

Original Research

# Inter-professional education unveiling significant association between asthma knowledge and inhaler technique

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## ABSTRACT\*

**Objectives:** To explore whether an association exists between health care professionals' (HCPs) asthma knowledge and inhaler technique demonstration skills.

**Methods:** HCPs' asthma knowledge and inhaler technique demonstration skills were assessed at baseline at an inter-professional educational workshop focusing on asthma medication use. Asthma knowledge was assessed via a published questionnaire. Correct inhaler technique for the three inhalers, the Accuhaler, Turbuhaler and pressurized Metered Dose Inhaler (pMDI) was assessed using published checklists.

**Results:** Two hundred HCPs agreed to participate: 10 specialists (medical doctors specialized in respiratory diseases) (5%), 46 general practitioners (23%), 79 pharmacists (39%), 15 pharmacists' assistants (8%), 40 nurses (20%) and 10 respiratory therapists (5%). Backwards stepwise multiple regression conducted to determine predictors of HCPs' inhaler technique, showed that out of many independent variables (asthma knowledge score, profession, age, gender, place of work, years in practice and previous personal use of the study inhaler/s), asthma knowledge score was the only variable showing significant association with inhaler technique ( $R^2=0.162$ ,  $p<0.001$ ).

**Conclusion:** This study revealed significant associations between asthma knowledge and inhaler technique scores for all HCPs. Providing inter-professional workshops for all HCPs involved integrating education on asthma knowledge and practice of inhaler technique skills are looked-for.

**Keywords:** Nebulizers and Vaporizers; Asthma; Health Knowledge, Attitudes, Practice; Interprofessional Relations; Jordan

## INTRODUCTION

Asthma is a chronic condition that has no cure, and it continues to impact on the health of millions of people, both worldwide (prevalence 5-10%)<sup>1</sup> and in Jordan (prevalence 8.8%).<sup>2</sup> Several inhaler devices have been developed; pressurized Metered Dose Inhaler (pMDIs) and the commonly used dry powder inhalers (DPI): the Accuhaler (ACC) and the Turbuhaler (TH).

Despite well-established management guidelines and ability of preventative asthma inhaler therapy to control the disease in most cases if used correctly<sup>1</sup>, asthma remains a poorly controlled condition among many people.<sup>3</sup> One main reason is poor knowledge by patients of asthma treatment and inhaler technique.<sup>4,5</sup> Research in the primary health care setting indicates that educating patients in correct use of their inhalers results in mastery of good inhaler technique and improved asthma control.<sup>6-8</sup>

In clinical practice, it is important to maximize the opportunities to deliver this education across the spectrum of the primary health care setting, therefore, every health care professional (HCP) involved in asthma management needs to take the opportunity to educate asthma patients and reinforce key messages about their disease and its treatment.<sup>1,9</sup> HCPs can play an important role in delivering inhaler technique education to asthmatic patients.<sup>10-13</sup>

However, many HCPs do not have the needed skills to deliver correct education to their asthmatic patients.<sup>3</sup> Incorrect inhaler technique has been reported among pharmacists<sup>3,14</sup>, nurses<sup>15</sup>, respiratory specialists and general practitioners.<sup>16</sup> Problems with inhaler technique were found with both pMDIs and DPIs.<sup>16,17</sup> A resolution to this problem, starting with the HCP, is necessary.<sup>16</sup>

Both knowledge and skills are important concepts that describe HCPs' competence in the world of clinical practice.<sup>18</sup> Knowledge refers to learning concepts, principles and information regarding a particular subject(s), while skill refers to the ability of using information and applying it in a specific context.<sup>18</sup> Competence is achieved when HCPs possess the knowledge and skills required to provide direct care to patients.<sup>19,20</sup> We suspect that better knowledge predicts better skills, but in the world of asthma, does better asthma knowledge predict better inhaler technique demonstration skills?

In light of this, the primary aim of this study was to explore the association between asthma knowledge

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and inhaler technique demonstration skills during an inter-professional educational program. The secondary aim included assessing how HCP characteristic (age, gender, years in practice, professional group, place of work (reflecting socio-economic status) and personal use of asthma devices) impact inhaler skills. Results of the impact of the workshop on HCP inhaler technique skills are reported elsewhere.<sup>21</sup>

## METHODS

HCPs from Amman, Jordan, were approached for participation in this cross sectional study during an eight month period (March-November 2009). Medical respiratory specialists (physicians specializing in management of airways disease), general physicians (GP), pharmacists, pharmacists' assistants, nurses and respiratory therapists were invited into the study. The study was approved by the Ethics Committee at the Jordan University Hospital. The HCPs were recruited from hospitals (public and private) and community pharmacies in the capital, Amman. HCPs involved in asthma management or education (medical respiratory specialists, general physicians (GP), pharmacists, pharmacists' assistants, nurses and respiratory therapists) were selected randomly to be approached about the study, using a complete HCP lists provided by the relevant professional societies and random number generator. HCPs who agreed to participate signed informed consent. They were invited to attend an educational workshop, designed in accordance with a model previously developed and validated by one of the authors (IB).<sup>10</sup> The workshop was delivered by a certified asthma educator (IB) who has delivered this workshop previously on several occasions to HCPs in Australia, University of Sydney.<sup>10</sup> Inclusion criteria included current practice at a community pharmacy or hospital located within the Amman area, and not being involved in any other clinical study. Questionnaires regarding HCPs' demographic characteristics (age, gender, years of experience, receiving previous education on inhaler technique demonstration skills, time since last education on inhaler demonstration skills (years, mean, SD), profession (specialist, GP, Pharmacist, Pharmacist assistant, nurse, respiratory technician) were then completed by the participants.

Participants were also asked to self - complete a HCP asthma knowledge questionnaire (HQ) and a consumer asthma knowledge questionnaire (CQ). The HQ comprised 18 true/false questions about asthma and its treatment, as published by Kritikos *et al.*<sup>22</sup> Question 12 was omitted as it involves an incentivized GP program specific to Australia; the HQ score is therefore presented as mean score (SD) out of 17. The CQ comprised 12 true/false questions about asthma and its treatment directed for consumers, with the score presented as mean score (SD) out of 12. Hence, the attributed score included one point for a true response with maximal (highest) score of respectively 17 and 12, respectively.

Table 1. Checklists for assessment of Accuhaler; Turbuhaler and pMDI technique in adults	
<b>Accuhaler</b>	
	<ol style="list-style-type: none"> <li>1. Open inhaler</li> <li>2. Push lever back completely</li> <li>3. Exhale to residual volume</li> <li>4. Exhale away from mouthpiece</li> <li>5. Place mouthpiece between teeth and lips</li> <li>6. Inhale forcefully and deeply</li> <li>7. Hold breath for 5 seconds</li> <li>8. Exhale away from mouthpiece</li> <li>9. Close inhaler</li> </ol>
<b>Turbuhaler</b>	
	<ol style="list-style-type: none"> <li>1. Remove cap from inhaler</li> <li>2. Keep inhaler upright</li> <li>3. Rotate grip around and then back until a click is heard</li> <li>4. Exhale to residual volume</li> <li>5. Exhale away from mouthpiece</li> <li>6. Place mouthpiece between teeth and lips</li> <li>7. Inhale forcefully and deeply</li> <li>8. Hold breath for 5 seconds</li> <li>9. Exhale away from mouthpiece</li> </ol>
<b>pMDI</b>	
	<ol style="list-style-type: none"> <li>1. Remove mouthpiece cover</li> <li>2. Shake the inhaler</li> <li>3. Hold inhaler upright</li> <li>4. Exhale to residual volume</li> <li>5. Keep head upright or slightly tilted</li> <li>6. Mouthpiece between teeth and lips</li> <li>7. Inhale slowly and press canister</li> <li>8. Continue slow and deep inhalation</li> <li>9. Hold breath for 5 seconds</li> </ol>
These checklists are in accordance to the literature. <sup>33, 34</sup>	

All questionnaires were administered in English since English is the official language of education for all HCPs in Jordan.

Inhaler technique assessment was completed using previously published methods (Table 1).<sup>10</sup> Three inhalers were included in this study: Accuhaler (ACC, also known as Diskus), Turbuhaler (TH) and pMDI. Each of the checklists comprised 9 steps. The participant's inhaler technique was assessed using placebo inhalers. Participants were given a score out of 9, corresponding to the number of steps correctly completed. During the workshop, participants took it in turns to act as the HCP and as the patient, so they could practice teaching patients correct inhaler technique.

All HCPs were then invited to attend an educational workshop on asthma management. The workshop was repeated over two evenings at the Ibn Al-haitham hospital in Amman. The workshop environment satisfied the requirements for a good learning environment.<sup>23</sup> The workshop costs were sponsored by AstraZeneca Jordan. GlaxoSmithKline provided placebo inhalers and peak flow meters. A summary of the learning techniques, time and content of each segment of the workshop is provided in the online supplement - Table 1.

## Data analysis

Data were analyzed using the Statistical Package for Social Science (SPSS) version 20. For continuous variables: inhaler technique mean scores (out of 9), and asthma knowledge mean scores; comparisons between groups were

performed by Independent Sample T test or Mann-Whitney U test, depending on the normality of distribution. Comparisons between groups were performed by One-way ANOVA. Preliminary checks to insure that there was no violation of the assumptions (normality, linearity, homogeneity of variance, homogeneity of regression slopes and reliable measurement of the covariate were performed. Proportional data were analyzed using Pearson's Chi-Square test (or Fisher's exact test).

Associations between inhaler technique demonstration skills and asthma knowledge scores (HQ and CQ scores) were investigated using Pearson Correlations.

Backwards stepwise multiple regression was conducted in order to determine predictors of HCPs' inhaler technique (average score over the three inhalers) as the dependent variable and the following independent variables: asthma knowledge average score (a score out of one for each participant, as total score over the two questionnaires (HQ (score=17) and CQ (score=12)) was divided by 29), profession, age, gender, place of work (hospital or community), years in practice and previous personal use of the study inhaler/s.

For all statistical analyses, p-values of 0.05 or less were considered significant. No multiplicity adjustment was made.

## RESULTS

A total of 496 HCPs were invited to participate in this study. Two hundred HCPs (40%) agreed to participate: 10 respiratory specialists (referred to as specialists later on) (5%), 46 GPs (23%), 79 pharmacists (39%), 15 pharmacists' assistants (8%), 40 nurses (20%) and 10 respiratory therapists (5%). Participants were from different hospitals and community pharmacies in Amman/Jordan, located

equally in higher socio-economic and lower socio-economic areas. Participants were also distributed equally between education, public and private hospitals.

The majority of specialists, GP and respiratory therapists were males (specialists 100%; GPs 72%; respiratory therapists 80%), while the majority of pharmacists, pharmacist assistants and nurses were females (pharmacist 63%; Pharmacist assistant 60%; nurse 77%).

Nurses were the youngest amongst the group (mean age 28.7; SD=5.7) followed by the GPs (30.7; SD=5.6), then the pharmacists (33.6; SD=8.4) and pharmacist assistants (33.7; SD=9.5). Respiratory technicians (40.7; SD=11.0) and specialists (44.7; SD=7.5) were the oldest amongst the group.

Majority of specialists and respiratory therapists received previous education on inhaler technique demonstration skills (specialist=96.67%, respiratory therapists=100%). As for the other HCPs, many never received such education (nurses=32.67%, GPs=48.33%, pharmacists=52.67%, Pharmacist assistants=58.0%). As for the time since last education on inhaler use (years, mean; SD), nurses had the most recent education (2.13; SD=0.33), followed by the GPs (2.93; SD=0.53), pharmacist assistants (5.13; SD=1.77), pharmacists (5.43; SD=0.87), respiratory therapists (7.17; SD=2.03) and specialists (10.67; SD=1.62). No significant correlation between years since last inhaler technique education, and inhaler technique scores was found for the pMDI ( $r=0.246$ ,  $p=0.11$ ), the TH ( $r=0.058$ ,  $p=0.59$ ) or the ACC ( $r=0.139$ ,  $p=0.21$ ).

Many of the HCPs were themselves using or had used inhalers for treating themselves or their close family members (specialists (6; 60%); nurses (5; 13%); GPs (12, 26%); pharmacists (17; 22%);

Table 2. Mean score (SD) for the Asthma Knowledge Questionnaire for HCPs (HQ) and Asthma Knowledge Questionnaire for consumers (CQ) for the participating HCPs (n=200).

Profession	*†Average inhaler technique score	ACC score (max 9)	TH score (max 9)	pMDI score (max 9)	‡Average knowledge score	HQ mean (SD) score out of 17	CQ mean (SD) score out of 12
Specialist physician (n=10)	6.80 (1.12)	6.3 (1.7)	6.4 (1.7)	8.7 (0.67)	0.86 (0.27)	13.80 (0.79)	11.00 (0.00)
General physician (n=18)	5.62 (0.45)	4.8 (0.51)	5.0 (0.8)	7.9 (0.94)	0.70 (0.11)	10.41 (2.17)	9.89 (1.91)
Pharmacist (n=42)	5.70 (0.69)	5.2 (0.85)	5.2 (1.10)	7.7 (0.91)	0.64 (0.11)	9.43 (2.47)	9.05 (1.36)
Pharmacist Assistant (n=10)	6.40 (0.64)	5.1 (0.88)	5.6 (0.79)	8.2 (1.2)	0.63 (0.11)	9.47 (2.36)	8.87 (1.36)
Nurse (n=8)	5.33 (0.33)	4.9 (0.35)	5.0 (0.41)	7.2 (0.97)	0.54 (0.88)	7.95 (2.29)	7.68 (1.69)
Respiratory therapist (n=10)	5.93 (0.21)	4.9 (0.32)	4.9 (0.32)	8.4 (0.68)	0.71 (0.88)	10.40 (1.96)	10.30 (1.25)
All (n=129)	5.86 (0.77)	5.2 (0.9)	5.2 (1.1)	7.9 (1.0)	0.65 (0.12)	9.63 (2.59)	9.12 (1.77)

All participants (n=200) completed the HQ and CQ questionnaire, and 65% (n= 129) agreed to demonstrate their inhaler technique. \* Average inhaler technique score is the average score over the three inhaler devices (max 9). † Asthma knowledge average score = ((HQ (score out of 17) + CQ (score out of 12))/29). ‡Significant differences were found between the HCPs ( $p<0.001$ , One way ANOVA). HQ= Health care professionals asthma knowledge questionnaire; CQ= Consumer asthma knowledge questionnaire; ACC= Accuhaler; TH= Turbuhaler; pMDI= Pressurized Metered Dose Inhaler.

Table 3. Proportion of HCPs (n= 200) that answered correctly the questions in the Health Care Professional Asthma knowledge Questionnaire (HQ) and Consumer Asthma knowledge Questionnaire (CQ).

<b>Health Care Professional Asthma knowledge Questionnaire (HQ). HCP '%'</b> with correct answer							
	Sp n=10	GP n=46	Phar n=79	PA n=15	N n=40	RT n=10	p-value
1. Asthma results from complex interactions among inflammatory cells, mediators, and other tissues in the airways (T)	100	97.8	97.5	80	70	100	<0.001
2. Asthma can be triggered by aspirin or other nonsteroidal anti-inflammatory drugs (NSAIDs) such as Nurofen (T)	100	95.7	82.3	86.7	47.5	70	<0.001
3. After the patient has recovered from a severe asthma attack, he/she should be maintained on the same dose of oral corticosteroid permanently to control his/ her condition (F)	100	84.8	68.4	46.7	57.5	100	0.014
4. The aim of asthma management is to empower health care professionals to take control of patient's disease (F)	20	10.9	24.1	20	27.5	20	0.426
5. Asthma episodes are associated with variable airflow obstruction that is often reversible with treatment (T)	100	93.5	77.2	93.3	80	100	0.194
6. All people with asthma should have a long acting beta2 agonist for symptoms relief (F)	100	76.1	48.1	73.3	40	60	0.001
7. The inflammatory process in asthma doesn't cause permanent changes in the airways (F)	80	73.9	63.3	53.3	45	90*	0.017
8. Multiple actuations of aerosol devices before inhaling from a spacer will result in more effective medication delivery (F)	100	30.4	40.5	40	45	20	0.009
9. The most common problem with dry powder inhaler (DPI) use is incorrectly coordinating drug release and inhalation (F)	80	17.4	25.3	53.3	22.5	30	0.007
10. It's a good idea to give cough syrups during an asthma attack to treat asthma related cough (F)	100	82.6	59.5	86.7	50	80	0.012
11. The genetic predisposition for the Development of IgE mediated response to common aeroallergens isn't a predisposing factor for developing asthma (F)	100	71.7	58.2	33.3	45	40	0.004
12. Inhaled non-steroidal anti-inflammatories such as sodium cromoglycate (Intal) are recommended as initial preventative therapy for children with frequent episodic to mild persistent asthma (F)	40	47.8	51.3	53.3	55	80	0.661
13. In some people with asthma, exercise induced symptoms may be the only manifestation of asthma (T)	100	87	57	53.3	65	60	0.012
14. When oral corticosteroids are initiated in an acute asthma attack, inhaled corticosteroids should be ceased to avoid any complications (F)	80	67.4	48.1	46.7	17.5	50	<0.001
15. Dry Powder Inhalers (DPIs) require higher inspiratory flow rates than metered dose inhalers (pMDI) (T)	60	58.7	67.1	73.3	72.5	30	0.003
16. Only nebulizers can be used in children less than 2 years old who have asthma (F)	20	23.9	27.8	40	25	10	0.598
17. Unlike short acting bronchodilators, formoterol (Foradile , Oxis ) effects usually last for 2 days (F)	100	50	46.2	53.3	37.5	100	<0.001
<b>Consumer Asthma knowledge Questionnaire (CQ). HCP '%'</b> with correct answer							
	Sp n=10	GP n=46	Phar n=79	PA n=15	N n=40	RT n=10	P
1. You can become addicted to asthma medications if you use them all the time (F)	100	87	62	53.3	47.5	100	<0.001
2. An asthma action plan can prevent hospitalizations due to asthma (T)	100	95.7	98.7	100	82.5	90	0.008
3. When you know that you are going to be exposed to something that triggers your asthma, you should take the recommended medication just before exposure (T)	80	84.8	74.7	86.7	45	90	<0.001
4. When you know that you are going to be exposed to something that triggers your asthma, you should wait until you develop symptoms before taking medication (F)	100	69.6	73.4	73.3	52.5	90	0.027
5. Side effects are less likely with inhaled medications than with tablets (T)	100	89.1	83.5	93.3	67.5	100	0.017
6. With preventer medications, it does not matter if some doses are missed or if you go on and off them (F)	100	87	65.8	73.3	55	60	0.006
7. If you get a cold or flu, you should increase your asthma medications (T)	20	65.2	35.4	20	27.5	50	0.001
8. Some medications can trigger asthma attacks (T)	100	87	92.4	86.7	90	100	0.626
9. You should use "preventer medication" when you have an asthma attack (F)	100	45.7	46.8	46.7	55	80	0.047
10. Going from a cold to hot environment can trigger asthma, but going from a hot to cold environment does not trigger asthma (F)	100	87	90	86.7	77.5	100	0.225
11. Parents should give "reliever medication" to a child as soon as they recognize the first sign of asthma (T)	100	87	83.5	86.7	85	90	0.816
12. Blue puffer (Ventolin), Brown puffer (Flixotide) and Green puffer (Serevent) are called "preventer medication" (F)	100	84.8	79.9	80	80	80	0.718

Specialist (Sp); General Practitioner (GP); Pharmacist (Phar); Pharmacist Assistant (PA); Nurse (N); Respiratory Therapist (RT).

pharmacist assistants (4; 27%); respiratory therapist (4; 40%). No significant difference in inhaler score (average score for the TH, ACC and pMDI) was found between HCPs who reported previous personal use of the inhaler/s (mean 5.88; SD=0.97) and those who did not (5.84; SD=0.60); p=0.528, Mann Whitney U-Test). As for asthma knowledge (average score out of 1), previous personal use showed a significant difference in asthma

knowledge average score between HCPs who reported previous personal use (mean 0.72; SD=0.12), and those who did not (0.65; SD=0.126), p=0.001, Mann Whitney U Test.

For asthma knowledge (HQ score out of 17)<sup>22</sup>, significant variation between HCPs was found (p<0.001, One way ANOVA), with specialists

Table 4. Summary of the final regression model ( $R^2= 0.162$ ,  $p<0.001$ ) for the dependent variables Inhaler technique score (average for Accuhaler, Turbuhaler and pMDI) with its associated predictors, size and direction of the association (n= 200). Dependent variable: Inhaler technique score (average score for the devices: ACC, TH and pMDI)

Associated predictors	Beta	t	P value
Profession of the HCP	-0.101	-0.880	0.382
Age	-0.058	-0.232	0.818
Gender	-0.043	-0.360	0.720
Years in practice	0.199	0.853	0.396
Place of work	0.035	0.311	0.757
Personal use of asthma devices	0.048	0.460	0.647
*Asthma Knowledge average score	0.403	3.889	<0.001

\* Asthma knowledge average score = ((HQ (score out of 17) + CQ (score out of 12))/29). HQ= Health care professionals asthma knowledge questionnaire; CQ= Consumer asthma knowledge questionnaire. "Beta" is the standardized regression coefficient, "Beta" values with their "p" values show whether each variable is making a statistically unique contribution to the model ( $P<0.05$ ) or not. The t test given by the "T" value, tests the significance of each coefficient, it can determine the relative importance of each variable in the model (useful predictors usually have "t" values above 2 or below -2).

scoring the highest (12.20; SD=2.70), and nurses scoring the lowest (7.95; SD=2.29) (Table 2).

For the CQ knowledge (score out of 12), there was also a significant difference between HCPs ( $p<0.001$ , One way ANOVA), with physicians scoring the highest followed by the respiratory therapists, while nurses scored the lowest here (Table 2).

Significant association between place of work and HQ ( $p<0.001$ ) scores and CQ scores ( $p<0.001$ ) was found. HCPs recruited from the 'private/medium socio-economic status' and 'educational/public/medium socio-economic status' hospitals performed significantly better than HCPs recruited from 'private/high socio-economic' or 'public/low socio-economic' status hospitals. Inhaler technique scores were also significantly different across the hospitals ( $p<0.001$ ), showing similar results to asthma knowledge (online supplement - Table 2).

Table 3 provides a detailed description about the proportion of HCPs that answered each of the questions in the HQ and CQ questionnaires correctly.

A strong association was found between HCPs' scores for the HQ and CQ asthma knowledge questionnaires ( $r=0.345$ ,  $p<0.001$  Pearson correlation).

Results of backwards multiple regression showed that the final model ( $R^2=0.162$ ,  $p<0.001$ ) for the dependent variable Inhaler technique score (average for ACC, TH and pMDI) with its associated predictors, size and direction of the association (n=200) showed significant association only with asthma knowledge average score (Table 4).

## DISCUSSION

This is the first study to investigate associations between asthma knowledge and inhaler technique demonstration skills comparing all HCPs engaged in asthma patient education. The study reveals a strong association between inhaler technique demonstration skills and asthma knowledge, indicting perhaps the importance of optimizing knowledge in order for good inhaler technique skills to be maintained. We previously communicated the

positive impact of this inter-professional education focused on inhaler technique use, involving the specialists, pharmacists, pharmacist assistants, respiratory therapists and nurses. The education not only optimized the HCP's inhaler technique skills, but also maintained it over long term.<sup>21</sup>

To the best of our knowledge, this is the first study that provides a detailed comparison between the different HCPs with regards to their answers to the individual questions in the HQ and CQ questionnaires. It highlights the pitfalls in asthma knowledge practiced by the different health professionals. These identified pitfalls are important in designing future educational workshops on asthma management.

The HCP asthma knowledge questionnaire (HQ) and consumer asthma knowledge questionnaire (CQ) used in this study contain questions about asthma and its treatment for HCPs and consumers respectively.<sup>22</sup> They were considered to be more suitable for this study population than other, more recent, questionnaires, which were directed at specific groups such as teachers of elementary schools<sup>24</sup>, healthcare workers with occupational asthma<sup>25</sup>, or adult asthma patients and parents/guardians of children with asthma in non-English speaking countries.<sup>26,27</sup> Strong correlations were found between both HQ and CQ scores. Generally HCPs were able to score higher on the CQ, which is probably due to its content being more consumer based and hence simpler. Both the HQ and CQ are internationally validated asthma knowledge questionnaires used for the assessment of the HCPs involved in this study.<sup>22</sup> It is an updated questionnaire with current concepts of asthma and its management based on international asthma management guidelines. Specialists scored highest in answering these questionnaires, which is similar to previous findings.<sup>16,22</sup> As for the CQ, results were consistent with previous findings as well, where respiratory therapist and specialists scored the most in answering the questionnaire.<sup>22</sup> This is most likely due to the higher rate of contact between the specialists and respiratory therapists with asthmatic patients. Specialists in Jordan have a system to identify patients with poor inhaler technique and are engaged in inhaler technique education.<sup>21</sup> Also, patients reported that they obtain education on inhaler technique most commonly from their

specialist (69%) followed by the hospital clinic (respiratory therapist) (49%).<sup>28</sup> This is different to the case in many countries, where specialists do not have time to provide inhaler technique education to patients. This could also be due to variations in the health system and the professional curricula between the countries.

Nurses have a critical role in educating patients on correct inhaler technique and in assessing potential barriers to successful learning of technique by the patients.<sup>29</sup> Although they are a key component of patient education in the hospital, this study showed that they lack adequate knowledge of asthma medications.<sup>17</sup> In Jordanian hospitals, nurses are the only HCPs that can have stretched interactions with the inpatients. Similar to previous studies<sup>15,17</sup>, nurses performed poorly in this study signifying poor asthma knowledge and inhaler technique demonstration skills. This is alarming considering their vital role in this area. Considering that only about a third of the nurses in this study ever received education on inhaler technique, which was more than 2 years before this study, these results are not surprising and call on the policy makers to introduce continuous educational programs in hospitals regarding asthma management.

Pharmacists in this study also scored fairly low on both the HQ and CQ questions, especially questions pertaining to medication use. Studies have shown that solutions at the University level are needed to address these weaknesses in pharmacists/pharmacy students.<sup>30</sup> Recent results have shown that the current standard educational training on correct use of inhalers in a representative Jordanian Faculty of Pharmacy is missing the practice element. The majority of pharmacy students (78%) reported that lack of practice with inhaler devices and insufficient training with real asthma patients is a primary barrier to demonstrating correct inhaler technique. Follow-up studies showed that engaging pharmacy students with real asthma patients in a simulated scenario involving correct device technique education resulted in better device technique demonstration skills among students.<sup>31</sup> Hence, hands-on-training with the inhaler devices, for pharmacists/pharmacy students and nurses/nursing students are needed for better demonstration skills of inhaler technique.<sup>3,21</sup>

Knowledge refers to theory and skill refers to successfully applying knowledge in practice. Unveiling the significant association between asthma knowledge and inhaler technique skills opens new perspectives in the world of HCP's inhaler technique demonstration skills. Asthma knowledge (average score across both the HQ and CQ questionnaire scores) was the only variable that showed association with HCP' inhaler technique score (average score across the three inhaler devices). Hence, based on this significant association identified in this study, optimizing both asthma knowledge and inhaler technique skills is vital.

Acquiring of knowledge and skills in asthma management and proper inhaler technique is

expected to be extrapolated to direct patient care, as previous studies have shown that improved inhaler technique demonstration skills by pharmacists and nurses following training can result in an increase in inpatients having their inhaler technique assessed and corrected<sup>32</sup>, and improved asthma outcomes.<sup>6,8</sup> Other studies have shown that acquiring knowledge and skills on correct inhaler technique improves confidence and willingness to perform patient inhaler technique education.<sup>10</sup>

Inhaler specific checklists (Table 1) were used in inhaler technique assessment for the three devices, TH, ACC and pMDI. Each of the checklists was comprised of 9 steps, giving each participant a score out of 9 corresponding to the number of steps correctly completed. Not all of the steps in these checklists are as likely to have the same clinical impact<sup>33</sup>; for example, step 4 in the TH checklist (exhale to residual volume) is not as critical as step 2 (hold inhaler upright [during priming]). However, in this study, all of the steps were given equal weight because HCPs need to demonstrate all steps associated with inhaler administration correctly and in the correct order, in order to educate patients properly on correct inhaler technique.<sup>10</sup>

This research poses a number of challenges. Most significant is the small proportion of some of the HCPs who agreed to participate in the study and eventually attend the workshop. A more balanced proportion of participants from the various disciplines would have made the comparisons between the various groups of HCPs more expressive. However, this is challenging due to the original differences in the number of HCPs in the various settings in Jordan. As the data of the questionnaires was dependent on self-reporting by participants, inaccuracies maybe inherent due to social desirability bias and the potential for misinterpreting questions. However, this was minimized by establishing face and content validity, piloting the questionnaire prior to distribution and making it anonymous. The study focuses on the Jordanian population, however, due to the focus of the study (educational technique with related factors influencing aerosol therapy in asthma control) being a reality in other countries as well, results can be extrapolated to other populations. Most asthma guidelines recommend the use of a spacer with the pMDI, but HCPs also need to be able to train patients in use of a pMDI alone (e.g. for use of short-acting bronchodilators); in this study, pMDI technique was only assessed without a spacer. It would be useful to also check HCP technique with pMDI and spacer. Finally, although inhaler technique assessment was based on previously published methods<sup>10,11</sup>, no universal accordance on the steps (and critical steps) of good inhaler technique, specifically for pMDIs, is yet found.<sup>33</sup>

## CONCLUSIONS

Significant association between asthma knowledge and inhaler technique demonstration skills was unveiled through the inter-professional educational program conducted in this study. Poor asthma knowledge among HCPs could be a potential cause

to losing inhaler technique demonstration skills quicker over time. Optimizing asthma knowledge with inhaler technique demonstration skills periodically may both be needed for inhaler technique demonstration skills to be maintained. This paper presents novel important findings that can propose desired strategies to optimizing inhaler technique demonstration skills within the inter-professional domain.

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#### CONFLICT OF INTEREST

HKR has been a member of the Advisory Boards for AstraZeneca, GlaxoSmithKline, Novartis and Boehringer Ingelheim; Chair of the data safety monitoring board for AstraZeneca, GlaxoSmithKline Merck and Novartis; provided consulting for AstraZeneca and GlaxoSmithKline; prepared and delivered independent medical presentations for AstraZeneca, GlaxoSmithKline, Mundipharma, Novartis and Teva; and has received unrestricted research grants from AstraZeneca and GlaxoSmithKline for investigator-sponsored research. As for the other authors, no financial or other potential conflicts of interest exist.

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