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REVIEW

Assessment of Educational Inhaler Technique Interventions Among Community Pharmacists: A Systematic Review

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Objective: Community pharmacists are the last point of contact before patients are provided with an inhaled asthma device and are expected to adequately educate and train patients on its use. Evidence has shown that pharmacists lack the knowledge and skills required to appropriately counsel patients on these devices. The aim of this systematic review was to focus on evaluating the effects of educational interventions on community pharmacists knowledge of inhaler technique.

Methods: A literature search was conducted using the databases Pubmed and Embase with no applied time restrictions. The databases were searched from inception to December 2018. Articles were eligible for inclusion if they reported outcomes evaluating the improvement in pharmacists knowledge of inhaler technique after an educational intervention and provided details of the intervention. Pharmacists working in settings other than community pharmacies and inhaler devices used for conditions other than asthma were excluded.

Results: Five studies met the eligibility criteria. Workshops and one-on-one instruction were the main educational strategies used in these studies to augment the pharmacists knowledge of asthma inhaler devices. A checklist was utilized by all studies to evaluate the pharmacists improvement of inhaler technique after an educational intervention. All studies showed an improvement in inhaler technique of pharmacists post-intervention.

Conclusion: Studies identified in this systematic review have shown that an educational intervention produced positive outcomes related to the pharmacists knowledge on the steps involved in using asthma inhaler devices. However, the study findings focused on short-term retention of knowledge of inhaler technique and did not address the application of these results in clinical practice.

Keywords: asthma, inhaler technique, educational activity, community pharmacy

Introduction

Asthma is a chronic disease that relies heavily on the use of inhaled therapy for management. Inhaler devices play a pivotal role in the management of asthma to produce optimal outcomes for patients when used appropriately. The most commonly used inhaler devices for asthma are the metered dose inhaler (MDI) and dry powder inhaler (DPI). The DPIs were introduced for ease of use as they are breath-activated and do not require the need to coordinate inhalation and actuation, as required with the MDI.[1] Studies have shown incorrect inhaler technique can lead to inadequate asthma management resulting in poor asthma control and clinical outcomes.[1–3] Rates of incorrect inhaler technique continue to remain high among

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asthma patients with minimal improvement in recent times.[4,5] Since this remains a real challenge in achieving optimal asthma control, investing more time in educating patients on appropriate inhaler use becomes crucial for healthcare professionals.

Although many studies have focused on efforts directed towards enhancing patient knowledge and skills, standardizing education and training methods among patients and healthcare professionals becomes vital when addressing inappropriate inhaler use.[5] Educational interventions such as discussion and demonstration workshops and one-on-one "hands-on" instruction have been applied to healthcare providers to reinforce inhaler technique methods; however, a follow-up to evaluate the effectiveness of the intervention is also required.[6–8] One such method of evaluation is the Kirkpatrick model which consists of four levels of evaluation.[9] Moreover, healthcare providers should be assessed on their knowledge and usage of asthma inhaler devices since they play a prominent role in the care of patients with asthma.

When looking closely into the pharmacy profession, pharmacists are advised to provide counseling to patients on the appropriate use of medications. As the last point of contact before the patient is provided with the inhaled asthma device, the responsibility falls on the pharmacist to reinforce education already provided or subsequently provide adequate education and training to the patient. However, evidence has shown that many pharmacists and other healthcare professionals lack the skills necessary to appropriately counsel patients on inhaled devices.[10–16] Currently, it is unclear how inhaler technique of pharmacists can be enhanced; therefore, the aim of this systematic review was to focus on evaluating the effects of educational interventions on community pharmacists knowledge of inhaler technique.

Methods

A literature search was conducted using the databases Pubmed and Embase with no applied time restrictions. The database search was conducted from inception through to December 2018. Search terms included "asthma" AND "inhaler technique" AND ("community" OR "pharmacist" OR "pharmacy") AND ("educational" OR "intervention" OR "counseling" OR "workshop" OR "continuing education" OR "professional development") AND "knowledge." Database searching was open to all fields in Pubmed and "Quick Search" in Embase. The reference lists of articles that were eligible were manually scanned to identify any article that may have been previously missed. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) reporting standards were followed in this systematic review.[17] No review protocol was published.

Articles were eligible for inclusion in the systematic review if they reported outcomes evaluating the effect of an educational intervention on community pharmacists inhaler technique, provided information regarding the nature of the intervention and were published in English. Educational interventions included those which provided the participant with information and guidance on inhaler technique, no limitations were placed on the types of inhalers used. Studies were included only if they provided detailed information on the specific type of intervention used, this included group workshops and one-on-one instruction. Community pharmacists were defined as fully qualified pharmacists working within a local pharmacy with direct access to the public. Conference abstracts and pharmacists working outside a community pharmacy setting were excluded. To ensure a focused review on a specific disease state, inhaler devices used for conditions other than asthma were excluded. After removing duplicates obtained from the search described above, titles and abstracts of potentially eligible articles were scanned independently by two investigators. Full-text versions of any remaining eligible article were retrieved and independently reviewed to make a final decision for inclusion. Any discrepancy in whether to include an article was resolved by discussion among the two investigators.

Data extraction was completed using a tool developed in Microsoft Excel® that recorded article identifiers, population size, type of inhaled device evaluated, intervention, and outcomes. Extraction was completed by one investigator and then verified by the other. Once data extraction was complete, both investigators reviewed the findings of each study. Risk of bias was not assessed due to variability in study designs. The primary outcome of interest was evaluating the effects of educational interventions on community pharmacists knowledge of inhaler technique.

Results

Among the databases searched for this review, 193 studies were identified. After removal of duplicates and unrelated articles, five studies met the pre-established inclusion criteria (Figure 1). All included studies evaluated the community pharmacists improvement in using the MDI and DPIs after an educational intervention, except for one study conducted by Erickson et al which focused only on

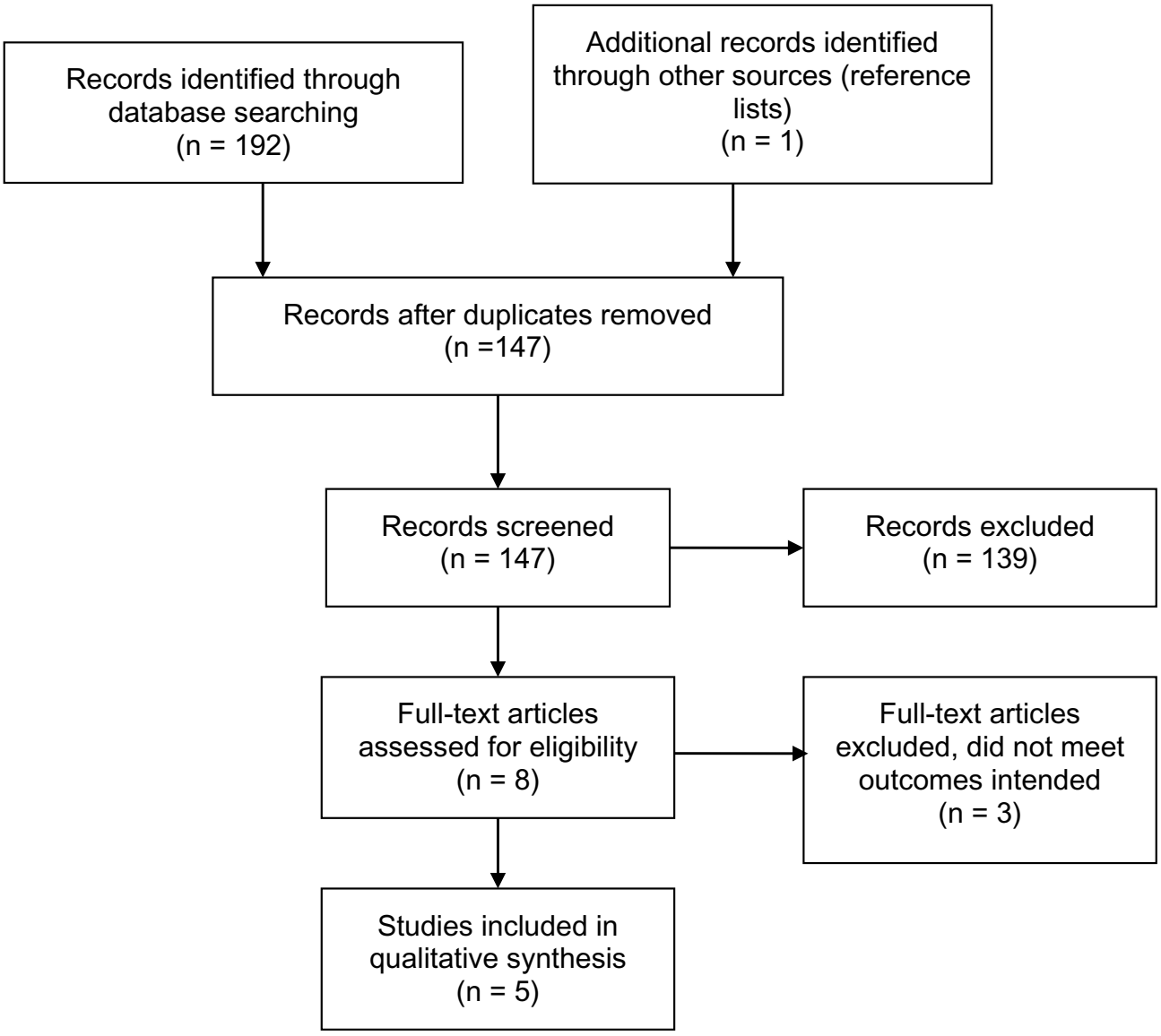

Figure 1 Flow diagram outlining the systematic review process.

the MDI and one study by Basheti et al which focused only on DPI.[18,19] Study summaries are provided in Table 1.

A checklist was used among all studies to assess the pharmacists knowledge on inhaler technique. The common steps seen among all checklists included information on how to open the inhaler, the position of the device prior to inhalation, and the time required in holding the breath after inhalation (Table 2). Within the checklists, the level of detail listed in each step differed among the studies, some provided minimal instruction while others provided detailed instruction within each step.[18,20] Three studies used a 9-point checklist that was extracted from previously published literature.[18,19,21] These steps included inhaler position, head position, and hand-lung coordination. Nguyen et al used an 8-point checklist that differed from the 9-point checklist as they did not mention the head position when using the inhaler.[22] The checklist utilized by Cain et al contained 6 items that were derived from the manufacturer recommendations, which included all steps mentioned above but combined to give a fewer number of points.[20]

The studies in this review used workshops and one-on-one instruction to deliver the educational intervention to improve the pharmacists knowledge of utilizing asthma inhaler devices. Four studies assessed the short-term knowledge retention of inhaler technique, with one assessing the impact of long-term retention.[18–20,22] Four studies

Table 1 Studies Included to Assess the Impact of an Educational Intervention on Community Pharmacists Inhaler Technique

Author/Year	Study Design	N	Type of Inhaler Evaluated	Intervention	Outcome
Erickson et al (2000)[18]	Questionnaire, Pre-post interventional study	39	MDI	4-hr educational session	Non-significant difference in mean MDI technique score at baseline (7.2 ± 1.1) and at follow-up (7.5 ± 1.3)
Basheti et al (2009)[19]	Pre-post interventional study	31	DPI (Turbuhaler and Diskus)	3-hr educational session for active group	6 months post-intervention: all active group pharmacists demonstrated correct inhaler technique for Turbuhaler and Diskus 2 years post-intervention: active group had better inhaler technique compared to control for Turbuhaler (83% vs 11%) and Diskus (75% vs 11%)
Cain et al (2001)[20]	Pre-post interventional study	Not mentioned	MDI and DPI (Turbuhaler and Diskus)	Individual instruction	4–6 weeks post-intervention produced mean scores of 89.3% ± 12.8 for MDI, 83.8% ± 15.8 for Turbuhaler and 88.3% ± 12.4 for Diskus
Basheti et al (2014)[21]	Pre-post interventional study	14	MDI and DPI (Turbuhaler and Diskus)	2-hr educational session	Improved inhaler technique before and after intervention for MDI (3.5 vs 8.93), Turbuhaler (4.29 vs 8.79), and Diskus (2.0 vs 8.75)
Nguyen et al (2018)[22]	Questionnaire, pre-post interventional study	103 educational intervention 87 simulated study	MDI and DPI (Turbuhaler)	4-hr educational session	Post-intervention: mean inhaler technique scores for both the MDI and Turbuhaler improved from 3.0 to 7.4 and 0.1 to 7.4 out of a maximum score of 8.0, respectively ($p < 0.001$) 6–8 week post-intervention simulated patient encounter: inhaler technique scores significantly better among those who attend training (6.1 vs 4.3, out of a maximum score of 8, $p < 0.001$)

used an educational workshop that ranged from 2 to 4 hours to improve the pharmacists inhaler technique while one study used individual instruction as an interventional education strategy.[18–22] Table 2 outlines the detail regarding the evaluation methods used to assess inhaler technique among pharmacists.

Erickson et al provided a 4-hour session that included both a didactic and active learning component such as role-plays and demonstration.[18] The pharmacists inhaler technique was assessed pre-intervention and 6 months after the workshop through a self-assessment questionnaire. Mean MDI technique knowledge scores showed a modest, non-significant increase from baseline compared to follow-up (7.2 vs 7.5, p=0.29). Scores were based on the number of steps correctly identified out of 9. Seven or more steps were correctly identified by 87% of the participants at follow-up compared to 76% of participants at baseline.

Basheti et al provided a 3- and 2-hour educational workshop for pharmacists who were assigned to either the active or control group, respectively.[19] All pharmacists received initial training on basic asthma management, inhaled medications and peak flow meter (PFM) technique. Thereafter, pharmacists in the control group received training on teaching PFM technique to patients while the active group received PFM, Turbuhaler and Diskus device training. Pharmacists were assessed pre- and post-intervention, 3 and 6 months post-training during the 6-month follow-up study and at 2 years post initial training by a single investigator. At initial assessment, few pharmacists were able to demonstrate correct inhaler technique (Turbuhaler n = 4, 13%, Diskus n = 2, 6%). Post-training, all pharmacists (n = 31) demonstrated the correct technique. Two years post-intervention, the active group showed significantly better inhaler technique compared to the control group for Turbuhaler (83% vs 11%) and Diskus (75% vs 11%), $p<0.05$. A small sample size limits the generalizability of the results as only 31 out of 120 pharmacists were recruited for the intervention.

Cain et al provided one-on-one instruction to the pharmacist on the proper use of the MDI and two DPIs (Turbuhaler and Diskus).[20] Assessment of inhaler technique was completed by the same investigator who provided the intervention. The greatest change 4–6 weeks post-intervention was evident with the DPIs where 88.3% of pharmacists achieved the correct number of steps compared to 49.8% at baseline. For the MDI, the mean baseline and post-intervention scores were

Table 2 Evaluation of Inhaler Technique Among All Studies

Author/Year	Assessment Checklist Steps	Assessment Period	Evaluators
Erickson et al (2000)[18]	**Checklist for MDI technique** Step 1 — shake inhaler Step 2 — breath just before inhaling Step 3 — head position Step 4 — inhaler position Step 5 — placement of MDI Step 6 — hand–lung coordination Step 7 — breath hold Step 8 — exhale rate Step 9 — timing of second dose	Pre-intervention Post-intervention (6-month follow-up)	Self-assessment of 9-point checklist
Basheti et al (2009)[19]	**Checklist for Turbuhaler technique** 1. Remove the cap from the inhaler 2. Keep inhaler upright 3. Rotate grip anti-clockwise then back until a click is heard 4. Exhale to residual volume 5. Exhale away from the mouthpiece 6. Place mouthpiece between teeth and lips 7. Inhale forcefully and deeply 8. Hold breath for 5 seconds 9. Exhale away from mouthpiece **Checklist for Diskus Technique** 1. Open inhaler 2. Push lever back completely 3. Exhale to residual volume 4. Exhale away from mouthpiece 5. Place mouthpiece between teeth and lips 6. Inhale forcefully and deeply 7. Hold breath for 5 seconds 8. Exhale away from mouthpiece 9. Close inhaler	Pre-intervention 6-month follow-up study (assessment at 3 and 6 months) Post-intervention (2 years after initial study)	Single investigator assessed all pharmacists
Cain et al (2001)[20]	**Checklist for MDI Technique** 1. Remove the cap. 2. Shake canister thoroughly. 3. Breathe out steadily to FRC or RV. 4. Insert or place the mouthpiece 2–4 cm away from mouth while keeping the canister upright. 5. Discharge the inhaler while taking a slow, deep breath. 6. Hold breath in full inspiration for 5–10 seconds and exhale. **Checklist for Turbuhaler Technique** 1. Remove the cover. 2. Turn the bottom clockwise until it clicks while keeping the inhaler upright. 3. Turn the bottom counterclockwise to the maximum while keeping the inhaler upright. 4. Turn head away from the inhaler and exhale to FRC or RV. 5. Place the mouthpiece between lips horizontally or vertically and inhale deeply and forcefully. 6. Hold breath in full inspiration for 5–10 seconds and exhale. **Checklist for Diskus technique** 1. Put thumb on the thumb grip and push the grip away from you as far as it will go until the mouthpiece appears and snaps into position. 2. Slide the lever away from you as far as it will go until it clicks while keeping the Diskus horizontally. 3. Holding the Diskus horizontally and away from mouth, breathe out to FRC or RV. 4. Put the mouthpiece to lips and breathe in steadily and deeply. 5. Remove the Diskus from mouth. Hold breath in full inspiration for 5–10 seconds and exhale. 6. Put thumb on the thumb grip and slide the thumb grip back toward you as far as it will go to click it shut.	Pre-intervention Post-intervention (4–6 weeks)	Single investigator assessed all pharmacists

(*Continued*)

Table 2 (Continued).

Author/Year	Assessment Checklist Steps	Assessment Period	Evaluators
Basheti et al (2014)[21]	**Checklist for MDI technique** Remove the mouthpiece cover Shake the inhaler Hold the inhaler upright Exhale to residual volume Keep head upright or slightly tilted Place the mouthpiece between teeth and lips Inhale slowly and press the canister Continue slow and deep inhalation Hold breath for 5 s **Checklist for Turbuhaler Technique** Remove cap from the inhaler Keep the inhaler upright Rotate grip counterclockwise and then back until a click is heard Exhale to residual volume Exhale away from the mouthpiece Place the mouthpiece between teeth and lips Inhale forcefully and deeply Hold breath for 5 Exhale away from the mouthpiece **Checklist for Diskus technique** Open the inhaler Push the lever back completely Exhale to residual volume Exhale away from the mouthpiece Place the mouthpiece between teeth and lips Inhale forcefully and deeply Hold breath for 5 s Exhale away from the mouthpiece Close the inhaler	Pre-intervention Post-intervention Follow-up (4 months)	Single investigator assessed all pharmacists
Nguyen et al (2018)[22]	**Checklist for MDI technique** Step 1: Remove the cap Step 2. Shake inhaler Step 3. Hold inhaler upright Step 4. Breath out all the way Step 5. Place the inhaler mouthpiece between your lips (and teeth); keep your tongue Step 6. Press the inhaler just after starting a very slow and very deep breath in (until the lung is full) Step 7. Remove the inhaler from your mouth and hold your breath while counting to 10 or as long as possible Step 8. Breathe out slowly No checklist for DPI provided	Pre-intervention Post-intervention Follow-up (6–8 weeks)	Researchers and simulated patients assessed all pharmacists

72.2% and 89.3%, respectively, whereas the DPI scores were 61.2% at baseline and 83.8% post-intervention. They did not report the number of pharmacists who participated in the study.

Basheti et al provided a 2-hour educational session where all participants were educated on the correct inhaler technique through physical demonstration and assessed after the workshop and at 4 months by a single investigator.[21] Improvements in mean inhaler scores before and after training for the MDI (3.5 vs 8.93), Turbuhaler (4.29 vs 8.79), and Diskus (2.0 vs 8.75) were statistically significant ($p<0.001$). Four months post-intervention, a decrease in mean inhaler technique score was observed in pharmacists who attended the workshop for the MDI (8.5), Turbuhaler (7.5) and Diskus (7.5).

Nguyen et al provided a 3-hour educational session with a focus on the MDI and one DPI.[22] The workshop focused on basic asthma knowledge and asthma management. Pharmacists were evaluated according to an 8-step checklist and assessed after the session and at 6–8 weeks'

follow-up using a simulated patient methodology by multiple researchers. After completing the training session, 48.5% and 53.4% of pharmacists were able to correctly demonstrate all steps for the MDI and DPI, respectively, when compared to 0.3% for the MDI and 0.6% for the DPI at baseline. Mean inhaler technique score improved for the MDI from 3.0 to 7.4 and DPI from 0.1 to 7.4 ($p<0.001$). At 6–8 weeks follow-up, there was a significant difference in mean MDI technique scores between the pharmacists who had the intervention compared to those who did not (5.4 vs 1.7, $p<0.001$). No outcomes were reported for the DPI and the long-term effects of the study were not assessed.

Discussion

The studies identified in this systematic review have shown that an educational intervention produced positive outcomes related to the community pharmacists knowledge and skills with using asthma inhaler devices. Various asthma inhaler devices and checklists were utilized during the assessment. Although findings were favorable, these results should be interpreted carefully due to the variable nature of the studies.

The primary outcome of interest was the improvement of inhaler technique after an educational intervention. A variety of instructional methods were used to enhance the pharmacists competence on correct inhaler technique; however, no studies incorporated the Kirkpatrick model to evaluate the effectiveness of the educational intervention.[9] Although the Kirkpatrick model was not mentioned in any of the included studies, the included studies used self-assessment questionnaires and pre- and post-checklist comparisons were utilized to assess the degree of knowledge (Kirkpatrick Level 2) gained after the educational session. Kirkpatrick Level 1 (reaction) was not evaluated by any of the studies to assess the participant's feedback to the educational session. Furthermore, Kirkpatrick Level 3 (behavior) and Level 4 (evaluation) were not addressed in these studies due to the short duration of the studies and no assessment of training impact was measured in practice. Therefore, the true effectiveness of the educational sessions in improving the competence of community pharmacists in using asthma inhaler devices remains inconclusive.

One of the shortcomings of the included studies was the study duration. While short-term improvement was evident when assessed post-intervention by all studies, the long-term impact was assessed only by Basheti et al.[19] This becomes important when evaluating the retention of the knowledge gained after the training sessions. A study by Butler and Raley concluded that continuous educational interventions provide enhanced long-term feedback or retention of outcomes compared to a single intervention alone.[23] This is not only beneficial for enhancement and retention of inhaler skills resulting in improved patient care, but also for professional development and continuing education. Saini et al showed that the inhaler technique must be reinforced to patients on a monthly basis to achieve optimal outcomes.[24] A recent review by Klijn et al assessing the effect of an educational intervention on inhaler technique in patients also concluded that the effect is evident short term.[25] It is also reported that the type of inhaler and disease state do not play a significant role in the management of inhaler use, further strengthening the need for an initial intervention aimed at establishing the correct technique. As a result, community pharmacists should engage in continuous educational development sessions to enhance their skills in providing effective counseling to patients using inhaled asthma devices.

Multiple checklists were used in the included studies to assess the inhaler technique, with most taken from previously published literature or manufacturer's recommendations. Basheti et al have shown that inhaler checklists are the most feasible and accessible method to assess inhaler technique among trained personnel.[26] However, high heterogeneity between checklists raises concerns when making direct comparisons that leads to the variability seen among patients and healthcare professionals when using inhaler devices. Consequently, standardizing checklists for assessment is important to achieve the best outcomes across all studies and assist in providing quality education and assessment for pharmacists, simultaneously resulting in a high standard of care to patients.[26]

The type of inhalers utilized for assessment varied among the studies, community pharmacists must have the required knowledge to counsel patients on a variety of inhaled devices. Research suggests that the DPIs are becoming increasingly popular due to their ease of use, whereas the MDIs are associated with the highest average frequency of errors within patients.[4,27] However, results from a recent study and previous systematic reviews suggest that there is no difference in clinical effectiveness between the standard MDI (with or without a spacer) compared to alternative inhaled devices (such as the DPI – Turbuhaler and Diskus).[28–30] It is evident that patients can use MDIs as effectively as other inhaled devices, if the correct inhalation technique is taught. This strengthens the

need for quality education within pharmacists to allow them to counsel patients on a variety of inhaled devices correctly, as they are the last point of contact before the patient is provided with the device.

Within our studies, the assessment of inhaler technique pre- and post-intervention varied, with three studies using a single investigator for assessment thus reducing bias and ensuring consistency between the evaluation of pharmacists. The remaining two studies used self-assessment or a variety of researchers and simulated patients which may introduce assessment bias. In future studies, assessing the inhaler technique should include a standardized checklist to provide consistency across the assessment of inhaler technique and quality education for patients and pharmacists. Interventions should be carried out on multiple occasions to reinforce the concepts taught. Additionally, evaluating the effect of educational interventions on patient outcomes would be beneficial to assess the vigor of the intervention.

The findings of this review should be interpreted in light of some limitations. Four studies included in the review had a small sample size which may not be representative of the full population and one study did not provide sample size. The inclusion criteria may have overlooked interventions involving digital education or e-health interventions. The majority of studies did not assess the effect of the intervention directly on patients which would have analyzed the effectiveness of the intervention more accurately in relation to patient care. This review focused on community pharmacists; therefore, it may not be of use to pharmacists counseling patients on inhaler technique in different fields of pharmacy. The mixed nature of the studies precluded the use of a single quality assessment tool. However, our approach was justified and provided appropriate insight into the quality of included studies. The majority of the studies did not have a control group within the study design; therefore, an accurate improvement in knowledge and skills cannot be concluded. Finally, the educational intervention was only linked to the MDI and DPIs, therefore generalization cannot occur for all inhaler types available.

Conclusions

An educational intervention was found in all studies to improve the community pharmacists knowledge of inhaler technique on asthma inhaler devices. There was an increase in the number of pharmacists who were able to correctly identify all steps required on an asthma inhaler device checklist. Based on current findings, there is no conclusive evidence to show the impact of an educational intervention on the retention of long-term asthma inhaler technique. Therefore, the educational strategies utilized in these studies can only be recommended as a tool to support short-term knowledge retention.

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