inhaler technique scores were noted immediately after the workshop (Table 1). When comparing inhaler technique scores at baseline (before the training session), no difference was noted between the Diskus and Turbuhaler ($p=0.824$), nor between the Diskus and the pMDI ($p=0.290$), or between the Turbuhaler and pMDI ($p=0.391$). However, a significant difference was found in inhaler technique scores for each of the three devices before and immediately after the workshop, with higher mean scores for all inhalers after the training session (Table 1).

No significant difference was found in the Diskus inhaler technique score when comparing immediately after the workshop scores and four weeks later (mean scores 8.9 (0.31) vs 8.7 (0.57)). The same results were found for the Turbuhaler (mean scores 8.9 (0.31) vs. 8.7 (0.57)) and pMDI scores (mean scores 8.0 (0.00) vs. 7.7 (0.57)). No correlation (Pearson's



Table 1. Mean inhaler technique scores for the Diskus, Turbuhaler and pMDI for study participants (n=20) before the workshop and immediately after the workshop

	Diskus (Score out of 9)			Turbuhaler (Score out of 9)			pMDI (Score out of 8)		
	Pre	Post	P-value	Pre	Post	P-value	Pre	Post	P-value
Mean	3.85	8.9	<0.001	3.70	8.9	<0.001	4.50	8.0	<0.001
SD	(2.87)	(0.31)		(3.20)	(0.31)		(2.65)	(0.000)	

correlation) was found between inhaler technique for the Diskus (p=0.430), Turbuhaler (p=0.781), or pMDI (p=0.688) with years of experience.

Individual steps performance

Steps assessment for the Diskus showed that the majority of participants did not perform most of the steps correctly before the workshop (Table 2). The steps that were performed incorrectly by most of the participants (80.0%) were exhaling away from the mouthpiece, followed by holding the breath for 5 seconds (70.0%), inhaling forcefully and deeply, and exhaling

away from the mouthpiece (65.0%).

After the training workshop and 4-weeks later, almost all of the steps were performed correctly by most participants (Table 2). Figure 3 displays the inhaler technique scores for the three study inhalers across the different study stages (pre-workshop, post-workshop and four weeks post-workshop).

Regarding the Turbuhaler, the pre-workshop assessment revealed that most participants did not perform the steps correctly, including exhaling away from the mouthpiece (90.0%), placing the mouthpiece between the teeth and lips

Table 2. The proportion of participants (n=20) who demonstrated the inhaler technique skills of the Diskus before the workshop, after the workshop, and four weeks after the workshop

Action	The percentage of the action performed correctly		
	Before the workshop	After the workshop	Four-weeks after the workshop
Open inhaler	65%	100%	90%
Push lever back completely	65%	100%	100%
Exhale to residual volume	40%	100%	95%
Exhale away from mouthpiece	20%	100%	95%
Mouth-piece between teeth and lips	45%	100%	95%
Inhale forcefully and deeply	35%	95%	100%
Hold breath for 5 seconds	30%	95%	95%
Exhale away from mouthpiece	35%	100%	100%
Close inhaler	45%	100%	100%
Average score	42.22%	98.89%	96.67%

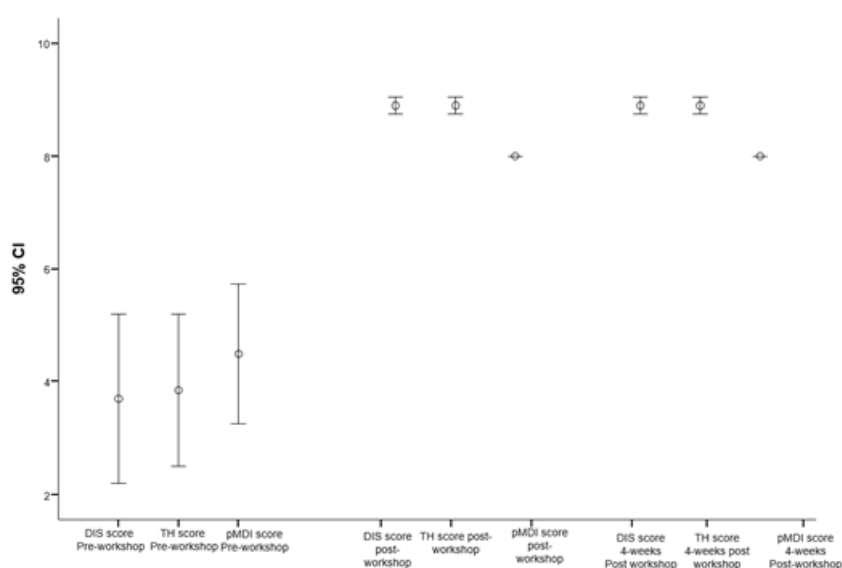


Figure 3. Inhaler technique score for the Diskus (DIS), Turbuhaler (TH), and pMDI for the study participants (n=20) pre-workshop, post-workshop, and 4-weeks post workshop



(85.0%), and then inhaling forcefully and deeply (75.0%). Immediately after the workshop and four weeks later, most participants correctly performed almost all steps (Table 3).

As for the pMDI technique assessment, most participants did not perform most of the steps correctly, as shown in Table 4. The steps that were performed incorrectly by most of the participants included holding their breath for 5 seconds (65.0%), followed by placing the mouthpiece between the teeth and lips (60.0%), and then keeping the head upright or slightly tilted and inhaling slowly whilst pressing the canister (55.0%). After the workshop, most of the participants performed all of the steps correctly, whereas four weeks after the training session, almost all of the steps were performed correctly by most of the

participants.

Asthma Knowledge Scores

The AKQ score before the workshop session ranged from 3 to 7 (score out of 8), with a mean score of 4.85 (SD=1.27). After the workshop session, the AKQ score ranged from 5 to 8, while the mean score increased to 7.50 (SD=0.95). Scores of the AKQ four weeks following the workshop ranged from 6 to 8, with a mean score of 7.55 (SD=0.76), as shown in Table 5. A significant difference in AKQ scores was found before (mean =4.85, SD=1.27) and after (mean=7.50, SD=0.95) the workshop training session ($P<0.001$), and before and four weeks after the workshop training session (mean=7.55 (SD=0.76), $P<0.001$). No significant difference in scores was found immediately after

Table 3. The proportion of participants (n=20) who correctly demonstrated the inhaler technique skills of the Turbuhaler before the workshop, after the workshop, and four weeks after the workshop

Action	The percentage of the action performed correctly		
	Before the workshop	After the workshop	Four-weeks after the workshop
Remove the cap from the inhaler	70%	100%	100%
Keep inhaler upright	70%	100%	100%
Rotate grip anti-clockwise then back until a click is heard	70%	100%	90%
Exhale to residual volume	35%	95%	95%
Exhale away from the mouth piece	10%	100%	100%
Place mouth piece between teeth and lips	15%	100%	90%
Inhale forcefully and deeply	25%	100%	100%
Hold breath for 5 seconds	35%	95%	95%
Exhale away from mouthpiece	55%	100%	100%
Average score	42.78%	98.89%	96.67%

Table 4. The proportion of participants (n=20) who correctly demonstrated the inhaler technique skills of the pMDI before the workshop, after the workshop, and four weeks after the workshop

Action	The percentage of the action performed correctly		
	Before the training session	After the training session	4-weeks after the training session
Remove mouthpiece cover and shake	75%	100%	90%
Hold inhaler upright	80%	100%	100%
Exhale to residual volume	70%	100%	95%
Keep head upright or slightly tilted	45%	100%	95%
Mouthpiece between teeth and lips	40%	100%	100%
Inhale slowly and press canister	45%	100%	90%
Continue slow and deep inhalation	60%	100%	100%
Hold breath for 5 seconds	35%	100%	100%
Average score	56.25%	100%	96.25%

Table 5. The mean score (out of 8), lowest and highest scores obtained by study participants (n=20) in the Asthma Knowledge Questionnaire (AKQ) before the workshop, after the workshop, and four weeks after the workshop

	Before the workshop session	After the workshop session	Four weeks after the workshop session
Mean AKQ score (SD)	4.85 (SD =1.27)	7.50 (SD = 0.95)	7.55 (SD = 0.76)
lowest AKQ score	3	5	6
Highest AKQ score	7	8	8



the training session and four weeks ($P=0.577$). No correlation between AKQ score and years of experience was found ($p=0.626$).

DISCUSSION

The therapeutic efficacy of asthmatic medications is related to the patients' inhalation technique.¹³ As a result of inadequate medication delivery into the lungs, patients experience poor disease control, exacerbations, and therapy failure.¹³ Incorrect inhaler technique can be related to HCPs' insufficient knowledge of inhalers and their correct use.^{20,28} Several studies found that HCPs lack knowledge of proper inhaler use, preventing them from adequately teaching patients.^{3,33-35} Being at the front line when managing hospitalized patients with asthma, nurses can help patients learn proper inhaler techniques and assess potential learning barriers.³⁶ Being the drug experts, pharmacists can help their peer nurses optimize their inhaler technique demonstration skills.^{20,28} This is the first study to show that nurses in the UAE demonstrate poor inhaler technique skills, and that a 3-hour workshop developed and provided by the drug experts, their peer clinical pharmacists, can significantly improve and maintain their inhaler technique demonstration skills and asthma knowledge.

Similar to previous studies,³⁷⁻³⁹ nurses performed poorly in this study before the training workshop, signifying poor asthma knowledge scores ranging from 3 to 7 (out of 8), with a mean score of 4.85. The case was similar for the DPIs, the Diskus and the Turbuhaler, and the pMDI. However, a significant improvement in the nurses' correct technique demonstration skills was found after the training workshop for all devices. Of noteworthy, such improvements continued to be noted four weeks after the training workshop.

The findings of this study reflect the lack of knowledge of inhaler techniques among nurses in the UAE, highlighting the need for education and training sessions on the proper use of inhalers, calling upon policymakers to introduce continuous educational programs in hospitals regarding asthma management. A significant association between asthma knowledge and inhaler technique demonstration skills has been highlighted previously through an inter-professional educational program.⁴⁰ Thus, poor asthma knowledge among HCPs can lead to loss of confidence and willingness to perform patient inhaler technique education,²⁰ leading to suboptimal patient care and therapeutic management. Similarly, previous studies reported an improvement in pharmacists and nurses' knowledge and inhaler technique demonstration skills following workshop training, leading to improvements in patients' asthma outcomes.^{40,41}

The nurses were reported to have inadequate skills to deliver correct inhaler technique education for patients with asthma.³⁷⁻³⁹ Both DPIs and pMDIs, require several steps to be performed correctly for an efficient inhalation manoeuvre.⁴² HCPs must be adequately educated and trained to ensure their ability to use these medications efficiently.^{6,43}

In this study, nurses' inhaler technique was assessed by direct observation using Diskus, Turbuhaler, and pMDI. Inhaler-specific checklists were used in the inhaler technique assessment for the Diskus and Turbuhaler. For assessing pMDI technique skills, a specific checklist, previously validated and published, was used. In the literature, the critical errors for all DPIs (Diskus and Turbuhaler) were reported to be 'lack of inhalation through the mouthpiece' and 'blowing into the device before inhalation'.⁴⁴ While pMDI critical errors were reported to be 'not holding the inhaler upright', 'exhaling into the after mouthpiece, and 'poor coordination between the start of inhalation and dose actuation'.^{45,46} This study finding reported that the predominant error performed by the nurses using DPIs was 'exhaling away from the mouthpiece', while the predominant error for the pMDI was 'holding of breath for 5 seconds, followed by placing the mouthpiece between teeth and lips'. It has been reported that errors in inhaler techniques using both inhaler devices, the DPIs and pMDIs are frequent.^{47,48} The occurrence of these errors can lead to insufficient drug delivery, adversely affecting drug efficacy and control of asthma.⁴⁹ Although not all of the steps in these checklists have the same clinical impact,³⁰ it is important to ensure that all of the steps are performed correctly by the nurses to educate patients properly.²⁰

The study's post-training results showed that almost all the nurses performed the steps correctly, being able to handle and use the devices effectively. At the end of the workshop training, there was a significant increase in nurses' asthma knowledge and inhalation technique skills.

Educating and providing regular training sessions for nurses can ensure the correct use of inhalation devices, thus improving the provided patient care and eventually improving the management of asthma prognosis.

Planning for the healthcare professionals' workshop applied in this study followed principles established education on inhaler technique demonstration skills developed previously by a group of expert pharmacists in the area. Written information such as medication inserts has proven insufficient in educating HCPs on inhaler technique and may convey limited and incomplete information.^{28,50} In addition, the acquisition of knowledge alone does not necessarily translate into effective patient education; physical demonstration of technique with follow-up assessment and education is essential.²⁸ A previous study provided a brief education to nurses on pMDIs technique performance, giving a short educational session demonstrating the proper pMDI techniques; two weeks later, the nurses were re-evaluated on their technique, showing improvements from 29.8% steps done correctly to 89.4% steps done correctly.³⁹ The educational workshop conducted in this study improved the pMDI from 56.25% correct steps to 100% correct steps at the end of the workshop to 96.25% four weeks later. As for the DPIs, the Diskus and Turbuhaler, improvements from 42.22% and 42.78% steps done correctly to 98.9% at the end of the workshop, to 96.67% four weeks from the workshop were noted. Hence, the workshop designed in this study, integrating hands-on education for nurses following the "train the trainer"



approach, gave excellent results. This is important for nurses to develop their skills to educate their patients to ensure effective use of the treatment and self-management behaviors, a crucial aspect of nurses' care for asthma patients.⁵¹

Limitations of this study include the fact that it was conducted in one hospital, which may not be representative of other hospitals in the UAE. A convenience sample was also used, which sped up data collection and reduced costs but may not represent the entire study population (nurses in the UAE). A larger and more representative sample should be incorporated in follow-up related studies. Social bias may have influenced the results of this study four weeks after the workshop. Nurses are expected to demonstrate their inhaler technique to a specialist in the area, which may not be the case while caring for patients in the hospital due to their busy schedules. Future studies can benefit from assessing nurses' ability to demonstrate the correct use of the inhaler devices to asthma patients in the respiratory wards in the hospital, i.e., during nurses' real working hours.

CONCLUSIONS

This study provides insight into the ability of nurses in the UAE to demonstrate the correct use of the DPIs and pMDIs. Results showed nurses' poor demonstration of inhaler technique

skills at baseline were significantly improved after a 3-hour workshop prepared and delivered by expert pharmacist on asthma management and inhaler technique education, and maintained for four weeks. The asthma knowledge of the nurses was also improved significantly following the workshop. This optimal asthma knowledge was maintained long-term as well. The outcomes of this study may provide a good resource for educators in asthma training for the HCPs. Future studies can assess the effect of such educational interventions on the ability of nurses to demonstrate the correct use of inhaler techniques to their patients in the hospital while working in the real work environment.

FUNDING

The study was funded by the College of Research and Graduate Studies, University of Sharjah (Competitive Research Project No. 1701090124-P).

CONFLICTS OF INTEREST

The authors declare no relevant conflicts of interest or financial relationships.

References

1. Mahboub BSH, Santhakumar S, Soriano JB, et al. Asthma insights and reality in the United Arab Emirates. *Ann Thorac Med*. 2010;5(4):217-221. <https://doi.org/10.4103/1817-1737.69109>
2. Mahboub BH, Al-Hammadi S, Rafique M, et al. Population prevalence of asthma and its determinants based on European Community Respiratory Health Survey in the United Arab Emirates. *BMC Pulm Med*. 2012;12(1). <https://doi.org/10.1186/1471-2466-12-4>
3. Basheti IA, Qunaibi E, Bosnic-Anticevich SZ, et al. User error with diskus and turbuhaler by asthma patients and pharmacists in Jordan and Australia. *Respir Care*. 2011;56(12):1916-1923. <https://doi.org/10.4187/respcare.01205>
4. De Oliveira MA, Bruno VF, Ballini LS, et al. Evaluation of an educational program for asthma control in adults. *J Asthma*. 1997;34(5):395-403. <https://doi.org/10.3109/02770909709055381>
5. Van Der Palen J, Klein JJ, Kerkhoff AHM, et al. Evaluation of the long-term effectiveness of three instruction modes for inhaling medicines. *Patient Educ Couns*. 1997;32:87-95. [https://doi.org/10.1016/s0738-3991\(97\)00100-6](https://doi.org/10.1016/s0738-3991(97)00100-6)
6. Hanania NA, Wittman R, Kesten S, et al. 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):111-116. <https://doi.org/10.1378/chest.105.1.111>
7. Interiano B, Guntupalli KK. Metered-dose inhalers: do health care providers know what to teach? *Arch Intern Med*. 1993;153(1):81-85. <https://doi.org/10.1001/archinte.153.1.81>
8. Jones JS, Holstege CP, Riekse R, et al. Metered-Dose Inhalers: Do Emergency Health Care Providers Know What to Teach? *Ann Emerg Med*. 1995;26(3):308-311. [https://doi.org/10.1016/s0196-0644\(95\)70078-1](https://doi.org/10.1016/s0196-0644(95)70078-1)
9. Plaza V, Sanchis J, Antepará I, et al. Medical personnel and patient skill in the use of metered dose inhalers: A multicentric study. *Respiration*. 1998;65(3):195-198. <https://doi.org/10.1159/000029259>
10. Tsang KWT, Lam WK, Ip M, et al. Inability of physicians to use metered-dose inhalers. *J Asthma*. 1997;34(6):493-498. <https://doi.org/10.3109/02770909709055393>
11. Newman SP, Weisz AWB, Talaei N, et al. Improvement of drug delivery with a breath actuated pressurised aerosol for patients with poor inhaler technique. *Thorax*. 1991;46(10):712-716. <https://doi.org/10.1136/thx.46.10.712>
12. Lahdensuo A, Muittari A. Bronchodilator effects of a fenoterol metered dose inhaler and fenoterol powder in asthmatics with poor inhaler technique. *Eur J Respir Dis*. 1986;68(5):332-335.
13. Lindgren S, Bake B, Larsson S. Clinical consequences of inadequate inhalation technique in asthma therapy. *Eur J Respir Dis*.



- 1987;70(2):93-98.
14. Giraud V, Roche N. Misuse of corticosteroid metered-dose inhaler is associated with decreased asthma stability. *Eur Respir J*. 2002;19(2):246-251. <https://doi.org/10.1183/09031936.02.00218402>
 15. Fink JB, Rubin BK. Problems with inhaler use: A call for improved clinician and patient education. *Respir Care*. 2005;50(10):1360-1374.
 16. King D, Earnshaw S, Delaney J. Pressurised aerosol inhalers: the cost of misuse. *Br J Clin Pract*. 1991;45(1):48-49.
 17. Basheti IA, Reddel HK, Armour CL, et al. Counseling about turbuhaler technique: Needs assessment and effective strategies for community pharmacists. *Respir Care*. 2005;50(5):617-623.
 18. Basheti IA, Armour CL, Bosnic-Anticevich SZ, et al. Evaluation of a novel educational strategy, including inhaler-based reminder labels, to improve asthma inhaler technique. *Patient Educ Couns*. 2008;72(1):26-33. <https://doi.org/10.1016/j.pec.2008.01.014>
 19. Basheti IA, Reddel HK, Armour CL, et al. Improved asthma outcomes with a simple inhaler technique intervention by community pharmacists. *J Allergy Clin Immunol*. 2007;119(6):1537-1538. <https://doi.org/10.1016/j.jaci.2007.02.037>
 20. Basheti IA, Armour CL, Reddel HK, et al. Long-term maintenance of pharmacists' inhaler technique demonstration skills. *Am J Pharm Educ*. 2009;73(2):1-8. <https://doi.org/10.5688/aj730232>
 21. Ilic AD, Zugic V, Zvezdin B, et al. Influence of inhaler technique on asthma and COPD control: A multicenter experience. *Int J COPD*. 2016;11(1):2509-2517. <https://doi.org/10.2147/copd.s114576>
 22. Wang W, Xu T, Qin Q, et al. Effect of a Multidimensional Pharmaceutical Care Intervention on Inhalation Technique in Patients with Asthma and COPD. *Can Respir J*. 2020;2020:1-10. <https://doi.org/10.1155/2020/8572636>
 23. Perumal R, Leite M, van Zyl-Smit RN. The relationship between clinical trial participation and inhaler technique errors in asthma and COPD patients. *Int J COPD*. 2020;15:1217-1224. <https://doi.org/10.2147/copd.s249620>
 24. O'Donnell J, Birkinshaw R, Burke V, et al. The ability of A&E personnel to demonstrate inhaler technique. *Emerg Med J*. 1997;14(3):163-164. <https://doi.org/10.1136/emj.14.3.163>
 25. Bodenheimer T, MacGregor K, Stothart N. Nurses as leaders in chronic care. *Br Med J*. 2005;330(7492):612-613. <https://doi.org/10.1136/bmj.330.7492.612>
 26. Rance KS. Helping patients attain and maintain asthma control: Reviewing the role of the nurse practitioner. *J Multidiscip Healthc*. 2011;4:299-309. <https://doi.org/10.2147/jmdh.s22966>
 27. Alasad J, Tabar NA, Aburuz ME. Patient satisfaction with nursing care: Measuring outcomes in an international setting. *J Nurs Adm*. 2015;45(11):563-568. <https://doi.org/10.1097/nnn.0000000000000264>
 28. Basheti IA, Qunaibi EA, Hamadi SA, et al. Inhaler technique training and health-care professionals: effective long-term solution for a current problem. *Respir Care*. 2014;59(11):1716-1725. <https://doi.org/10.4187/respcare.02671>
 29. Kritikos V, Krass I, Hui SC, et al. The validity and reliability of two asthma knowledge questionnaires. *J Asthma*. 2005;42(9):795-801. <https://doi.org/10.1080/02770900500308627>
 30. Basheti IA, Bosnic-Anticevich SZ, Armour CL, et al. Checklists for powder inhaler technique: A review and recommendations. *Respir Care*. 2014;59(7):1140-1154. <https://doi.org/10.4187/respcare.02342>
 31. Bosnic-Anticevich SZ, Sinha H, So S, et al. Metered-dose inhaler technique: The effect of two educational interventions delivered in community pharmacy over time. *J Asthma*. 2010;47(3):251-256. <https://doi.org/10.3109/02770900903580843>
 32. Milavetz G, Kelly HW, Whelan AM, et al. Optimizing drug delivery from metered-dose inhalers. *Diap*. 1991;24(4):409. <https://doi.org/10.1177/106002809102500614>
 33. Plaza V, Giner J, Rodrigo GJ, et al. Errors in the Use of Inhalers by Health Care Professionals: A Systematic Review. *J Allergy Clin Immunol Pract*. 2018;6(3):987-995. <https://doi.org/10.1016/j.jaip.2017.12.032>
 34. Plaza V, Sanchis J, Roura P, et al. Physicians' knowledge of inhaler devices and inhalation techniques remains poor in Spain. *J Aerosol Med Pulm Drug Deliv*. 2012;25(1):16-22. <https://doi.org/10.1089/jamp.2011.0895>
 35. Self TH, Arnold LB, Czosnowski LM, et al. Inadequate skill of healthcare professionals in using asthma inhalation devices. *J Asthma*. 2007;44(8):593-598. <https://doi.org/10.1080/02770900701554334>
 36. Lareau SC, Hodder R. Teaching inhaler use in chronic obstructive pulmonary disease patients. *J Am Acad Nurse Pract*. 2012;24(2):113-120. <https://doi.org/10.1111/j.1745-7599.2011.00681.x>
 37. De Tratto K, Gomez C, Ryan CJ, et al. Nurses' knowledge of inhaler technique in the inpatient hospital setting. *Clin Nurse Spec*. 2014;28(3):156-160. <https://doi.org/10.1097/nur.0000000000000047>
 38. Giner J, Roura P, Hernández C, et al. Knowledge and Attitudes of Nurses in Spain about Inhaled Therapy: Results of a National Survey. *J Aerosol Med Pulm Drug Deliv*. 2016;29(1):86-93. <https://doi.org/10.1089/jamp.2014.1198>
 39. Kellman DA, Iseron KV, Levy RD, et al. Brief Education Improves Proper Metered-Dose Inhaler Use. *J Emerg Med*. 2020;58(4):667-672. <https://doi.org/10.1016/j.jemermed.2020.02.011>
 40. Basheti IA, Hamadi SA, Reddel HK. Inter-professional education unveiling significant association between asthma knowledge and inhaler technique. *Pharm Pract (Granada)*. 2016;14(1):713. <https://doi.org/10.1089/jamp.2014.1198>
 41. Adeyeye OO, Kuyinu YA, Bamsile TR, et al. A preliminary assessment of nurses' asthma education needs and the effect of a training programme in an urban tertiary healthcare facility. *African J Respir Med*. 2015;10(2):13-17.
 42. Beerendonk I van, Mesters I, Mudde AN, et al. Assessment of the Inhalation Technique in Outpatients with Asthma or Chronic



- Obstructive Pulmonary Disease Using a Metered-Dose Inhaler or Dry Powder Device. *J Asthma*. 1998;35(3):273-279. <https://doi.org/10.3109/02770909809068218>
43. Duerden M, Price D. Training issues in the use of inhalers. *Dis Manag Heal Outcomes*. 2001;9(2):75-87. <https://doi.org/10.2165/00115677-200109020-00002>
 44. Molimard M, Raheison C, Lignot S, et al. Assessment of handling of inhaler devices in real life- an observational study in 3811 patients in primary care. *J aerosol Med*. 2003;16(3):249-254. <https://doi.org/10.1089/089426803769017613>
 45. Molimard M, Gros V Le. Impact of patient-related factors on asthma control. *J Asthma*. 2008;45(2):109-113. <https://doi.org/10.1080/02770900701815727>
 46. Price DB, Román-Rodríguez M, McQueen RB, et al. Inhaler Errors in the CRITIKAL Study: Type, Frequency, and Association with Asthma Outcomes. *J Allergy Clin Immunol Pract*. 2017;5(4):1071-1081.e9. <https://doi.org/10.1211/pj.2017.20202501>
 47. Basheti IA, Obeidat NM, Ammari WG, et al. Associations between inhaler technique and asthma control among asthma patients using pressurised MDIs and DPIs. *Int J Tuberc Lung Dis*. 2016;20(5):689-695. <https://doi.org/10.5588/ijtld.15.0557>
 48. Chorão P, Pereira AM, Fonseca JA. Inhaler devices in asthma and COPD - An assessment of inhaler technique and patient preferences. *Respir Med*. 2014;108(7):968-975. <https://doi.org/10.1016/j.rmed.2014.04.019>
 49. 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):1-7. <https://doi.org/10.1186/1710-1492-9-8>
 50. Sawalha AF, Sweileh WM, Zyoud SH, et al. Comparative Analysis of Patient Package Inserts of Local and Imported Anti-Infective Agents in Palestine. *Libyan J Med*. 2008;3(4):181-185. <https://doi.org/10.3402/ljm.v3i4.4790>
 51. Chew SY, Leow JYL, Chan AKW, et al. Improving asthma care with Asthma-COPD Afterhours Respiratory Nurse at Emergency (A-CARE). *BMJ open Qual*. 2020;9(2):e000895. <https://doi.org/10.1136/bmjopen-2019-000894>

