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IMPROVING INHALER TECHNIQUE EDUCATION IN A PEDIATRIC EMERGENCY DEPARTMENT

by

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Abstract

Background: Efficacy of inhaled medications for asthma is dependent upon proper administration technique. Rates of metered dose inhaler and spacer misuse are high among both patients and healthcare providers, and gaps in patient education practices are widespread. Practice guidelines recommend patient technique be demonstrated and assessed at every encounter using a checklist of critical steps with repetition until competency is achieved.
Local problem: The purpose of this project was to improve metered dose inhaler and spacer technique education provided by registered nurses in a pediatric emergency department. Nurses in this setting do not receive training on metered dose inhaler technique, and patient technique demonstrations are not routinely assessed or documented utilizing checklists.
Interventions: All nurses working in the pediatric emergency department (n=20) received education on metered dose inhaler and spacer technique at the initiation of the project. Training checklists were developed and incorporated into the electronic medical record based upon practice guidelines. Prior to discharge, patients with asthma were asked by a nurse to demonstrate their technique using a metered dose inhaler and spacer. The nurse used the checklist in the patient's electronic medical record to assess and document competency in the critical steps of metered dose inhaler and spacer technique. Instruction was provided by the nurses to remedy any patient errors until competency was demonstrated.
Results: In patient chart audits conducted over a 10-week period 138 charts met audit criteria; 95 of which had documented checklists. One-hundred percent of patients and/or caregivers with documented checklists were able to demonstrate competency in all critical steps prior to discharge, with 35% requiring additional education to correct errors in technique.
Conclusions: This project demonstrated the benefit of maximizing a pediatric emergency department encounter to provide evidence-based asthma education on a critical component of asthma management. Similar projects are needed that focus on inhaler technique in other settings, as well as with other inhalation devices.

Keywords: asthma, metered dose inhaler, spacer, technique

Background and Significance

Asthma is one of the most common chronic conditions among children, with an estimated 7.1 million children in the United States affected (Akinbami, Moorman, & Lu, 2011). African-American children have the highest prevalence with one in six affected nationally (Centers for Disease Control and Prevention, 2018). Despite effective treatments African-American children experience a four-fold greater rate of emergency department (ED) visits, three times greater rate of hospitalizations, and eight times higher death rates as compared to non-Hispanic white children (Akinbami, Moorman, Garbe, & Sondik, 2009). In Baltimore City, 20% of children are affected by asthma, and the rate of ED visits for pediatric asthma is among the highest in the nation (Baltimore City Health Department, 2017). These disparities are associated with multiple factors including: genetic factors, low socioeconomic status, greater exposure to environmental triggers, lack of consistent medical care, and poor medication adherence (Hill, Graham, & Divgi, 2011).

Inhaled corticosteroids are the cornerstone of preventive asthma therapy, and have been proven to significantly decrease asthma morbidity and mortality (Covar, 2016; National Asthma Education and Prevention Program (NAEPP), 2007). Multiple inhalation devices exist; however, the metered dose inhaler (MDI) with spacer is the preferred method in children due to its efficacy, ease of use, and cost-effectiveness (Papadopoulos et al., 2012). MDI efficacy is dependent upon proper technique order to maximize medication deposition in the lungs versus the oropharynx (Usmani, 2015). Rates of MDI and spacer misuse are high, particularly in inner city practice settings. Reznik, Silver, and Cao (2014) found that in a group of urban minority children, less than 4% of caregivers were proficient in technique. Low caregiver educational status has also been associated with significantly higher rates of MDI and spacer misuse

(Capanoglu, Misirlioglu, Toyran, Civelek, & Kocabas, 2015). Common errors include insufficient breath hold after inhalation, inhaling too forcefully, not exhaling before actuation, and not shaking the inhaler (Capanoglu et al., 2015; Melani, Bonavia, & Cilenti, 2011). Compounding this problem is the fact that health care providers (HCPs) often lack competency. Physicians, nurses, pharmacists, and respiratory therapists are often unable to demonstrate proper technique with MDIs and spacers; few report receiving formal technique training (Basheti, Qunaibi, Hamadi, & Reddel, 2014; DeTratto et al., 2014). Additionally, few patients report being asked by a HCP to demonstrate device use; a practice endorsed by national and global practice recommendations (Global Initiative for Asthma (GINA), 2017; NAEPP, 2007; Reznik et al., 2014). Both NAEPP (2007) and GINA (2017) practice guidelines recommend that patient technique be assessed at every healthcare encounter using a checklist of critical steps. The NAEPP guidelines (2007) detail the critical steps of MDI and spacer use, and the Inhalation Device Skill Assessment Tool (IDSAT) is a validated a checklist of critical steps for both MDI with spacer and MDI with spacer and mask. The IDSAT was developed by Pradel et al. (2003) to assist HCPs with evaluating patient technique, as well as to assist with HCP training.

Project Overview

This quality improvement (QI) project took place in a pediatric emergency department (PED) in a large academic medical center located in an inner city setting and aimed to address the gaps in current asthma care as compared to the recommendations made by global and national practice guidelines (GINA, 2017; NAEPP, 2007). The nurse manager in the PED recognized that MDI and spacer education on correct usage technique for both patients and HCPs was an area in need of improvement, as was patient technique assessment and documentation. The nurse manager reported that there were patient teaching variations in the critical steps of

MDI and spacer use, and HCPs were not routinely having patients perform return demonstrations to allow for assessment of proper technique as recommended by GINA (2017) and NAEPP (2007). HCP documentation included a general statement that patient education had been performed, but did not include details specific to MDI and spacer training. Also lacking was a checklist to document assessment of patient technique and education in the electronic medical record (EMR).

The purpose of this QI project was to improve patient and caregiver MDI and spacer technique by implementing a practice change of having patients with asthma demonstrate their technique; followed by assessment and documentation using a checklist in the EMR (Appendix A and B). Any patient and/or caregiver demonstrating an error in a critical step of MDI/spacer technique was provided with additional education until able to demonstrate competency in all steps. The target population included all RNs (n=20) working in the PED.

Theoretical Framework

The Knowledge to Action Framework (KTA), a framework grounded in planned action theory designed to address gaps between current and best practice, was used to guide this project (Graham et al., 2006). The framework developers designed the model to facilitate translation of knowledge into practice in order to improve health through evidence-based, cost-effective healthcare. The model is centered upon two major concepts: knowledge creation and knowledge application, or action. Knowledge inquiry, knowledge synthesis, and creation of knowledge products comprise the knowledge creation component. Each stage results in greater knowledge refinement as it is tailored to enhance usability for end users. The action cycle frames project execution with seven key steps: identification of the problem, adapting knowledge to local context, assessing barriers and facilitators to knowledge use, the intervention phase, monitoring

knowledge use, evaluation of outcomes, and sustaining the knowledge use. Graham et al. (2006) highlight the complexity of the cycle, with fluid boundaries between the phases allowing adjustments for problems encountered throughout the course of the project.

This Doctor of Nursing Practice project began with a knowledge inquiry and synthesis to enhance understanding of the problem as well as potential solutions. External data was gathered through a literature review to describe the problem of suboptimal MDI and spacer technique, as well as lack of proper patient teaching and documentation practices. Information was also obtained from the literature on successful interventions for addressing the problem. The importance of contextual knowledge was considered as well; speaking with stakeholders and surveying the RNs working in the target setting provided internal data regarding current practice. Information gained from the RNs regarding previous education and experience with MDIs and spacers and current practices regarding patient education allowed for the tailoring of project activities to fit user needs. External and internal data was synthesized and the end result was a plan for implementation; in this case development of an RN competency training in MDI and spacer technique in the form of a brief face-to-face demonstration and implementation of a checklist for patient assessment to be documented and included in the EMR. The checklist based upon the NAEPP guidelines and existing tools is a product of knowledge creation.

Identification of the problem in this project resulted from a combination of methods: discussions with stakeholders, review of the literature, and an RN survey. Although the problem is prevalent in various units and among various disciplines of HCPs, the target setting for this project was chosen as the PED. Change agents were identified: the nurse manager, two senior RNs working various shifts, and the co-chair of the hospital's Asthma Committee. Successful interventions were gleaned from the literature; the result was a plan for face-to-face education for

the RNs to achieve competency in MDI and spacer technique, and a change in practice to include assessment of patient technique by observing their technique through demonstration, followed by documentation on a device specific checklist of essential steps. Project planning took into consideration the local context and intervention details were planned based upon unit needs. The setting selection was impacted by the fact that each patient would already have an MDI and spacer available. Information technology support was recruited to facilitate incorporation of the checklist into the EMR. Ongoing communication with project champions allowed for continued assessment of any arising barriers in order to adjust and tailor interventions where needed, and this was facilitated by the fluid stages in the framework. Knowledge use was monitored day to day by the project champions working on the unit, as well as through chart reviews, which also served to evaluate outcomes for use of the checklist for documentation of patient education and device technique, with a goal of 100% compliance with use of the checklist. Additionally, RN competency after face-to-face training was a measured outcome, and was assessed using the same checklist to be used for patients. Results were disseminated to stakeholders, and the nurse manager and project champions would continue to facilitate sustainability. Strong buy-in by the stakeholders, demonstrated in the request for this project, will enhance sustainability, as will incorporation into the EMR.

Literature Review

A literature review was conducted on the current and best evidence in support of interventions proven effective in training and evaluating patients in proper inhaler technique. Evidence was reviewed first for interventions to improve HCP competency, and then for interventions aimed at patient and caregiver competency. Included studies are summarized in

Table 1 and were critically appraised based on key elements recommended by Melnyk and Fineout-Overholt (2015).

Basheti et al. (2014b) conducted a randomized controlled trial (RCT) in Jordan to assess HCP competency with various devices before and after a workshop with hands-on learning. Device specific checklists were used to aid in evaluation, and significant improvement from baseline for all devices was measured both immediately and four months post workshop ($p<0.001$). Study strengths include random selection of HCPs, assessment using a checklist administered by the same investigator to reduce measurement bias, and rigorous statistical analyses. It should be noted that the potential for nonresponse bias exists due to the small proportion of recruited HCPs that attended the workshop; 200 agreed to participate in technique demonstrations, however only 48 of 129 agreeing to attend the workshop attended. Additional caution is advised as baseline data was obtained by self-report; however, this was addressed by using a piloted questionnaire determined to have face and content validity.

Leung et al. (2015) also evaluated the impact of hands on education on various inhaler devices, including MDI with spacer, for HCPs in a study using an experimental pre-test post-test design. Educational sessions were conducted at three Canadian medical practices with 41 family physicians. Device specific checklists were used to assess HCP technique; at baseline all had critical errors. Additionally, half reported providing no inhaler training in practice. Post intervention all errors were remedied, and a greater percentage reported incorporating inhaler training into their practice. Limitations of this study include a reliance on self-reported data, lack of statistical analysis for significance, small sample size, and potential selection bias since not all targeted HCPs participated. Generalizability is increased by including multiple devices, however only physicians were included.

Klijn et al. (2017) conducted a systematic review in the Netherlands including studies from across the world, including the United States, to assess effectiveness of various interventions on inhaler technique for patients. Thirty-nine studies were included; most took place in outpatient and pharmacy settings. Ninety-five percent of studies showed significant improvement in technique on various devices regardless of the educational method, although most were physical demonstrations. Additionally, shorter elapsed time since intervention was found to be a predictor of competency, suggesting a need for repeated education and assessment. Authors enhance validity by detailing the search strategy and including only high quality RCTs. Studies included both pediatric and adult patients with asthma or COPD making it applicable to various populations. Authors caution that the included studies were conducted using well-trained HCPs which is often not the norm in clinical practice, highlighting the need for provider education.

Gillette, Rockich-Winston, Kuhn, Flesher, and Shepherd (2016) conducted a systematic review in the United States including both experimental and observational studies to examine interventions for improving inhaler technique in children. Studies were restricted to English language and children age 6-18 years of age. The authors reported that in the studies reviewed, education was beneficial regardless of HCP discipline providing patient instruction. Several key components of success were identified: repeated instruction, repeated assessment even in patients previously deemed competent, and having children demonstrate their technique for assessment and repeat until it is correct. While a systematic review of RCTs is stronger, the authors included a detailed search strategy and two independent investigators rated study quality. The authors suggest a weakness exists in that statistical analyses were not conducted to determine effect size.

Jolly, Mohan, Guleria, Poulose, and George (2015) performed a study in India using a randomized parallel-group design which also advocates that repeated patient demonstration of MDI and spacer technique is necessary, and that using a standard device specific checklist based on the NAEPP guidelines (2007) improves technique in patients. Adult patients were randomly chosen from a pulmonary clinic and randomized into a written instruction or physical demonstration group. Patients were evaluated using a checklist at baseline and after instruction, with repeated instruction until all steps were correct. Patients were reassessed after two months. Only one patient out of 117 had correct technique at baseline, and 97% had all steps correct after three instructional sessions with significantly greater improvement in the physical demonstration group. There was a significant difference in improvement post intervention in the physical demonstration group ($p<0.001$). There was a decline in competency after two months, which improved after additional instruction. A study strength is random group assignment; however, convenience sampling poses a threat to validity. An additional consideration is that patients were all adults and most did not use a spacer device, which affects generalizability.

Giraud, Allaert, and Roche (2011) also discussed the need for repeated technique demonstration by patients for several different inhalation devices; and assessment by a HCP using a checklist. Their observational study in France of adult patients examined inhaler technique before and after a brief training session. Results revealed that a median of two instructional sessions, with a range of 1-10, was required for patients to achieve competency; with the repetition of demonstration until competency was achieved based on a checklist. Frequency of optimal technique increased significantly, from 24-79% ($p<0.001$); and asthma control and medication compliance improved significantly as well at one-month post intervention. Strengths include a relatively large sample size of 727 patients, as well as detailed

statistical analyses of results. Lack of randomization and control is a potential threat to validity; however, thought was given to performing the intervention with pharmacists rather than physicians to reduce potential bias of physicians assessing their own patients. Additionally, the study population included only adults so care must be taken when generalizing to pediatric patients.

In summary, this review of the literature provided evidence that patient inhaler technique remains a critical area in need of attention and can be remedied by improved MDI and spacer training. Patient education can be optimized after a short hands-on HCP training to improve HCP competency, and the use of a checklist to document patient return demonstration technique (Basheti et al., 2014b; Giraud et al., 2011; Jolly et al., 2015; Leung et al., 2015). Key components of successful interventions include: training patients using physical demonstration, assessing patient demonstration using a checklist of essential steps, and repeating until competency is achieved (Gilette et al., 2016; Giraud et al., 2011; Jolly et al., 2015; NAEPP, 2007).

Project Implementation

Preparation Phase

This project was approved by the nurse manager of the PED and took place over a 14-week period during the Fall of 2018. In preparation, checklists for MDI with spacer and MDI with spacer and mask were developed based upon instructions provided by the NAEPP guidelines (2007) as well as existing checklists developed and validated by Pradel et al. (2003) (see Appendix A and B). Checklists were provided to the hospital's Information Technology (IT) department for incorporation into the EMR in advance of project implementation. Dot phrases were created in the EMR to allow RNs to access each checklist by typing the proper dot

phrase; either ".mdispacerchecklist" or ".mdispacermaskchecklist" to allow for documentation in the patient's EMR. Two one-hour training sessions, designated as mandatory by the nurse manager, were held during weeks one and two. During the training sessions, every RN employed in the PED was trained on the proper technique of medication administration using a placebo inhaler with an MDI with spacer and MDI with spacer and mask. Sessions were conducted by the project leader with a project champion present to assist. Instruction was in the form of face-to-face instruction using a combination of verbal and physical demonstration methods to review the critical steps in MDI and spacer technique as listed on the device specific checklists. Training details are included in Appendix C. Upon completion of instruction, each RN was asked to return demonstrate technique with each device using a placebo inhaler. Technique was assessed and documented by either the project leader or project champion using the proper checklist. Competency was defined as the ability to demonstrate 100% of the steps correctly, and any RN achieving less than 100% was provided additional instruction until competency was demonstrated. During the educational sessions RNs were familiarized with checklist components, as well as how to access and document on checklists in the EMR. It was communicated by the project leader and champion that completion of the checklist would be the new standard of care for all asthmatics treated in the PED.

This project was a quality improvement project; its focus was to address a gap in care delivery. The practice change fell within the standard of care, and there was no associated risk. No patient identifiers were to be collected. Therefore, a non-human subjects research determination was submitted to the University of Maryland Baltimore IRB via the Collaborative Institutional Comprehensive Evaluation of Research Online (CICERO). No additional approvals were necessary other than the permission of the nurse manager.

Implementation Phase

The project go-live date occurred during week 3, at which point the expectation was communicated by the nurse manager and project champions that each patient with asthma treated in the PED was to be asked by an RN to demonstrate their MDI and spacer technique prior to being discharged. This was done using either a placebo device or the patient's MDI in instances were a dose of medication was due. In some cases, the caregiver would assist in demonstration; this would be left to the discretion of the RN based on their assessment of the child's age and ability. For each patient and/or caregiver, the RN was expected to document assessment of their technique via demonstration in the patient's EMR using the device specific checklist. Performance of each critical step was documented as either correct ("1"), or incorrect ("0"). Instruction was provided to remedy any error until the patient was able to demonstrate competency in 100% of the steps as outlined on the checklist. Documentation of patient competency was the goal for each patient prior to discharge, and was reflected as an answer of "yes" by the RN to the checklist question "did the patient or caregiver demonstrate correct technique in all steps prior to discharge?" Patients and/or caregivers requiring additional instruction to remedy any errors were identified by an answer or "yes" by the RN to the checklist question "did the patient or caregiver require additional education?"

Chart audits were performed by the project leader on a weekly basis from week 4 to week 14 to assess RN compliance with the use of the checklist and documentation of patient/caregiver competency with MDI/spacer technique. Printed RN notices were generated weekly and delivered by a project champion for any RN not in compliance with checklist documentation. There were three occasions where individual RNs were addressed personally by a project champion for concerns with repeated non-compliance with the practice change. In two instances

it required further education on accessing the checklists in the EMR, and in a third it required a reminder on the importance of the change and the unit expectations; all three RNs began to document the checklist after being addressed.

Data Collection

Weekly chart reviews were performed using an audit tool (Appendix D). A report was created with the assistance of Information Technology staff to be run weekly that identified patients that were treated in the PED between the ages of four and 18 years who required treatment with an MDI. Charts were excluded from the audit if the patient required a hospitalization, as the majority of their education would not have occurred in the PED. Charts that met the inclusion criteria were assessed for the presence of the completed checklist, as well as whether a spacer or spacer with mask was used and whether it was the patient or caregiver completing the demonstration. Checklists were reviewed to determine patient competency prior to discharge from the PED, whether or not additional instruction was required to achieve competency, as well as which specific steps required attention.

Results of chart audits were communicated to the project champions each week throughout the ten weeks of data collection; specifically, percentage of charts included in the audit that were in compliance with the practice change, and names of RNs not in compliance each week. Information on number of charts audited and percentages of patients/caregivers reaching competency in MDI/spacer technique, as well as percentages needing additional education were also provided.

Results

Over a ten-week data collection period, 138 charts met the criteria for audits. Ninety-five charts (69%) had checklists documented in the EMR. Characteristics including patient age,

device used, and frequency of caregiver assistance in demonstrations is shown in Table 2. RN compliance with checklist documentation increased greatly after the first three weeks of implementation, with compliance for the last seven weeks ranging from approximately 80-90% each week (Figure 1). One-hundred percent of patients and/or caregivers that had documented checklists in their medical record were able to demonstrate competency in every critical step in medication administration prior to discharge from the PED. Thirty-three patients/caregivers (35%) required additional education to correct critical errors in technique. Most patients and/or caregivers with errors on initial demonstration committed one error, however some committed multiple errors (Figure 2). For seven patients it was unclear which specific errors were witnessed as the RN documented evaluation of only the final demonstration, which was completed after additional education was provided in order to reach competency. Error frequencies for each critical step are displayed in Figure 3; the most commonly noted error was inhaling too quickly, as indicated by a whistle sound from the spacer.

Discussion

This QI project provides evidence in support of the interventions chosen to meet both the short and long-term project goals. The short-term goal that 100% of RNs would be able to demonstrate competency in all critical steps of medication administration technique with an MDI and spacer, both with and without a mask, was achieved after a brief, hands-on technique training. This is similar to findings reported by Basheti et al. (2014b) and Leung et al. (2015). While work by Basheti et al. (2014b) included RNs, it had a broad target population comprised also of physicians, pharmacists, pharmacy assistants, and respiratory therapists; work by Leung et al. (2015) focused only on physicians. RNs were chosen as the target population for this project due to their key role in patient education, despite often lacking training and proficiency in

inhalation device training (DeTratto et al., 2014). The attainment of this short-term goal helped to address an identified gap by promoting the standardization of patient education on the critical steps of MDI and spacer technique.

The second short-term goal was to incorporate the checklists into the EMR; this was also achieved. Checklists of critical steps and procedures have proven to be valuable memory and decision support aides for HCPs; in this project the use of the checklists in combination with their ease of accessibility in the EMR further contributed to standardization of care (Clay-Williams & Colligan, 2015). Current literature supports that checklists in healthcare be short, grounded in evidence, and formally introduced to clinicians to ensure knowledge on correct use; all elements that were present in this project which contributed to project strength and likely enhanced success (Weiser & Berry, 2013).

In addition to standardization of critical steps of MDI and spacer use taught in the PED, the gap in practice surrounding teaching practices was addressed as well. The new expectation on the unit that every asthmatic will be asked by an RN to demonstrate their technique using a MDI and spacer prior to discharge, followed by assessment and provision of additional education until each patient is able to demonstrate 100% competency further contributes to standardization of care. While efforts to reach 100% compliance with checklist documentation are ongoing, when only the patients with documented checklists are considered, the long-term goal of 100% of patients and/or caregivers demonstrating competency in all critical steps for the use of the MDI and spacer was achieved. These findings support the key interventions highlighted in the literature including: education utilizing physical demonstration methods, the importance of patient/caregiver demonstration of technique followed by HCP assessment with repetition until competency is demonstrated, and use of a device specific checklist of critical steps (Gilette et al.,

2016; Giraud et al., 2011; Jolly et al., 2015; Klijn et al., 2017). The finding in this project that 35% of patients and/or caregivers with documented checklists required additional education to correct errors emphasizes the importance as well, given that these patients were all receiving MDI treatments during their PED course of treatment; thus it was not an introduction of a novel skill. Findings on the most commonly observed errors provide information on important areas of emphasis when providing patient education, particularly breathing in slowly so that the spacer does not produce a whistle sound.

Overall, the results of this project were expected; no unintended consequences or benefits occurred as a result. The only goal that was not met by the completion of the project was 100% RN compliance with the checklist. Lewin's Change Management Model (Lewin, 1951) emphasizes the importance of maximizing driving forces when trying to facilitate change. The only obstacle revealed explicitly during implementation was a learning curve for some RNs with accessing the checklists in the EMR. This only applied to two RNs, so it is likely that an additional restraining force was a disruption to existing workflow practices. The increase in compliance over the course of the project provides promising evidence in support of the use of driving forces: strong stakeholder support, involvement of motivated project champions to provide ongoing encouragement for the use of the checklist, and frequent communication between project champions and the project leader throughout the process.

A potential limitation is generalizability to other settings and target populations. This setting was chosen due to the availability of spacers for use with demonstrations and training; a project strength was that there was no cost for the interventions required of this project. Modifications would be necessary for implementation in settings that do not stock spacers; for example, requesting that patients bring their spacers with them to appointments. Dissemination

and spread to other disciplines of HCPs as well as other patient populations must be considered as well, however there does exist evidence in the literature that this intervention can benefit various populations (Basheti et al., 2014b; Leung et al., 2015). Evidence exists as well for similar interventions to assess patient technique with other inhalation devices (Basheti et al., 2014b; Basheti, Bosnic-Anticevich, Armour, & Reddel, 2014a; Pradel et al., 2003).

Conclusion

The setting for this project was a PED located in an inner city where asthma disparities, morbidity, and mortality for children are among the highest in the nation. This particularly vulnerable group of asthmatics are often more likely to use the emergency setting for asthma care due to caregiver preferences and challenges with access to care (Mudd et al., 2016). Due to often suboptimal rates of preventive asthma care in this group, these children and caregivers have a great need for education on all aspects of asthma management, including MDI and spacer technique. The primary benefit of this project was that every patient during the course of the project that had a checklist completed in their EMR was discharged from the PED with documentation of the ability to demonstrate 100% competency in all critical steps of MDI and spacer technique. Those that needed additional education were able to receive it, thus maximizing the opportunity during an ED encounter to provide essential education on a critical component of asthma management.

Identifying key stakeholders and solidifying buy-in for the project early in the planning process was a critical step in supporting project sustainability. The nurse manager and project champions are committed to further promote sustainability by continuing to remind RNs of the requirement that the checklist be documented in the EMR for all asthmatics. Project champions will be responsible for training newly hired RNs on proper use of MDI and spacer as well as use

of the checklists during their orientation, and each year refresher training on MDI and spacer technique will be included as part of annual training requirements. As a result of this project, the medical facility has identified MDI and spacer training as a priority focus area for all units that prescribe MDIs; it will be spread to other units within the institution. The literature supports a need across many different practice settings and patient populations (Gilette et al., 2016; Giraud et al., 2011; Jolly et al., 2015; Klijn et al., 2017; Leung et al., 2015). Sustainability will also be enhanced by presentation at regional and national conferences. Future QI projects on inhaler technique assessment and education should broaden to include other inhaled devices such as those often encountered with controller medications.

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Table 1

Evidence Table

Author, Year	Objective and Intervention	Design	Sample	Outcomes	Results	Level and Quality Rating
Basheti, Qunaibi, Hamadi, & Reddel, 2014	To assess HCP (various disciplines, including RNs) ability to use common inhalers correctly and evaluate an educational intervention for efficacy both short and long term.	True experimental design with randomization and control: Randomly selected HCPs were invited to attend an educational workshop. Prior to attendance, participants completed questionnaires on inhaler knowledge and confidence, and asked to demonstrate the use of 3 inhaler devices (MDI, Diskus, Turbuhaler). After receiving education, they were asked to demonstrate again immediately after and then 4 months later. At 4 months, technique was compared with HCPs who did not receive educational intervention.	48 HCPs attended the workshop (of 129 who demonstrated initial inhaler technique)	Inhaler device technique as measured by a standardized checklist of critical steps.	There was a significant improvement in technique for all devices immediately after training in the form of a single workshop. Those who attended the workshop scored significantly higher at 4 months post than a comparison group which did not.	2 B
Gilette, Rockich-Winston, Kuhn, Flesher, &Shepherd, 2016	To summarize the evidence on prevalence of correct inhaler technique (including MDI/spacer), what interventions improve technique (various disciplines providing	Systematic review	28 studies of various size, children 6-18 years of age. Reviewed articles were experimental and observational, and included if 1 outcome measure was results of inhaler technique. Study quality was assessed	Technique - Performance of all critical steps correctly, percentage of steps correct. Asthma outcomes – asthma control (not specified how this was operationalized), hospitalizations, medication adherence	Technique was improved regardless of HCP discipline performing the education, repeated education is necessary, and having children demonstrate technique is associated with better technique. Good inhaler technique is associated with improved	1A

	teaching, face to face, video, telemedicine), and how improved technique impacts asthma outcomes.		using Downs and Black checklist.	(not specified how this was measured)	asthma control, decreased hospitalization rates, and improved medication adherence.	
Giraud, Allaert, & Roche, 2011	To evaluate the effectiveness of MDI training by pharmacists, to include demonstration and return demonstration by patient. Also to examine link between technique and asthma control and adherence.	Prospective observational study, 2-hour training session at participating pharmacies on inhaler technique. Patients were assessed pre- and post using MDI checklist of critical steps.	727 adult patients recruited from 123 pharmacies	Patient technique using device specific checklist. Recorded number of attempts and length of education time before demonstrating competency.	At baseline, 24% demonstrated optimal technique, this rose to 79% after training ($p<0.001$). Median duration of training was 6 minutes, median of 2 attempt were necessary.	3B
Jolly, Mohan, Guleria, Poulose, & George, 2015	To evaluate the effectiveness of a structured educational intervention on patient MDI/spacer technique	Randomized, parallel-group design. Patient MDI technique at baseline was evaluated using a checklist based on NAEPP guidelines. Patients were split into 2 groups- written instruction and demonstration and then evaluated post, with repeat instruction until competent. Repeat assessment after 2 months.	Sample included 117 adult patients recruited from an outpatient pulmonary clinic.	MDI/spacer technique as measured by a checklist of critical steps	At baseline, only 1/117 patients performed all steps correctly. After 3 sessions of intervention. 97% were competent. Slight decline in checklist scores after 2 months, remedied by additional education. Significant ($p<0.001$) difference in improvement post intervention in the demonstration group vs written instruction.	3B

Klijn, Hiligsmann, Evers, Roman-Rodriguez, van der Molen, & van Boven, 2017	To provide a systematic review of effectiveness of various educational interventions on inhaler technique. Included physical, video, and internet based demonstrations.	Systematic review	39 studies, all high quality RCTs, included pediatric and adults	Primary outcome was percentage or number of correct steps performed	Most were individual interventions, most were physical demonstrations. Over 90% of studies showed improvement in technique, regardless of method of education.	1A
Leung, Bhutani, Leigh, Pelletier, Good, & Sin, 2015	To assess the impact of a small group, hands on educational program on physician level of comfort with inhaler training.	Experimental, one group pre- test/post-test: Family physicians enrolled were provided hands-on education on inhaler devices, including MDI/spacer. Questionnaires were completed pre- and post regarding their teaching practices.	41 physicians in family practice	Observation of technique demonstration post intervention for presence and number of certain critical errors using device Pre/Post questionnaire results – percentage of physicians reporting providing inhaler training as part of their practice, and percentage that rated their teaching as “good” or “excellent”	A “hands on” small group educational program is effective in improving physician competency, attitudes about inhaler training, as well as implementation of teaching into practice.	3 C

Table 2

Description of Checklist Components (n=95)

Category	**No. (%)**
Age	
4-8 years	55 (58%)
9-13 years	28 (28%)
14-18 years	12 (14%)
Device	
MDI with spacer	65 (68%)
MDI with spacer and mask	30 (32%)
Person Completing Demonstration	
Patient	50 (53%)
Caregiver	45 (57%)

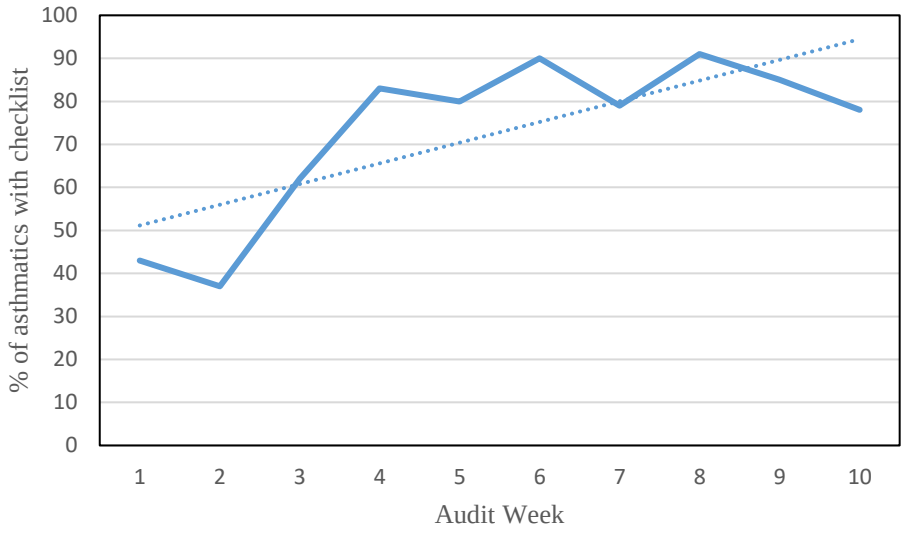

Figure 1. RN compliance with checklist documentation

Figure 2. Number of critical steps missed for patients with errors on initial demonstration

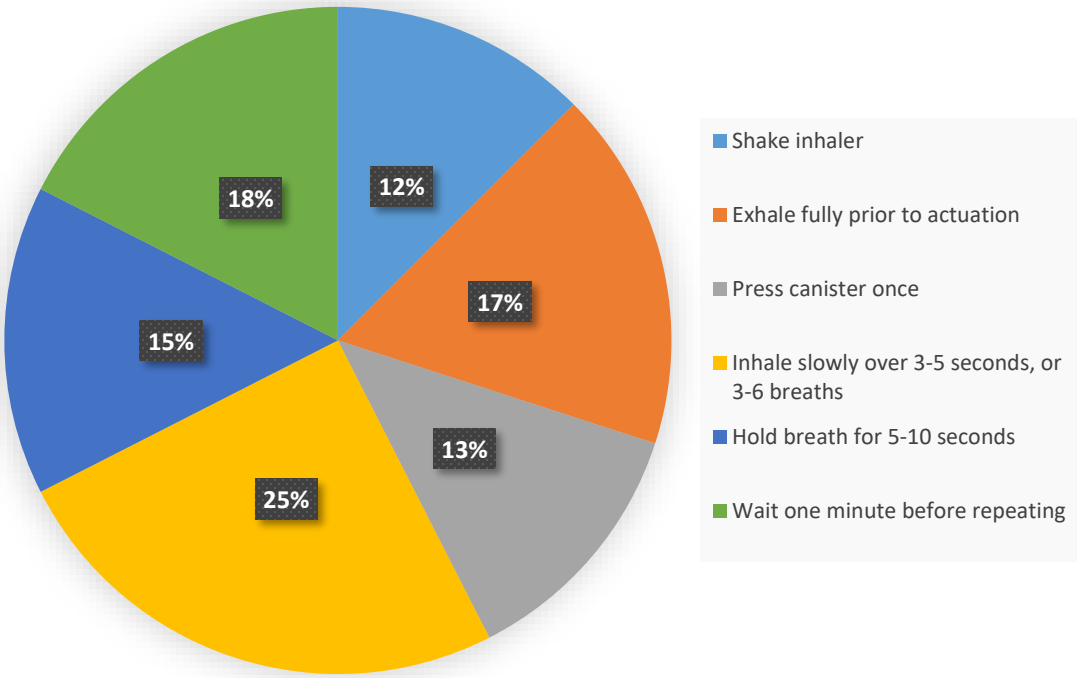

Figure 3. Critical errors observed in patient/caregiver demonstrations

Appendix A
Inhaler Checklist for MDI with Spacer
(NAEPP, 2007; Pradel et al., 2003)

Evaluation Form for the Metered Dose Inhaler (MDI) with Spacer

INHALATION TECHNIQUE		**Code**	
Educator:		Yes = 1 No = 0	
Please assess each of the following steps. Does the patient/caregiver:		Patient	Caregiver
1	Remove cap from inhaler and shake the inhaler **vigorously**.		
2	Place the inhaler in the spacer.		
3	Stand up or sit up straight.		
4	Take a deep breath in, and then blow out completely to empty the lungs.		
5	Place the mouthpiece of the spacer in mouth and close lips around mouthpiece to form a tight seal.		
6	Press down on the canister **ONCE** just as inhalation starts. • If the patient takes multiple inhalations **with** additional actuation, score as 0.		
7	Breathe in **slowly** until the patient has taken a full breath **for at least a 3 to 5 second** inhalation. • **If there is a whistle, the patient is breathing too fast, score as 0.**		
8	Hold breath for at least 5 seconds (optimally 10 seconds).		
9	Ask the patient **if provider/educator instructed him/her to repeat.** Yes ☐ No ☐ • **If yes, ask how long he would wait until taking the second puff** **(Wait 1 minute between puffs)**		
OR	If patient offers to repeat inhalation, **ask how long he/she would wait until taking the second puff.**		
Did the patient or caregiver require additional education? **Yes** ☐ **No** ☐			
Did the patient or caregiver demonstrate correct technique in all steps? **Yes** ☐ **No** ☐			

Appendix B
Inhaler Checklist for MDI with Spacer and Mask
(NAEPP, 2007; Pradel et al., 2003)

Evaluation Form for the Metered Dose Inhaler (MDI) with Spacer and Mask

INHALATION TECHNIQUE		**Code**	
Educator:		Yes = 1 No = 0	
Please assess each of the following steps. Does the patient/caregiver:		Patient	Caregiver
1	Remove cap from inhaler and shake the inhaler **vigorously**.		
2	Place the inhaler in the spacer.		
3	Place the soft mask to the face so that mouth and nose are covered **without leaks**.		
4	Press down on the canister **once** just as inhalation starts.		
5	Breathe in slowly until the patient takes a full breath. • **If there is a whistle, the patient is breathing too fast, score as 0.**		
6	Keep the mask firmly in place for **at least 3 to 6 breaths OR hold breath for at least 5 seconds, optimally 10 seconds** (in this case patient may remove mask).		
7	Ask the patient if provider/educator instructed him/her to repeat. Yes ☐ No ☐ • If yes, ask how long he would wait until taking the second puff **(Wait 1 minute between puffs)**		
OR	If patient offers to repeat inhalation, ask how long he/she would wait until taking the second puff.		
Did the patient or caregiver require additional education? **Yes** ☐ **No** ☐			
Did the patient or caregiver demonstrate correct technique in all steps? **Yes** ☐ **No** ☐			

Appendix C

Registered Nurse Training Plan

Learning Objectives	Content Outline	Method of Instruction	Time Spent	Method of Evaluation
Demonstrate 100% competency in steps of proper technique for medication administration using MDI with spacer	Each step was reviewed as outlined on MDI with spacer checklist (Appendix A)	Verbal instruction and physical demonstration, with return demonstration for evaluation.	20 minutes	Each RN was asked to return demonstrate use of MDI with spacer using a placebo inhaler. MDI with spacer checklist was used to assess competency. Additional education was provided when needed until 100% of RNs demonstrated 100% of steps on checklist correctly.
Demonstrate 100% competency in steps of proper technique for medication administration using MDI with spacer and mask	Each step will be reviewed as outlined on MDI with spacer and mask checklist (Appendix B)	Verbal instruction and physical demonstration, with return demonstration for evaluation.	20 minutes	Each RN was asked to return demonstrate use of MDI with spacer/mask using a placebo inhaler. MDI with spacer/mask checklist was used to assess competency. Additional education was provided when needed until 100% of RNs demonstrated 100% of steps on checklist correctly.
Understand the components and how to use device specific checklists for assessment and documentation of patient technique	-Each step of the checklist was reviewed as above, as well as how to score patient technique using "1" for correct completion individual steps and	Verbal instruction and demonstration	10 minutes	100% of nurses will verbalized understanding of how to score patients, and where and how to document in the patient's EMR.

	"O" for incorrect completion. -RNs were instructed to document that any steps scored as "0" will be addressed with additional education provided until patient is able to demonstrate all steps correctly. -RNs were taught where to document the checklist and how to access it as a Smart Phrase.			
Understand components and expectations of practice change	RNs will understand that every asthmatic patient age 4-18 treated in the PED for asthma will be asked to demonstrate technique with MDI and either spacer or spacer with mask prior to discharge, and their technique will be assessed and documented by an RN using the proper device checklist.	Verbal instruction	5 minutes	100% of RNs verbalized understanding of required practice change in the PED

Appendix D

Chart Audit Tool

Date of Audit: _____

Date	Age	Completed Checklist Yes = 1 No = 0	Device Used Spacer = 1 Spacer/Mask = 2	Person completing demonstration Patient=1 Caregiver=2	If checklist present, did RN document that patient demonstrated competency Yes = 1 No = 0	Was a need for additional instruction documented after initial patient demonstration? Yes = 1 No = 0	Critical Steps Performed Incorrectly