Inhaler education for hospital-based pharmacists: How much is required?

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OBJECTIVE: To compare the effectiveness of a more intensive educational intervention with a less intensive intervention on the ability of hospital pharmacists to be prepared to educate patients regarding inhaled device technique.
DESIGN: Randomized controlled trial. Inhaler technique and knowledge were assessed pre-education, immediately after and three months after education by a research assistant blinded to the educational allocation.
SETTING: Tertiary hospital pharmacy department.
POPULATION STUDIED: Hospital-based pharmacists.
INTERVENTION: A 1 h 'hands-on' session with feedback (more intense education, MIE) or written materials describing inhaler use (less intense education, LIE).
MAIN RESULTS: The change in overall score from pre-education to early posteducation for MIE was greater than for LIE (mean [95% CI]) (2.64 [1.27 to 4.01] versus 1.26 [0.05 to 2.47], P<0.001). Assessment scores improved for all device demonstrations and general knowledge. The change in score from the pre-education to the late posteducation period was only slightly higher in the MIE group than the LIE group, a difference that was not statistically significant (1.78 [0.82 to 2.74] versus 1.22 [0.06 to 2.39], P=0.09). Scores in both groups were lower in the late posteducation period compared with the early posteducation period. Greater increases in total score in the immediate posteducation period were associated with a low baseline score and the MIE intervention.
CONCLUSION: Individual coaching in inhaler technique produces greater improvement in inhaler knowledge among hospital pharmacists than provision of written materials. However, the advantage of the more intensive intervention was short-lived, with little advantage evident in three months.

Key Words: *Education; Inhaler; Pharmacist*

Un enseignement sur les inhalateurs pour les pharmaciens hospitaliers : jusqu'à quel niveau ?

OBJECTIF : Comparer l'efficacité d'un enseignement plus intensif (EPI) avec celle d'un enseignement moins intensif (EMI) sur la capacité des pharmaciens à démontrer aux patients l'utilisation des dispositifs d'inhalation.
MODÈLE : Essai contrôlé et randomisé. La technique d'utilisation des inhalateurs et les connaissances sur ces dispositifs ont été évaluées avant la période d'enseignement, immédiatement après et trois mois après par un assistant de recherches n'ayant pas eu connaissance de la répartition des groupes éducationnels.
CONTEXTE : Département de la pharmacie d'un hôpital de soins tertiaires.
POPULATION ÉTUDIÉE : Pharmaciens hospitaliers.
INTERVENTION : Une session pratique d'une heure avec des commentaires (EPI) ou des brochures décrivant le mode d'emploi de l'inhalateur (EMI).
PRINCIPAUX RÉSULTATS : Le changement dans le score global allant de la période pré-éducationnelle jusqu'à la période post-éducationnelle immédiate était plus élevé pour le groupe à EPI que pour le groupe à EMI (moyenne [IC à 95 %](2,64 [1,27à 4,01] par rapport à 1,26 [0,05 à 2,47], p < 0,001). Les scores à l'évaluation se sont améliorés pour toutes les démonstrations sur les appareils et les connaissances générales. Le changement dans le score de la période pré-éducationnelle à la période post-éducationnelle tardive était légèrement plus élevé pour le groupe à EPI que pour le groupe à EMI, une différence non significative sur le plan statistique (1,78 [0,82 à 2,74] par rapport à 1,22 [0,06 à 2,39], p = 0,09). Les scores des deux groupes étaient

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moins élevés dans la période post-éducationnelle tardive comparativement avec la période post-éducationnelle précoce. Les augmentations les plus fortes observées dans le score total dans la période post-éducationnelle immédiate étaient associées à un score de référence faible et à un enseignement plus intensif (EPI).

CONCLUSION : L'enseignement individuel des techniques d'emploi des inhalateurs entraîne une plus grande amélioration des connaissances sur les inhalateurs chez les pharmaciens hospitaliers que la fourniture de brochures. Cependant, l'avantage d'une intervention plus intensive était de courte durée, avec peu de bénéfices évidents trois mois après.

Successful therapy of asthma and chronic obstructive pulmonary disease (COPD) depends on the proper use of various types of inhalation devices (metered dose inhalers [MDI], Turbuhalers [Astra Pharma Inc, Mississauga, Ontario] and spacing devices). Measured consequences of inadequate inhalation technique include significantly less bronchodilation by beta$_2$-agonists, decreased efficacy of therapy and increased illness-related morbidity (1). It has been well documented that patients have difficulty learning to use inhaled devices and require ongoing education from health care practitioners to maintain proper technique (2-7).

Demonstration of the correct inhalation technique by health professionals using placebo MDIs is more effective than verbal instruction alone for improving patients' inhaled device technique (4,8,9). This is consistent with principles of adult learning in that interactive, practical teaching results in better skill development than traditional didactic teaching methods. However, health professionals will be ineffective teachers if they are not competent in the proper technique themselves. Regrettably, several studies have found medical personnel, including physicians, respiratory therapists, nurses and community-based pharmacists, often lack even basic inhaler device skills (10-16). Two recent studies have specifically assessed community-based pharmacists abilities to use inhalation devices (15,16).

Kesten et al (15) looked at the ability of community-based pharmacists in Metropolitan Toronto to use inhaled medication delivery systems and answer basic knowledge questions. Of the 45 pharmacists who participated, the proportion able to demonstrate 10 of 11 essential steps with the MDI, MDI with Aerochamber (Trudell Medical, London, Ontario), and Turbuhaler, were 62%, 47%, and 29%, respectively. The mean knowledge score was 50%, with only 21% of pharmacists scoring above 70%. The authors concluded that pharmacists were less familiar with the more recently marketed Turbuhaler (at that time) compared with the traditional MDI device and that pharmacists require further teaching regarding inhaled medication delivery systems (15).

Mickle et al (16) evaluated the patient education practice of 52 Tennessee-based community pharmacists when dispensing a MDI to an undercover 'patient'. Only 13% of pharmacists offered to educate the patient without first being asked, while only 53% of pharmacists offered education after being asked how to use the MDI. Of those who did educate the patient, 71% discussed less than half of the steps correctly, and only one of the 52 pharmacists actually demonstrated use of the MDI. These results demonstrate that few pharmacists educate patients on the correct use of an MDI and that many pharmacists are not aware of the correct technique.

While many health care professionals, including community-based pharmacists, have been studied, the skills and knowledge of hospital-based pharmacists have not been assessed in this manner. Because many patients initiate inhaled therapy in hospitals, pharmacists in this practice area are in the ideal setting to prepare patients for discharge into the community with the ability to self-administer an inhaled medication properly (17). Re-education is important in maintaining patient compliance with correct technique (4,8). Hospital-based pharmacists have an excellent opportunity re-educate asthma and COPD patients during their hospital admission. This need is justified further, when upon discharge from hospital, many patients bypass their community pharmacy until their next refill is needed, losing this community-based opportunity for education on inhaled device technique and maintenance.

To improve the basic knowledge about educating asthma patients, several groups of medical personnel have received intensive educational workshops conducted by specialized educators (18-21). These programs, which are comprehensive and detailed, are intended for health professionals specializing in asthma care. Although specialized, comprehensive asthma education is important, it is also important to educate the wider health care professional population in asthma care 'essentials' if patient inhaler technique is to be monitored and taught at every appropriate opportunity. We do not know whether this requires individual 'hands-on' coaching for all health practitioners or whether a simpler intervention will suffice.

Crompton (22) has suggested that practitioners may have sufficient information to educate patients by simply referring to materials provided to them by the drug manufacturers, such as package inserts. Before scarce resources are allocated to intensive educational programs for all health professionals dealing with patients who use inhaled devices, the effectiveness of other forms of more intensive versus less intensive education must be determined. The objective of this study was to compare the effectiveness of a more intensive educational intervention (a 1 h workshop with a specialized educator) with a less intensive intervention (reading the package insert) on the ability of hospital-based pharmacists to be prepared to educate patients regarding proper inhaled device administration using a randomized controlled design.

METHODS

This study was conducted at The Toronto Hospital – General Division, a tertiary care university-based teaching hospital. Institutional ethical approval was obtained before initiation of the study. All pharmacists who were employed by the inpatient pharmacy department were approached by the research coordinator to participate in the study. Pharma-

TABLE 1
Educational interventions

Less intensive	
15 mins to read manufacturers' package inserts for each of three products:	
Metered dose inhaler	
Metered dose inhaler with Aerochamber (Trudell Medical, London, Ontario)	
Turbuhaler	
More intensive	
One hour workshop with three to six participants including didactic and hands-on practical components:	
Verbal and visual explanation of technique for each of the three devices:	
MDI	5 mins
MDI with Aerochamber	5 mins
Turbuhaler	5 mins
Educator demonstration of use of each device (two correct and one incorrect demonstration)	5 to 10 mins
Discussion and questions	10 mins
Participant practice with each device with feedback from instructor	10 mins
Maintenance care of each device	5 to 10 mins
Discussion and questions	5 mins
TOTAL	60 mins

TABLE 2
Steps to assess inhaled device demonstration score (14,15)

Step	Metered dose inhaler	Aerochamber (Trudell Medical, London, Ontario)	Turbuhaler (Astra Pharma Inc, Mississauga, Ontario)
1	Remove cap	Remove cap and connect	Remove cover
2	Shake inhaler	Hold inhaler and spacer together and shake	Hold inhaler upright
3	Hold inhaler upright	Exhale to functional residual capacity (FRC) or residual volume (RV)	Turn bottom clockwise then counterclockwise
4	Tilt head back or keep at level	Tilt head back or keep at level	Exhale away from inhaler to FRC or RV
5	Exhale to FRC or RV	Insert mouthpiece between lips	Insert mouthpiece between lips
6	Insert or keep mouthpiece 2 to 4 cm away from mouth	Actuate canister once	Breathe in forcefully and deeply
7	Begin breathing then actuate canister once	Inhale slowly and deeply	Do not exhale, remove inhaler from the mouth
8	Continue slow, deep inspiration	Should hear a hissing sound and not a whistle	Hold breath to comfort (5 to 10 s)
9	Hold breath for 5 to 10 s	Hold breath for 5 to 10 s (may repeat steps 7 to 9)	Exhale
10	Exhale, wait 20 to 30 s before a second actuation	Wait for 20 to 30 s before a second actuation	Hold upright
11	Shake again before a second actuation	Shake again before a second actuation	Rotate bottom again before a second actuation

cists at The Toronto Hospital – Western Division were excluded due to previous involvement in a formal inhaled device education program one year before this study. Potential participants were asked to participate in a study of a new education program to determine the best method to prepare health care professionals on how to teach patients inhaled device technique. The exact types of interventions to which they could be assigned were not explicitly described, so participants were unaware of the number of different types or levels of interventions that were available. Participants were given an information sheet and asked to give informed written consent for participation. An effort was made during all assessment phases to keep the atmosphere relaxed. It was stated clearly that the survey and demonstration of technique were in no way related to job performance review and that all individual results were confidential. The numbers of subjects who decline participation and reasons for nonparticipation were logged.

Using a computer-generated randomization scheme, participants were randomly allocated in blocks of four to two forms of education: an intensive 1 h workshop with a trained asthma educator; or a 15 min review of the manufacturer's package inserts for a MDI, MDI plus an Aerochamber, and Turbuhaler. Approximately, three to six pharmacists were in each educational intervention session for both groups. The workshop was based on adult learning principles, using tech-

TABLE 3
Questions for knowledge-based part of interview: *Answers are in parentheses below each question (14,15)*

True/false
When using the aerosol inhaler (MDI), a rapid inspiration is recommended. (False)
Patients should make sure to wash the Turbuhaler (Astra Pharma Inc, Mississauga, Ontario) mouthpiece two to three times per week. (False)
Aerochamber use results in a significant reduction in the amount of aerosol that is deposited in the mouth and throat. (True)
It is okay if you do not feel the Turbuhaler powder go down. (True)
It is important to rinse your mouth out or gargle after inhaled corticosteroid use. (True)
Inhaled steroid effectiveness is improved by taking a beta-agonist first (False)
Short Answer
How long do you tell patients to wait before taking a second puff? (At least 20 s)
How long do you tell patients to hold their breath for after taking a puff? (At least 8 to 10 s)
How often do you tell patients to clean their Aerochamber? What instructions do you give them? (a. Once per week; b. Running warm water through the back end and leave to dry.)
What do you tell your patients to look for when an aerosol canister is empty? (Count doses, shake canister or place canister in water and examine how it floats)
What do you tell your patients to look for when a Turbuhaler is empty? (Appearance of red dot/bar in window on Turbuhaler)

niques such as focusing teaching on real-life situations and problem-based scenarios; involving participants actively in their learning by performing activities; and giving participants feedback during instruction to consolidate new information and skills (23-25). During the review of the package inserts in the less intensive group, the asthma educator was present, but did not assist the participants or provide placebo-inhaled devices for demonstration and practice of inhaler technique. These sessions were one-time interventions with no scheduled educational reinforcement (Table 1). The subjects were explicitly asked not to discuss their intervention with any other colleagues so as not to jeopardize the study.

Baseline demographic characteristics, including education history, were collected via a brief questionnaire. Before, immediately after and three months after the educational intervention, subjects were assessed on their ability to demonstrate two inhalations from each of three commonly used inhaled devices, a MDI, a MDI with an Aerochamber and a Turbuhaler, in this sequence, with a previously published scale to determine correct inhaled device technique (14,15,26) (Table 2). The subjects were not specifically provided with the package inserts to review before their assessment; however, there was sufficient time before their assessment for this to be feasible if initiated by the subject. To assess inhaler technique, subjects were given placebo devices with which to demonstrate correct usage. One research assistant blinded to the subjects' intervention was trained to assess proper inhalation technique using placebo devices, acting as a 'mock' patient.

Each subject also completed a basic knowledge questionnaire regarding the use and maintenance of inhaled device systems (Table 3) (14,15). The participant was given a score of 0 if he or she skipped a step, performed a step inadequately, answered a question incorrectly or skipped a question. Participants were given a score of 1 for each step performed correctly and for each question answered correctly. A brief questionnaire was also completed by participants at the three-month assessment to determine additional education obtained since the initial session regarding inhaled devices, the frequency of counselling patients about inhaled devices and to assess changes in the use of inhaled devices when counselling patients.

The scales used to assess demonstration of inhaler technique and the knowledge survey have been previously assessed for face and content validity and have been used successfully in two studies of approximately 150 subjects (14,15). Manzella and colleagues (27) assessed a similar scale developed exclusively for evaluation of MDI technique and found the instrument had satisfactory reliability with a reliability coefficient of 0.73. Testing also found acceptable face, content, convergent and discriminate validity. These previous evaluations support the use of a standardized, written evaluation scale such as the one used in this study.

Due to the nature of the educational intervention, the participants could not be blinded to the intervention. Participants were kept blinded to the content of the assessment and survey until the time of completion.

Data analysis: All statistical analysis was done using SAS version 6.12 statistical software (SAS Institute Inc, Cary, North Carolina). Ten per cent of the data was entered in duplicate into the database to detect and reduce data entry errors.

For the primary outcome, each participant's score was added separately for each device and for the knowledge survey, then used to arrive at average mean scores (± standard deviation) for both groups. Unpaired, two-tailed *t* tests were used to compare the individual change in scores from pre- to postintervention between the two intervention groups.

For secondary outcomes, unpaired, two-tailed *t* tests were used to compare the change in scores from preintervention to follow-up period and from the postintervention to follow-up period between the two intervention groups. The difference between groups and change from baseline of the proportion of pharmacists able to demonstrate correctly all (11 of 11) or nearly all (10 or more of 11) steps in the use of a MDI, MDI plus Aerochamber and Turbuhaler was calculated. The difference between groups and change from baseline of the proportion of pharmacists able to correctly answer all basic knowledge questions was calculated. Mantel Haenszel χ^2

TABLE 4
Subject demographics and characteristics

	Basic education	Intensive education
Sample size	24	24
Mean age (years)	34±8.86	36±9.98
Sex (% female)	67%	78%
Mean year of graduation	1985±8.57	1983±9.86
Mean years in practice	11.13±8.47	12.52±9.01
Staff pharmacist position (%)	78%	82%
Total score pre-education	7.98±1.64	7.46±1.64

Mean±SD

was used to compare the frequency of actual MDI, Aerochamber, Turbuhaler and questionnaire scores the subjects scored in each group for each period; that is, how many subjects in group 1 versus group 2 achieved a score of 1, 2, to 11.

Baseline characteristics of the subjects were compared between the two intervention groups using *t* tests for continuous variables and the χ^2 statistic for categorical variables. For all comparisons, differences were considered significant at a $P<0.05$, without adjustment for multiple comparisons.

A linear regression model using a stepwise procedure was fit to the data using the change in score from pre-education to posteducation as the response variable, and the education group, age, sex, year of graduation, the frequency of use of the devices, and the pre-education score as the independent variables (28). These variables were chosen because previous research has shown them to be potential predictors of practice oriented knowledge and skills in health care workers.

To detect a 20% difference in the change in percentage mean scores between both groups, with a standard deviation of 20% (14), 80% power, a 5% risk of a Type I error and a 10% drop out rate, it was determined that 35 subjects needed to be recruited.

RESULTS

Fifty subjects were screened for participation in the study, with two subjects declining involvement. Forty-eight subjects were recruited, with 24 randomized to each intervention group. Five subjects from the less intensive (basic) education group withdrew from the study, and one subject from the more intensive group withdrew from the study. Two pharmacists in the basic group withdrew due to departure from the hospital's employment, with the remaining pharmacists in both groups withdrawing from the study due to insufficient time or interest to complete the follow-up assessments. The baseline demographics and characteristics of the subjects who withdrew from the study did not differ from those who remained in the study. There was no significant difference between groups in baseline characteristics (Table 4). The range of scores was similar in the basic and intensive groups at baseline (3.75 to 9.75 versus 3.75 to 9.5, respectively) and at the three month follow-up (7 to 10.5 versus 6.25 to 10.75, respectively). However, in the posteducation period, the range of scores was slightly higher in the intensive group (6 to 11 versus 8.75 to 11).

TABLE 5
Change in scores between pre-, posteducation and follow-up periods

	Basic education	Intensive education	P
Change between pre- and posteducation	1.26±1.21	2.64±1.37	<0.001
Change between pre-education and follow-up (± standard deviation)	1.22±1.16	1.78±0.96	0.096
Change between posteducation and follow-up (± standard deviation)	–0.24±0.72	–0.86±1.11	0.042

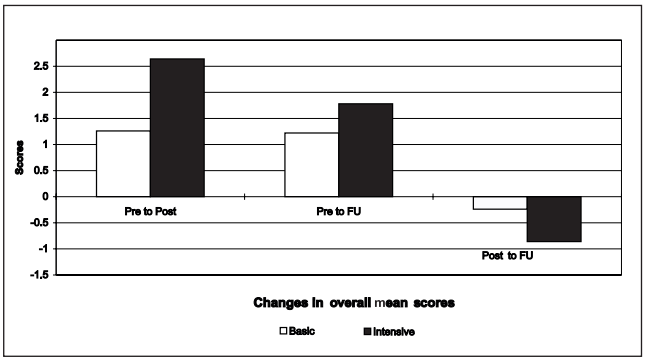

Figure 1) *Change in scores between pre-, posteducation and follow-up periods. Pre Pre-education; Post Early posteducation; FU Late posteducation*

The more intensive educational intervention produced a significantly greater increase in total score than the less intensive intervention group when measured in the immediate follow-up period (Table 5). However, three months after the intervention, the measured increases from baseline total score were not significantly different between groups; the decrease in total score from the immediate postintervention assessment to the three month assessment was significantly greater for the intervention group (Table 5, Figure 1).

There was no significant difference among demonstration scores for individual devices; changes occurred in parallel and were approximately equivalent in magnitude (Table 6). Actual total scores achieved at each stage of training are shown in Figure 2; the two intervention groups achieved similar long term total scores despite the temporarily larger increase in the immediate posteducation period for the intensive intervention group.

The frequency of the actual MDI, Aerochamber, Turbuhaler and questionnaire scores the subjects achieved in each group for each period were compared using Mantel Haenszel χ^2; that is, the numbers of pharmacists achieving a score of 1, 2, 3,…,11 for each measurement score. There was an overall difference in the frequency of scores in the following posteducation scores between the basic and intensive groups: MDI (P=0.021), Aerochamber (P=0.026), Turbuhaler (P=0.033), and total score (P=0.005). There was a trend towards a difference in the score frequencies for the postedu-

TABLE 6
Inhaled device scores pre-education, posteducation and at follow-up

	Pre-education scores		Posteducation scores		Follow-up scores	
	Basic education (n=24)	Intensive education (n=23)	Basic education (n=22)	Intensive education (n=23)	Basic education (n=19)	Intensive education (n=23)
Metered dose inhaler (MDI) (± SD)	8.08±1.91	7.87±1.66	8.77±1.63	9.78±1.13	8.74±1.69	9.17±1.37
MDI with Aerochamber (± SD)	8.42±2.46	8.26±1.63	9.19±1.68	10.09±0.79	9.32±1.49	9.26±1.36
Turbuhaler (± SD)	7.75±2.72	6.39±3.23	9.64±1.59	10.48±0.84	9.42±1.12	9.43±1.64
Questionnaire score (± SD)	7.67±1.27	7.30±1.92	9.50±1.06	10.04±1.02	9.00±1.33	9.09±1.38

Aerochamber (Trudell Medical, London, Ontario); Turbuhaler (Astra Pharma Inc, Mississauga, Ontario)

cation questionnaire scores (P=0.087). No difference in the frequency of scores was found in the late follow-up period.

The percentage of pharmacists able to achieve perfect or near perfect demonstration and knowledge scores was similar between intervention groups at three month's follow-up (Table 7). Approximately half of the pharmacists in both groups achieved near perfect scores for individual devices, a level of skill and knowledge thought adequate for patient teaching purposes. However, for most individual scores, including the overall score, the pharmacists in the more intensive education group still retained somewhat greater knowledge and skills at three-month follow-up.

The stepwise linear regression model with the response variable as the change in overall score between the pre- and posteducation periods found that the two variables that contributed significantly to the model were the pre-education overall mean score (P<0.001) and the education intervention group (P<0.001). (This model resulted in an R^2 value of 0.78, which is considered a good model.) Lower baseline score and assignment to the more intensive intervention were associated with greater short term increases in demonstration and knowledge scores.

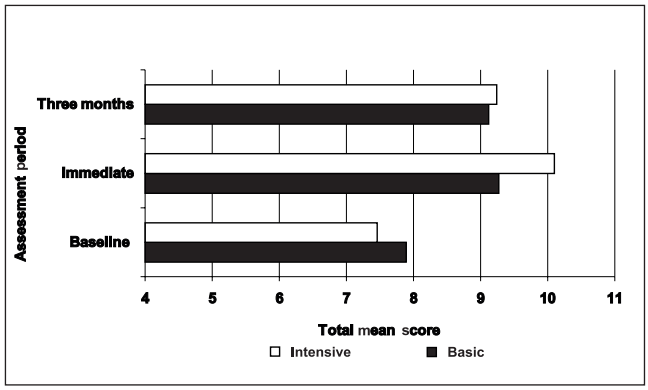

Figure 2) *Total score by group at baseline, immediately postintervention and three months postintervention*

DISCUSSION

Our data show that individual coaching of hospital-based pharmacists achieved greater short term increases in inhaler knowledge and handling skills than simply providing package insert materials. However, when measured at three months after the intervention, the advantage of more intensive training had diminished such that pharmacists had simi-

TABLE 7
Subjects with 'perfect' or 'near perfect' scores

	'Perfect' score (11/11)		'Near perfect' score (10/11)	
	Basic group (%)	Intensive group (%)	Basic group (%)	Intensive group (%)
Pre-education	n=24	n=23	n=24	n=23
Metered dose inhaler (MDI)	4.17	8.70	29.17	13.04
Aerochamber (AC)	20.83	4.35	45.83	13.04
Turbuhaler (TH)	8.33	0	25.00	13.04
Questionnaire	0	0	4.17	8.70
Overall score	0	0	0	0
Posteducation	n=22	n=23	n=22	n=23
MDI	9.09	34.78	45.45	56.52
AC	22.73	34.78	54.54	73.91
TH	31.82	65.22	63.64	86.96
Questionnaire	22.73	39.13	40.91	73.91
Overall Score	4.55	4.35	27.27	60.87
Follow-up	n=19	n=23	n=19	n=23
MDI	10.53	7.14	36.84	52.17
AC	26.32	21.74	47.37	43.48
TH	15.79	34.78	47.37	52.17
Questionnaire	15.79	21.74	42.10	30.43
Overall score	0	0	26.32	43.48

lar knowledge and handling skills whether they had been coached intensively or had merely examined the written materials provided. These findings suggest that it may be wasteful to provide intensive education to all health care providers and that optimal or feasible outcomes can sometimes be achieved by simpler and more cost effective means. Previous research in developing educational models in the psychomotor domain suggest that to learn a technique effectively, there should be five transitional phases to the educational intervention (imitation, manipulation, precision, articulation and naturalization), which would allow motor skill development from the unperfected to the proficient level (29,30). We only investigated a single intervention without reinforcement or follow-up. Therefore, an alternative hypothesis from our findings is that to maintain the initial benefit in knowledge and skills, repeated education, tailored to different stages of psychomotor learning may be required. However, this hypothesis requires testing and confirmation.

To our knowledge, no other study of health professional education has contrasted the long term effect of two explicit types of inhaler education. However, some of our findings are consistent with previously published results. Reznick et al (31) evaluated the impact of a single inhaler training session on the immediate and long term (two months) inhaler knowledge of 38 pediatric housestaff physicians. Similar to our findings, they reported that short term improvements in inhaler knowledge were generally not sustained. They concluded that health care providers are similar to patients in their need for repeated assessment and re-education in optimal inhaler use. Nonetheless, their data suggest a modest "long term" improvement in MDI performance had persisted at their follow-up assessment. Rebuck and co-investigators (32) also examined the long term impact of inhaler training on medical housestaff, reporting measurably better inhaler knowledge and handling of inhalers by internal medicine trainees who had received individual coaching eight months previously compared with a control group of trainees who received no instruction. Both of the aforementioned studies used coaching in inhaler use as the educational intervention; neither examined the impact of simply providing written materials.

We believe that our findings are generally applicable to the broader population of hospital pharmacists, if not other health care providers. Our study population was an unbiased and representative sample of hospital pharmacists, with all but two of 50 eligible pharmacists agreeing to participate. As well, there were few withdrawals during the study. We should emphasize that the pharmacists studied were not specialists in the respiratory area but were typical of general hospital pharmacists. Their primary responsibilities were for patient care in general medical or surgical areas or nonrespiratory specialty areas, and their need to assess and teach inhaler technique to patients was occasional rather than frequent. According to our assessment of the pharmacists at the three month follow-up, they instructed patients to use inhalers an average of less than two times per week. To our surprise, we could detect no relationship between the reported frequency of inhaler teaching and the total score achieved at the three month's follow-up.

Some potential limitations of our study must be noted. First, the lack of statistical difference between educational interventions in long term follow-up may be in part a reflection of small sample size. By studying a far larger number of hospital pharmacists we might have been able to detect a small and statistically significant long term advantage of individual coaching over written materials in the long term follow-up. However, our a priori sample size calculation suggests that our present study was sufficient to exclude any meaningful difference between interventions. Second, we noted that our study participants had a relatively high level of inhaler knowledge at baseline and that our ability to discern differences between educational interventions might have been better in a group with lower baseline knowledge. Nonetheless, we believe that our study group was reasonably representative of hospital-based pharmacists in general. Third, our attempt at a minimal educational intervention may have been confounded by our need to measure outcome variables. Our minimal intervention group did not merely receive written handouts but also handled devices three times under the watchful eye of a trained research assistant. Such device handling was not accompanied by corrective feedback and coaching for optimal use. Nonetheless, the less intensive intervention group may have had their attention focused on the educational outcome by this necessary monitoring. Although our study has suggested that less intensive educational interventions are sufficient to teach nonspecialist health care providers about inhalers, the minimal educational intervention should include the opportunity to handle placebo devices. Finally, because the order of the device assessment was not randomized, there is the potential for systematic bias in the inhaled device scores. As the subjects became comfortable during their assessment, their scores may rise accordingly. This may help explain the higher scores after the pre-education assessment for the Aerochamber and the Turbuhaler, which were the second and third in sequence. However, because these two devices also tend to be easier for subjects to learn to use, higher demonstration scores would be expected.

To determine alternate sources of education regarding inhaled devices during the three-month follow-up period, a survey was conducted that found that both groups sought out little additional education regarding inhaled devices on their own. In particular, no pharmacists in the less intensive group attended an intensive workshop on inhaled devices. Based on this self-report, cointervention of the less intensive group with more advanced education on inhaled devices was unlikely. Although pharmacists were all working at the same institution, increasing the potential for contamination between groups, their work sites are decentralized in different nursing units, with relatively little contact with each other on a regular basis.

In contrast with previous studies of inhaler use in our centre, we did not find significantly lower baseline demonstration scores for the inspiratory flow-driven Turbuhaler

compared with the other devices. Indeed, in the present study, the largest increase in the individual device scores and the highest score retained at follow-up was achieved with the Turbuhaler. In previous reports, we speculated that the Turbuhaler demonstration scores tended to be lower because the device was somewhat newer and less widely used than the ubiquitous MDI (14). Our earlier speculation seems to have been correct.

CONCLUSIONS

We believe that general hospital pharmacists' need for inhaler knowledge may be met by relatively simple educational interventions such as providing written materials and the opportunity to handle devices. We could identify no long term educational benefit to a one-time intervention of individual coaching, and suggest that if coaching is to be used, it be reserved for those with lowest baseline knowledge. Further studies are needed to assess the long term effectiveness of educational interventions and whether repeated or transitional educational interventions provide more sustained benefit in inhaled device knowledge and skills.

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