2012

Improving Metered Dose Inhaler (MDI) Technique Outcomes for Pediatric Patients in Primary Care Through Comprehensive Delivery Method Education

Ryan e. Morin
Student

DNP Capstone Project Proposal

Improving Metered Dose Inhaler (MDI) Technique Outcomes for Pediatric Patients in Primary Care Through Comprehensive Delivery Method Education

Ryan Morin, DNP, FNP-BC

Chair: Karen M. Plotkin, RN, HHCNS-BC, PhD

Committee Member Jean E. DeMartinis, PhD, FNP-BC

Abstract

Metered Dose Inhalers (MDIs) are a commonly prescribed delivery method for prescription medications in primary care that have been demonstrated to have poor rates of proper technique by patients resulting in less effective inhalation outcomes. Education that is comprehensive, consistent, and includes written and oral instruction and demonstration by the provider with return demonstration by the patient in addition has been found to have the highest rates of improvement in technique mastery and inhalation outcomes. Through the initiation of consistent, comprehensive education, this project demonstrated an increase in proper MDI technique checklist scores pre and post education in children at a primary practice pediatric outpatient facility that self-identified as lacking in consistent MDI technique assessment and education. The expected outcome of this project was to increase the amount of metered dose inhaler technique checklist steps performed properly 50% in the post-education demonstration compared to the patient's pre-education demonstration, while encouraging healthcare provider's involvement and ensuring patient comfort. Efficacy of education in increasing proper technique was measured through the comparison of pre and post-education demonstration of technique with the healthcare provider recording the proper steps that are completed at each demonstration.

Problem Identification

Introduction and Background

Asthma, a condition often managed through at least partly through the use of metered dose inhalers effects over 16 million Americans (Sullivan, Vahram, Slejko, Belozeroff, Globe & Lin 2010) and is the most common chronic illness for children in the United States according to the Asthma and Allergy Foundation of America (2011). According to Sullivan et al. (2010) Asthma is associated with higher healthcare costs for individuals, lower quality of life, and more frequent visits to emergency departments (ED). Patients with Asthma and Chronic Obstructive Pulmonary Disorder (COPD) (another disorder often treated at least in part by MDIs) that present to emergency departments are found to demonstrate high levels improper MDI technique (Hesselink, Pennix, Wijnhoven, Kriegsman & Eijk 2001) indicating a link between poor technique and ED visits. There are also wider societal costs as Sullivan et al. (2010) found that medical expenditures related to asthma are more likely than other conditions to be paid by Medicaid, as well as those with asthma having higher levels of absenteeism in the work place.

Medication compliance is a significant clinical issue throughout practice and in the case of the metered dose inhalers the relative complexity of this delivery vessel may further complications. As a result of the complexity and lack of knowledge on proper technique patients risk not having medication efficacious as it is intended which can increase symptoms of the disease it is attempting to treat (Melania,Bonaviab, Cilentic, Cintid, Lodie, Martuccif, Serrag, Scichiloneh, Sestinii, Alianij, & Nerik, 2011). Proper metered dose inhaler use is associated

with better symptom control and fewer hospitalizations, benefiting the not only the patient but healthcare system as well (Roy, Battle, Lurslurchachai, Halm & Wisnivesky, 2010).

Problem Statement

Proper technique of MDIs has proven to be associated with higher level of control of asthma and other pulmonary conditions. (Roy, Battle, Lurslurchachai, Halm, & Wisnivesky, 2010). Education initiatives have been shown to improve rates of proper technique, (Melania, et a. 2011) with a combination of both verbal and written instructions providing the best outcomes (Papi, et al. 2011). The National Heart Lung and Blood Institute (2007) Expert Panel Report 3 Guidelines for the Diagnosis and Management of Asthma state that the continual assessment of metered dose inhaler technique at should take place at any feasible healthcare encounter. The National Heart Lung and Blood Institute (2007) clinical guideline include that metered dose inhaler technique education be not only verbal and written instructions but demonstration by a trained healthcare provider, followed by demonstration by the patient in order to accurately gauge the patient's proficiency in the technique. Finally patients have been shown to have an incorrect perception on of their ability to use MDIs, often over-estimating their performances (Shu, O'Mahoney, Steward, Breay, & Burr, 2004) aligning with the idea that education should be proactive as patients may not be able to gauge when they need further instruction. This project examined the effects of standardized, consistent MDI usage education of pediatric asthma patients in a primary care practice by measuring pre-education and post-education technique through pre-established metered dose inhaler technique checklist scores.

Evidence of Problem

Specific Deficits in Improper Technique

In exploring further research issues with inhaler compliance were well documented in literature; with issues involving improper technique being well defined as described by Virchow, Crompton, Dal Negro, Pedersen, Magnan, Seidenberg, and Barnes, (2008) in their systematic review of 64 studies on the role of the inhaler device in the management of asthma. Specific deficits in patients technique that were defined by Virchow et al. (2008) include coordination of patient inspiration and inhaler activation, failing to continuously inspire slowly after activation, and fully exhaling before inspiration of the aerosol. Thai and George (2010) found in their systematic review on Asthma management and Health Literacy that failing to shake the metered dose inhaler is also noted to be a consistent misstep by patients in both inpatient and outpatient settings, however their review only included 10 relevant studies.

Furthering issues with technique, Roy, Battle, Lurslurchachai, Halm and Wisnivesky, (2010) found that approximately 50% of patients using metered dose inhalers omit fully exhaling before inspiration in their cohort trial, however they deduced that information from a relevant population size of just 107 people. In total, studies have describe the percent of adult patient's correct technique without instruction to be low as just 13% by Virchow et al. (2008) ,14% by both Hardwell, Hargadon, Barber, McKnight,

Holmes, and Levy (2008) and Basheti, Reddel, Armour, and Bosnic-Anticevich, (2007) and 17% by Ovchinikoka, Smith and Bosnic-Anticevich (2011).

Technique in the Pediatric Population

In the context of a pediatric population, percentage of proper metered dose inhaler use is smaller compared to adult usage, with one randomized control study finding that only 8.1% of children complete all of the recommended steps of metered dose inhaler technique (Sleath, et al. 2011). As children are at varying stages of both physical and cognitive development, care givers may assist in administration and education of the patient. Francisco and Rood, (2011) systematic review of 176 studies on pediatric asthma management concluded that this addition of caregivers in education has been demonstrated to positively affect metered dose inhaler technique in the pediatric population. Caregiver characteristics consistent with correct child MDI use include caregivers who had more years of education, as were shown by Sleath, et al. (2010) to be significantly more likely to get more of the steps correct (Pearson's r =0.14, P = .03).

Despite the positive correlation between caregiver involvement and technique demonstrated by Francisco & Rood, Welch, Martin, Williams, Gallet, Miller, Bennett, May, Lampl and Ramachandran (2010) found in their cohort study that the engagement of caregivers has limits in the improvement in MDI technique in children aged 1-6 are still shown to have knowledge deficits in metered dose inhaler technique. One week after education 15.5% of all caregivers demonstrated significant errors when using MDI (P□<□0.001) allowing the authors to conclude that "caregivers of young children with asthma demonstrate a number of errors in device use, including major ones that can

potentially result in poor lung delivery". Similar results about caregiver's knowledge deficits and errors in technique were reported by Sleath, B. et al (2011) in their aforementioned randomized control trial.

Patient Variables Effecting Technique

While the complexity of technique causes for the above noted errors, patients in contradiction to their poor demonstrated technique consistently estimate their MDI technique to be higher than observed (Virchow et al. 2008), (Basheti, Armour, Bosnic-Anticevich & Reddel, 2008), (Shu, Mahoney, Steward, Breay & Burr, 2006). Definitive variables have been identified to be correlated to poor metered dose inhaler technique. These include poor literacy rates, and poor health literacy rates as evidenced by Thai and George (2010) in their aforementioned systematic review. The authors also found that those who have been hospitalized with asthma who have higher reading levels had dramatically fewer mistakes on technique checklists which suggests that non-written educational modalities may be necessary to increase proper metered dose inhaler technique in the community. While this was in the context of patients instead of caregivers, the results do parallel Sleath, et al. (2010) findings that higher caregiver educational level is related to higher levels of correct MDI technique. Other patient characteristics linked to MDI technique include Ovchinikoka, Smith & Bosnic-Anticevich (2011) found that patient motivation is related to metered dose inhaler technique, with individuals that have self-described high motivation for correct metered dose inhaler use maintaining better technique over time, with an odds ratio of 1.2 for what they considered highly motivated patients in their observational study. Allen, Warwick-Sanders & Baxter (2009) studied various clinical tests to predict the ability for

the elderly adults to learn metered dose inhaler technique; however they did not investigate specific educational modalities to actually improve the metered dose inhaler technique but found that scores of lower then 24 on the Mini-Mental Status exam is predictive of being unable to accurately learn MDI technique. Children younger than 12 (odds ratio = 0.87, 95% confidence interval = 0.78, 0.97) was also identified by Sleath, et al. (2011) as a poor predictor of technique. This is consistent with previous work by Sleath, et al. (2010) which found that older children were significantly more likely to get more of the steps correct (Pearson's r =0.20, P= .001). Barriers identified to education of technique include the aforementioned poor perception of ability by patients (Shu, Mahoney, Steward, Breay & Burr, 2004) (Virchow et al., 2008), (Basheti, Armour, Bosnic-Anticevich & Reddel, 2008) suggesting that patients will not proactively seek out education as they assume they are using their metered dose inhaler correctly. Tangentially this suggests that providers simply asking about whether patients feel comfortable using their metered dose inhaler correctly may be an inaccurate way to assess their proficiency.

Healthcare Provider Variables Effecting Technique

A significant portion of care providers are unable themselves to articulate or demonstrate proper technique (Virchow et al., 2008) indicating that further training and educational pathways which highlight proper technique have benefit in educating the patient and well as the healthcare provider. Sleath, Ayala, Gillette, Williams Davis, Tudor, Yeatts, & Washington (2011) additionally found that despite being included in The National Heart, Lungs, and Blood Institute (2007) guidelines for the treatment of asthma assessment only 5.4% of encounters with patients prescribed metered dose

inhalers involved the patient demonstrating technique in their observational study, in which they asked pediatric patients and their caregivers after healthcare interactions whether National Heart, Lung and Blood Institute (2007) Clinical Guideline steps were followed. This aligns with the notion that health care providers may not be following, or may not know the most recent clinical guidelines in concluded in Virchow et al. (2008) systematic review.

Review of Literature

Research to Improve Technique

Research that has occurred to improve the technique of metered dose inhalers has been varied and sparsely documented throughout literature. (Papi, Haughney, Virchow, Roche, Palkonen, & Price, 2011) In the case of education provided by healthcare providers to patients to ensure proper metered dose inhaler technique in adults there does not appear to be any specific clinical guidelines on the subject however there are recommendations within systemic reviews on the treatment of asthma. The National Heart Lung and Blood Institute (2007) Expert Panel Report 3 Guidelines for the Diagnosis and Management of Asthma is based on systemic review of research related to the diagnosis and management of asthma. This review examined 442 studies in the arena of patient and provider education with 24 relating to the self-management of asthma by adults, 27 for the self-management of asthma by children, and 6 methods of involving improving clinician behaviors (National Heart, Lung, and Blood Institute, 2007). From these sources the authors further adapted their previous clinical guideline, in order to reflect the most recent and relevant research. In doing this the authors crafted a clinical guideline that states the

continual assessment of metered dose inhaler technique at any healthcare encounter is recommended. It also recommends that metered dose inhaler technique education include written and oral instruction as well as demonstration by a trained healthcare provider and demonstration by the patient in order to accurately gauge the patient's proficiency in the technique.

The heart of the National Heart, Lung and Blood Institute (2007) Guideline: patient education by trained clinicians, has uniformly been shown to be strongly associated with higher compliance with proper techniques (Melania, et al. 2011). Patients who receive metered dose inhaler technique instruction are consistently shown to have demonstrate higher levels of correct technique (Bosnic-Anticevich, Sinha, So & Reddel 2010), (Al-Showair, Pearson, & Chrystyn 2007), (Basheti, Reddel, Armour, & Bosnic-Anticevich, 2007), (Melenia, et al. 2011) with one study (Virchow et al., 2008) indicating patients as are high as 50% more likely to demonstrate proper technique compared to those who do not. Despite this while providing the patient with resources such as handouts and pamphlets has positive effect on use, written and verbal instruction alone does not result in high levels of demonstrated proper technique (Virchow et al., 2008) indicating a need for multi-faceted and comprehensive education.

Illustrating this point, Bosnic-Anticevich, Sinha, So and Reddel (2010) found that demonstration of technique by patients combined with written and oral instructions lead to higher levels of proper technique compared to written and oral instructions alone, indicating that providers may need to watch patient's technique in order to accurately assess their proficiency. Specifically they found that initially (6%) 1/52 of subjects had correct pMDI technique (where their checklist score 8/8), with mean baseline score 5 (SD 1) for both groups. However, when

given written and verbal information they improved pMDI technique at 16 weeks time. (7 ± 1, $p < .05$).

Perhaps most interesting though was when the researchers included an addition of physical demonstration resulted in significant improvement at weeks 4, 8, and 16 (7 ± 1, 7 ± 1, 7 ± 1 respectively; $p < .05$ for each). Subjects receiving written and verbal information alone were less likely to return for follow-up than those receiving physical demonstration (8 weeks: 6/25 versus 19/27; $p < .001$) as well suggesting that the benefits of demonstration may be beyond the scope of simply being more knowledgeable. At the time of the 8-week visit, 80% subjects in the physical demonstration group had correct technique prior to education, compared with 10% of subjects receiving written and verbal information alone ($p < .05$). In the context of the National Heart, Lung and Blood Institute (2007) Clinical Guideline this is an important distinction; that written and verbal information improved check-list scores, but the addition of demonstration most dramatically improved technique.

Al-Showair, Pearson, and Chrystyn (2007) found that mechanical instruction aids used in the presence of healthcare providers can help improve technique by allowing the patient to practice proper technique in front of healthcare providers. Basheti, Armour, Bosnic-Anticevich & Reddel (2007) found in their randomized control trial that including reminder stickers on metered dose inhaler technique physically on metered dose inhalers increased technique compared to those without an additional label affixed, suggesting as aforementioned that skill acquisition of metered dose inhaler technique may require on-going education or reminders for the patient.

Furthering the idea of proactive, on-going education Basheti, Reddel, Armour, & Bosnic-Anticevich, (2007), Hardwell, Hargadon, Barber, McKnight, Holmes, Levy (2008), and Takemura, Kobayashi, and Kimura, (2010) all found in their research that education that is repeated over multiple visits had higher level of adherence to proper metered dose inhaler technique. Takemura, Kobayashi, and Kimura specifically found in their cross sectional-study that patients reported higher levels of adherence to inhalation therapy was significantly related to the receiving of instruction on inhalation technique more than once, with an odds ratio of 2.90 (95% confidence interval 1.07–7.88; p = .037) This is consistent with the work done by Hardwell, et al. (2008) in their case control study found that there was a statistically significant increase in the numbers of patients able to use their pMDIs correctly following instruction after a second (129 to 260 of 1197 patients, $p<0.01$) and third (61 to 181 of 528 patients, $p<0.01$) educational visits and subsequent tests.

Aligning with this, Basheti, Reddel, Armour, and Bosnic-Anticevich, (2007) in another small randomized control trial found there was a significant difference in the proportion of MDI users who were able to demonstrate correct technique after 6 months compared with the control group with 10/20 in the MDI group [50%] vs 2/14 in the control group [14%]. They also found better scores in the intervention group of Asthma Quality of Life, a metric for measuring how asthma symptomology affects daily life at 3 months and 6 months adjusted for baseline was significantly higher (indicating less variability) for active compared with control patients (at 3 months: 83.8% ± 8.3% [mean ± SD] vs 77.6% ± 9.2%, $P < .001$; and at 6 months: 78.9% ± 9.7% vs 74.4% ± 8.9%, P = .002. This suggests that skill acquisition of metered dose inhaler use is an on-going process and lends further evidence that the provider be proactively providing education and assessment to accurately gauge the patient's proficiency and correct any errors. Additionally,

the work done by Basheti, Reddel, Armour, and Bosnic-Anticevich, (2007) bolsters the link between MDI technique education and positive asthma control.

Synthesis of Evidence

The research reviewed indicates that metered dose inhaler incorrect technique is a legitimate clinical problem on various levels. Systematic reviews have indicated that many steps are not performed correctly (Virchow et al. 2008), (Thai & George, 2010), (Roy, Battle, Lurslurchachai, Halm & Wisnivesky, 2010), and other studies suggest that over all levels of compliance are low in both the pediatric population (Sleath, et al. 2011) and in their caregivers, who may be tasked to assist them. (Welch et al. 2008)

These deficits have been identified to be caused by patient's misperception of their own skills, (Shu, Mahoney, Steward, Breay & Burr, 2004) (Virchow et al., 2008), (Basheti, Armour, Bosnic-Anticevich & Reddel, 2008) which can be compounded by providers not routinely assessing proper technique, and demonstrating proper technique. (Sleath, et al. 2011)

Education has been found to have a positive effect on technique. (Bosnic-Anticevich, Sinha, So & Reddel 2010), (Al-Showair, Pearson, & Chrystyn 2007), (Basheti, Reddel, Armour, & Bosnic-Anticevich, 2007), (Melenia, et al. 2011) Specifically this education has been shown to be most successful with written and oral instructions, as well as demonstration (Bosnic-Anticevich, Sinha, So, & Reddel, 2010), be repeated at any feasible health encounter (Takemura, Kobayashi, Kimura, 2010). All of these educational components are central tenets are prominently mentioned in the National Heart Lungs & Blood Institutes (2007) Expert Panel Report 3, Guidelines for the Diagnosis and Management of Asthma, supporting its recommendations for best practice.

Application of Theory

Through research it becomes apparent that patients and their care givers innately lack a capacity necessary to provide care for in the arena of MDI use. To this end, in applying Dorthy Orem's self-care deficit theory (1991) it becomes apparent that there is a need for a nursing action. In looking at Orem's theory it is apparent that individuals may be not be meeting their self-care needs in her description of health deviation self-care. According to Orem (1991) health deviation self-care includes "effectively carrying out medically prescribed measures". This is parallel to the problem of individuals being unable to properly use their MDI technique. Furthering her theory, Orem states that because of this lack of self-care nursing intervention is warranted. Orem mentions five ways in which nursing can help patients with self-care deficits and one of them is "teaching another". To this end providing effective MDI technique education appears to be in line with a nursing action to which Orem advocates responding with when patients are unable to meet their own self-care. Especially in an out-patient setting, the interaction with a healthcare provider is a small part of the continued management of healthcare needs, and allowing for the patient to meet their own self-care needs allow them to have more independence and less reliance on healthcare systems.

Project Description, Implementation, and Monitoring

Description of the Population

The population examined in this project consisted of patients who were metered dose inhaler users for maintenance of asthma or similar pulmonary conditions and presenting to the clinical site for any healthcare interaction. The sample was derived via a convenience sample of individuals that presented at Dr. Vicki Smith Pediatrics during the 11 weeks of data collection that were currently using a metered dose inhaler and have had a previous diagnosis of asthma. The age range of the patients was between 5 and 22 years old and the patients are varied in race, religion, and socioeconomic status. The average age was 12.45 years old with a standard deviation of 5.55 years. Data collection was completed on 118 patients over the eleven weeks of the initiative. The sample size was dependent upon the patients presenting that qualified, as well as the number of educational check-lists that were able to be completed by the healthcare providers.

Organizational Analysis

The clinical site consisted of a Medical Doctor, Nurse Practitioner, two Registered Nurses, two Medical Assistants, one part time bookkeeper, and two administrative workers. The office is wholly owned and operated by the Medical Doctor, Dr. Vicki Smith. The Medical Doctor and Nurse Practitioner provide primary healthcare to children and young adults from birth though age 22. The Registered Nurses participate in triaging patients, forwarding labs, and engaging in nursing visits including spirometry and vaccinations. The medical assistants assist with intake of patients, vital signs, vaccination, and supplemental administrative duties.

The project was necessitated by the aforementioned widespread lack of correct MDI technique as well as discussion with the owner and operator of the clinical site, Dr. Vicki Smith. Dr. Smith verbalized to the DNP Candidate that the site did not explicitly include MDI technique education in current electronic asthma education templates and that it is not often assessed because of time constraints. Upon examining the electronic templates, they did not include all steps of the most recent National Heart, Lung and Blood Institute (2007) Clinical Guideline, lacking areas such as repeat demonstration by patients. To this end the DNP Candidate recognized a need for improvement within the clinical site by not only altering electronic templates to include most recent clinical National Heart, Lung and Blood Institute guideline, but instituting a concerted effort to include MDI technique assessment and education at all reasonable visits.

Key Stake Holders

The key stakeholders in this Capstone project included Ryan Morin, RN, a Doctorate of Nursing Practice (DNP), Family Nurse Practitioner Tract (FNP), candidate, Dr. Vicki Smith the DNP Candidate's Preceptor, The clinical site Dr. Smith Pediatrics, and the patient population of Dr. Vicki Smith Pediatrics. From the University of Massachusetts School of Nursing, key faculty members of importance were Karen Plotkin RN, HHCNS-BC, PhD the Capstone Project Chair and Jean DeMartinis PhD, FNP-BC committee members. See Appendix 3.0 for Stake Holder Agreement

Barriers and Resources

Barriers to the implementation of the project included limited time available for care providers to introduce metered dose inhaler education, as well as time provided for individual

patient visits. In attempting to provide education at every feasible meeting there existed the barrier that some visits were scheduled for fifteen minutes, which afforded little time for thorough education and demonstration. Provider involvement of the initiative proved to be a barrier as attitudes towards their current education of metered dose inhaler technique, and time restrictions limited widespread involvement.

Resources that were used within facilities include pre-existing banks of literature within patient rooms that technique checklists can be placed in for ease of accessibility for healthcare providers. Prescheduled staff meetings and continuing education sessions were a functional resource within the site in order to provide a time to address training and education. In selecting a check list that is simple and straight forward, it allowed it to be more conveniently used by providers and with the aim to increase participation and to not interfere with normal practice. Although only a component of comprehensive asthma education, written materials consistent with the National Heart, Lung and Blood Institute (2007) clinical guideline already exist within the clinical site and were used unaltered as a written component of education.

Protocol and Plan

Design and Feasibility

This project was a pretest-posttest design measuring MDI technique scores. Patients MDI technique was measured at the beginning of the clinical interaction and then again after they are given comprehensive MDI technique education as part of their asthma education. Asthma education is a billable practice, allowing for it to be integrated into practice without prohibitive financial considerations. In considering the aforementioned barriers, resources, and population this project ultimately was feasible.

Expected Outcomes

Fundamentally the aim of the project was to improve MDI technique in patients. Specifically this was measured by pre and post education technique checklists completed by the healthcare provider which indicate specific steps of technique the patient performed correctly. The different steps in proper MDI technique have been documented to have varying levels of compliance (Roy, Battle, Lurslurchachai, Halm & Wisnivesky, 2010) and this project aimed to increase the number of steps performed properly by 50% in the post-education demonstration. This is a level that is consistent with previous studies showing improvement after one educational session. (Basheti, Reddel, Armour, & Bosnic-Anticevich, 2007) In order to necessitate this improvement another goal was to have the providers independent of the DNP Candidate complete at least ten check-lists each week. This not only promotes the education and in turn best practice, but helps to reach numbers of significance. The goal of having less than 5 check lists indicate a negative response from the patient or caregiver was also necessary to ensure the comfort

of the patient during education and to make sure that education is not otherwise negatively affecting their healthcare encounter. A negative response was defined as any verbalization of displeasure or interpretation of negative body language cues by the patients or caregivers when conducting the MDI education. Tangentially this study also provided the clinical site with both physical and electronic clinical check-lists hopefully ensuring further use of the National Heart, Lung and Blood Institute (2007) clinical guideline of including metered dose inhaler technique education as part of metered dose inhaler technique.

Expected Outcome	Rationale	Evaluation
Have a 50% increase between pre and post-education MDI technique scores	Demonstrated in studies to be feasible improvement after one educational session.	Established MDI technique checklist. (See Appendix 1.0)
Have healthcare providers complete at least 10 check lists independent of the DNP Candidate a week.	Needing to reach significant population size. Engaging other providers in project	Number of completed established MDI technique checklists.
Have less than 5 check-lists describe a negative experience by the patient in the field notes section.	Ensure comfort of patients.	Field notes section of established MDI technique checklist.

Figure 1. Goals, Expected Outcomes, Rationale, and Evaluation.

Budgeting

See Figure 2 for organization of the costs associated with this project. Budgeting for the project included considering the time cost of training care givers, added time to healthcare visits, and the physical costs of producing physical checklists for the healthcare provider and patients. The clinical site had dedicated bi-weekly meetings and

"working lunches" lunches which were used to educate care providers on the initiative eliminating the need for allocation of resources towards orientation to the project. Added time to visits varied as standardized education on metered dose inhaler usage likely both increased and decreased the current amount of time being spent by individual caregivers depending on the specific context. The clinical site did not add any additional time to scheduled encounters. As such the potential time costs were variable and were at kind by the facility; however it is important to note that Asthma education is a billable practice, which lessened potential time costs.

The cost of production of checklists consisted of the cost of production of printed materials used in the completion of the project. 500 check lists were produced and written educational materials were reproduced as necessary. The cost of the production of the check lists includes 500 sheets of paper, approximately 4$ and ink approximately 15$. The machines needed to create the check lists is already owned by the DNP Candidate and the 19$ in estimated cost were at kind by the DNP Candidate. The statistical software used to compile data is available at no cost to the DNP Candidate via the University of Massachusetts Amherst library. If goal or close to goal is reached in terms of technique improvement by even a relative few patients the cost to benefit of the project appears to be apt. If one or more patients are able to improve their MDI technique and by proxy management of their asthma, then the small cost of this project would be warranted.

Definitive Costs	
Item	Dollar Cost
500 sheets of white printer paper	4.00$
Black Ink for Printer	15.00$
Total Definitive Costs	**19.00$**

Variable Costs	
Item	Cost
Electricity	Negligible
Access to Printer, Computer	None - Already owned by DNP Candidate
Time Cost	Variable dependent upon additional time needed by providers. (No additional time was be scheduled for encounters)

Table 2. Organization of costs associated with DNP Capstone.

Ethical Considerations

Ethical considerations are small considering that the project was simply initiating an established clinical guideline. There appears to pose no discernible risk to patients and their caregivers by providing them MDI technique education as a component of their asthma medication. Field notes were taken to ensure that there was not significant negative perception or experience by patients during educational encounter. All federal guidelines per the Health Insurance Portability and Accountability Act were followed to insure and respect the privacy of patients.

Implementation and Evaluation

The aim of this project was to introduce standardized metered dose inhaler education using the recommendations from the National Heart Lungs & Blood Institute Expert Panel 3 on the Diagnosis and Management of Asthma. A teaching tool based on the exact recommendations from this clinical guideline was created by the DNP Candidate and was placed into an electronic template used for documentation at the

clinical site. The teaching tool includes all of the steps outlined in the clinical guideline and a screen grab can be seen in Appendix 3.0.

In initiating the project the need to train healthcare providers existed as healthcare providers have been found to have knowledge deficit relating to metered dose inhaler technique. (Virchow, et al. 2008) Training on the clinical guidelines was completed during the overarching orientation and training to the performance improvement project. Healthcare providers included one Doctorate of Nursing Practice, Family Nurse Practitioner Candidate, one Nurse Practitioner and one Medical Doctor. Training for healthcare providers was specifically be tailored towards two aims; Understanding the content of the teaching tool which by proxy is the clinical guideline, and understanding demonstration of the teaching tool to patients. This was done during a regularly scheduled working lunch which was reserved for continuing education and other opportunities. At the conclusion of the working lunch, the healthcare providers verbalized that they understood the aims and goals of project, as well as the established clinical guideline to which the education is based.

The aim of the project was that any patient with a documented history of asthma and MDI use would have been offered additional MDI education. Asthma status was be determined by examining the census before the arrival of the first scheduled visit. As part of educating patients and their parents or guardians on metered dose inhaler technique, healthcare providers asked for a demonstration of use, indicating proper steps of the technique on a pre-established technique check list in the “pre-education” column. The patient and their parent or guardian if present then were provided with metered dose inhaler technique consistent with the clinical guideline, including oral and existing

written instructions and included a provider demonstration. The provider then had the patient demonstrate technique as per clinical guideline correcting any errors. Finally the provider then asked for a second demonstration and recorded any progression or regression on the check lists. Further discussion occurred after the second demonstration to address individualized concerns. The healthcare provider included written observations of the interaction in the field notes section located below the checklist used by the DNP Candidate.

The check list used to gauge metered dose inhaler technique was one originally created by the Dutch Asthma Foundation (Palen, Klein, Kerkhoff, & van Herwaarden 1995) and since been used in studies concerning MDI instruction. (Bosnic-Anticevich, Sinha, & Reddel, 2010). It was be amended slightly to include the most recent clinical guideline recommendations, including step 10 “Rinse out your mouth after MDI use”. It was chosen because it has been demonstrated as an accurate metric, as well as the relative simplicity (10 items) compared to other check lists having used been used by researchers such as by (Hämmerlein, Müller & Schulz 2010) which included 21 items. Potential error in this tool includes human error of inaccurate perception of the steps, or checking off the wrong check box. See appendix 1.0 for the metered dose inhaler technique checklist. The checklists can provide quantifiable scores which are able to then statistically correlate the success at improving demonstrated technique with the aim of the project being higher levels of proper technique demonstrated after technique education.

While the steps of proper technique have varying levels of compliance (Roy, Battle, Lurslurchachai, Halm & Wisnivesky, 2010) the stated goal of the project would be to increase the overall percentage of correctly performed technique steps by 50% in the

post education demonstration. In creating the check list, there was space included for qualitative data. The healthcare provider included observations, additional questions asked by patients, caregivers, areas of most confusion and other relevant data. This allowed for the later examination of trends not quantifiable by the check list.

Data derived from paper checklists from all providers was collected once a week. After a period of eleven weeks all data was compiled and statistically regressed using SAS statistical analysis software, using an unpaired t test. All data was then be compiled, examined and presented as part of the final capstone project. A timeline of the implementation and evaluation of the project can be found in Appendix 2.0

Evaluation

Results

The performance improvement project began with the training of other providers at the site. Before the implementation of the project one Nurse Practitioner ceased employment with the agency leaving one Medical Doctor and the DNP Candidate as those implementing the project. Training consisted of presenting involved parties with the information to which the project was guided by, introduction to the specific education outlined as part of the initiative, and given a demonstration. The presenting parties all stated they understood, and then demonstrated the initiative for the DNP Candidate.

The proposed timeline was deviated from by approximately three weeks because of an academic commitment by the DNP Candidate. Aside from the three week delay, the remainder of the timeline was followed as proposed and data collection ended on July 27th, 2012. Statistical data was collected using the previously described pre and post education rubric.

Complete data was collected on 118 patients. Data was collected 111 times by the DNP Candidate and 7 times by the Medical Doctor. The patient's pre-education scores varied from 11% steps correct (1 out of 9 steps demonstrated) to 100% correct (9 out of 9 steps demonstrated) with a mean of 4.32 steps correctly demonstrated, a standard deviation of 1.857 and a variance of 3.45. Post education data ranged from 44% (4 out of 9 steps demonstrated) to 100% (9 out of 9 steps demonstrated) with a mean of 6.62, a standard deviation 1.45 of and a variance of 2.11. Using an unpaired t test, the two tailed p value of these results is less than 0.001 making the difference between the means of the pre and post education groups statistically significant.

In addition to the numerical data that was collected qualitative data was collected on worksheets to garner further information during the education Themes within this data included indications of how long patients have been using MDIs, age of asthma diagnosis, the level of compliance from children, and comments on specific steps of proper technique. While there are no specific quantifiable links, field notes do suggest that those that had were younger at age of diagnosis and have been using MDIs the longest has fewer questions asked to the healthcare provider. To this end, within the field notes there appeared to be more questions asked by caregivers if their child had recently begun using a MDI, and parents universally had questions about how long their child should hold their breath. It was also noted that seven different caregivers asked questions regarding what to do if they felt their child did one or more steps incorrectly. Another group of reoccurring questions involved caregivers concerns about when their child could be independent with MDI administration.

All questions asked by the parents were answered by the evaluator as part of over-arching asthma education. Occasionally these questions prompted a larger discussion with the caregiver

about asthma pathophysiology and MDI pharmacology. There were no indications in field notes of caregivers or patients responding negatively to, or refusing instruction, nor any described by the DNP Candidate or the Medical Doctor.

Per information collected by the officer manager, the reimbursement rates from MDI technique education as part of larger asthma education ranged between fifteen and twenty six dollars depending on insurance provider. While it is problematic to generate an exact financial figure, when considering the 118 documented individuals and assuming that insurances were billed in an equal distribution the MDI education provided generated and estimate of approximately 2360 dollars for the facility over the three months of the project.

Interpretation

The overarching interpretation suggests the clinical practice guideline to which this project was guided by is valuable both clinically in the increased MDI technique scores and financially in the cost benefit analysis. Clinically the mean increase of 2.3 steps demonstrated correctly and the statistically significant difference between the pre and post education group evinced a positive impact on MDI technique when providing comprehensive education within the time frame examined. The pre education group having a mean of 4.32 steps correct is largely consistent with existing research that indicates the pediatric population (Sleath, et al. 2011) as well as the general population (Virchow et al. 2008) (Hardwell, Hargadon, Barber, McKnight, Holmes, and Levy 2008), (Basheti, Reddel, Armour, and Bosnic-Anticevich, 2007), (Ovchinikoka, Smith and Bosnic-Anticevich, 2011) of having difficulty demonstrating all the steps of proper MDI technique. The larger variance and in turn standard deviation of the pre education mean, compared to that of the post education means indicates that patients had a wider

range of ability before education. Considering the comparative variance, it can be surmised that education allowed individuals do not only improve, but perform closer to the mean. This could indicate that disparate amounts of information and ability for MDI technique amongst a group can be corrected in this context with this type MDI technique education.

Two out of the three expected outcomes were met. The mean increase of 2.3 steps observed correctly was greater than 50% of the pre education correct steps of 4.32. This increase is consistent with at least one other study examining MDI technique education (Virchow et al., 2008) of the type of impact comprehensive MDI technique education can deliver. No patients verbalized displeasure, needed to stop the education, or gave any other indication to the healthcare providers as described in their field notes. This met the expected outcome of five or fewer negative reactions from patients and lends credence to the receptiveness of patients to this type of education.

The aim of involving and engaging all members of the healthcare was not met as the expected outcome of 10 completed check-lists by providers aside from the DNP candidate was not met as only 7 were filled out over the 11 week time period. This can be partially attributed to the over estimation of asthmatic patients presenting to the office. When considering this expected outcome the DNP candidate used information from census data that occurred during the December, a time where there are typically higher volumes of patients and higher volumes patients presenting with respiratory symptomology. This however is unlikely the entirety of the reason for the lack of completed check lists as the DNP Candidate completed more in fewer working hours. To this end, there are likely other confounding factors which decreased involvement from the other healthcare providers.

In examining the cost to benefit of this project, there appears strong evidence that this initiative is financially viable. As the costs are largely negligible, and there exists a defined ability to be reimbursed by insurance companies, there appears to be a net financial increase to practice by implementing this type of MDI technique education. This is in addition to potentially lowered overarching healthcare costs as a result of better MDI technique and in turn, better symptomology leading to fewer healthcare interactions. (Roy, Battle, Lurslurchachai, Halm & Wisnivesky, 2010).

Discussion

Future practice can include using additions to the electronic templates in order to remind providers to provider MDI technique education as part of care for relevant patients. This alteration is flexible in that it can be easily bypassed if time or situation does not allow for appropriate MDI technique education. Further evolution of the initiative can include creating more nuanced computer rules linking of MDI technique and various clinical templates. The MDI technique addition in templates should be updated as clinical guidelines evolve to reflect the most relevant data.

Moving forward clinical knowledge other aspects of MDI technique education must be evaluated. As occurred in this project, not every relevant patient was delivered MDI technique education. While this project did not suggest a reason for this occurrence, it is consistent with the problem of documented low levels of delivery by healthcare providers. (Sleath, et al. 2011) The Medical Doctor completed only 7 asthma checklists, further exhibiting the problem of lack of consistent education. To this end, understanding the barriers to providing education can be an important piece towards improving outcomes. In expanding this type of initiative, other

outcomes should be evaluated. Knowledge retention in longer time spans after education can give further evidence of the efficacy of this type of education.

Other outcome measures indicating disease management, such as return visits to primary care, or visits to the ER for asthma symptoms can further the understanding this type of education to reduce disease symptomology. A closer examination of spacer status, length of time using a MDI, and the use of other inhalers, all of which were casually indicated as part of the qualitative data, may give greater indication of proper technique when thoroughly evaluated. As there is a limit to time spent with a patient any further refinement to education can be beneficial to not only for the provider, but patient understanding as well.

Limits

In this project the interaction with patients and caregivers occurred during one visit, and further evaluation would be needed in order to test how patients and caregivers retain the information presented. Patient and caregiver demographic information was not explicitly taken, which is suggested by relevant research to have a potential effect on the ability to learn MDI technique. While caregivers were almost always included and present in the education, the ability for an adult caregiver to learn for themselves may have require different strategies. Patient outcomes were measured via patient demonstration, which is subjectively graded by the healthcare provider and there lacked an objective measure of technique. Pre and post education peak flow may have provided this measure, however they were not included because they would not have been part of routine measures of care for all the patients investigated, leading the DNP candidate to not include this metric.

Conclusion

This project indicates that pediatric MDI technique education is a valuable practice both in terms of increased patient ability, and potential financial benefit for healthcare facilities. This project specifically demonstrated a mean increase in MDI technique steps correctly observed by the healthcare provider as well as a decreased variance of ability after comprehensive MDI technique education. While there exists the need for further research to refine MDI education for both the pediatric and wider population, this type of education provides a financially viable and clinically effective intervention for healthcare providers to use. As MDI is a common delivery vessel in clinical primary practice, adopting similar education modalities can be a relatively easy way to benefit patients, providers, and the larger healthcare paradigm.

Appendix 1.0 – Metered Dose Inhaler Technique Check List

Performed by: **Patient Independently _____**, **Assisted by Parent or Guardian_____,**

Indicate a check mark if the patient correctly demonstrates step, omit if they do not.

Metered Dose Inhaler Technique Check List	Pre-Education	Post-Education
Step 1. Shake the inhaler		
Step 2. Hold inhaler upright		
Step 3. Exhale to residual volume		
Step 4. Keep head upright		
Step 5. Mouthpiece between teeth and lips		
Step 6. Inhale slowly and press canister		
Step 7. Continue slow and deep inhalation		
Step 8. Hold breath for 5-10 seconds		
Step 9. Rinse mouth		

(Originally Developed by the Dutch Asthma Foundation, 1995)

Field Notes:

_____

_____

_____

_____

_____

_____

Appendix 2.0 Project Timeline

May 1st, 2012 – Receive preliminary approval from Capstone Committee.

May, 2nd, 2012 – Created physical paper check lists, produced additional copies of existing written instructions at the clinical site

May, 4th, 2012 – Orientated relevant healthcare providers to the initiative through explanation of clinical guideline being used and technique check lists. Provided paper check lists and alter electronic clinical templates to include metered dose inhaler education and check lists.

May, 7th, 2012 – Started the collection of data amongst healthcare providers.

May, 14th, 2012 – Collected completed check lists from providers every Monday and Thursday for eight weeks. The project continued to collect data from providers and DNP Candidate.

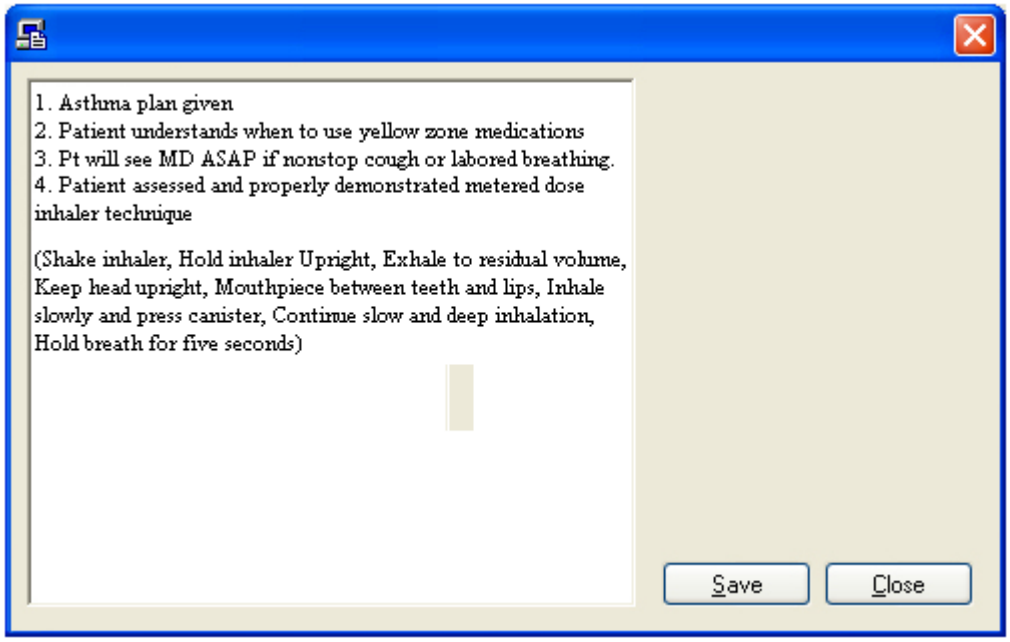
May 28th, 2012 – Computed numbers of completed checklists, projected likelihood of reaching goal responses.

July 27th , 2012 – Completion of Data Collection

July 27th, 2012 - Statistically analyze findings.

August 10th, 2012 – Prepared and displayed findings.

Appendix 4.0 Potential Teaching Tool Screen Grab



References

Al-Showair, R., Pearson S., & Chrystyn H. (2007) The potential of a 2Tone Trainer to help patients use their metered-dose inhalers. *Chest*, 131 (2), 1776–1782

Allen, S., Warwick-Sanders, M. & Baxter M. (2009) A comparison of four tests of cognition as predictors of inability to learn to use a metered dose inhaler in old age. *International Journal of Clinical Practice*, 63 (8), 1150-1153

Baptist, A., Talreja, N. & Clark, M. (2011) Asthma Education for Older Adults: Results From the National Asthma Survey. *Journal of Asthma,* 48 (2), 133-138

Basheti, I., Armour, C., Bosnic-Anticevich, S. & Reddel, H. (2008) Evaluation of a novel educational strategy, including inhaler-based reminder labels, to improve asthma inhaler technique. Patient Education and Counseling. 72 (1) 26-33.

Basheti I., Reddel H., Armour C., & Bosnic-Anticevich, Z. (2007) Improved asthma outcomes with a simple inhaler technique intervention by community pharmacists. Journal of Allergy and Clinical Immunology 119 (6) 1537–1538.

Bosnic-Anticevich, S., Sinha, H., So, S. & Reddel H. (2010) Metered-Dose Inhaler Technique: The Effect of Two Educational Interventions Delivered in Community Pharmacy Over Time. *Journal of Asthma*, 47 (3), 251-256

Brocklebank, D., Ram, F., Wright J et al., (2001) Comparison of the effectiveness of inhaler devices in asthma and chronic obstructive airways disease: a systematic review of the literature. *Health Technology Assessment,* 5 (26), 1–149

Chen et al. (2007) Asthma control, severity, and quality of life: Quantifying the effect of uncontrolled disease. *Journal of Asthma and Clinical Immunology,* 120 (2) 394-402

Orem, D.E. (1991). Nursing: Concepts of practice (4th ed.). St. Louis, MO: Mosby-Year Book Inc.

Giraud, V. & Roche, N. (2002) Misuse of corticosteroid metered-dose inhaler is associated with decreased asthma stability. *European Respiratory Journal*, 19 (2), 246-251

Gray, S., Williams, D., Pulliam, et al (1996) Characteristics predicting incorrect technique in older subjects. *Archives of Internal Medicine,* 156 (9), 984-988

Hämmerlein, A. Müller, U. & Schulz M. (2010) Pharmacist-led intervention study to improve inhalation technique in asthma and COPD patients. *Journal of Evaluation Used in Clinical Practice.* 17 (1), 61-70

Hardwell, A., Hargadon T., Barber V., et al. (2008) Technique training does not improve the ability of most patients to use pressurized metered dose inhalers. *Thorax,* 20 (1) 92-96

Haughney, J., Price, D., Barnes, N., et al. (2010) Choosing inhaler devices for people with asthma: Current knowledge and outstanding research needs. *Journal of Respiratory Medicine*, 104: 1237–1245

Melania, A., Bonaviab, M., Cilentic, V., Cintid, C., Lodie, M., Martuccif, P., Serrag, M., Scichiloneh, N., Sestinii, P., Alianij, M. & Nerik, M. (2011) Inhaler mishandling remains common in real life and is associated with reduced disease control. Respiratory Medicine, 105(6), 930-938.

Moher, D., Tetzlaff, J., Tricco, A., Sampson M. & Altman, D. (2007) Epidemiology and Reporting Characteristics of Systematic Reviews. *Public Library of Science Medicine,* 4 (3) 447-455

National Heart, Lung and Blood Institute (2007) Guidelines for the Diagnosis and Management of Asthma: Expert Panel Recommendations 3. United States Department of Health and Human Services.

Ovchinikoka, L., Smith, L. & Bosnic-Anticevich, S. (2011) Inhaler Technique Maintenance: Gaining an understanding from the Patient's Perspective. *Journal of Asthma*. Article Published Online Ahead of Print, May 31, 2011

Palen, J., Klein, J., Kerkhoff, H & van Herwaarden C. (1995) Evaluation of the effectiveness of four different inhalers in patients with chronic obstructive pulmonary disease. *Thorax* (1995) 50(11) 1183-1187.

Papi, A., Haughney, J., Virchow, J, Roche, N., Palkonen, S. & Price, D. (2011) Inhaler devices for asthma: a call for action in a neglected field. *European Respiratory Journal,* 37 (5), 982-985

Powell, H. & Gibson, P. (2003) Options for self-management education for adults with asthma. *Cochrane Database of Systematic Reviews*, 2003. Issue 1.

Savage, I. & Goodyear, L. (2003) Providing information on metered dose inhaler technique: is multimedia as effective as print? *Family Practice,* 20 (5), 552-557

Shu H., O'Mahoney, S., Steward, L., Breay, P., & Burr M. (2004) Inhaler technique in older people in the community. *Age and Aging*, 33 (2), 185-188

Takemura, M., Kobayashi, M., Kimura K., et al (2010). Repeated instruction on inhalation technique improves adherence to the therapeutic regimen in asthma. *The Journal of Asthma*, 47 (2), 202–208.

Virchow, J., Crompton, G., Dal Negro, R., Pedersen, S., Magnan, A., Seidenberg, J. & Barnes, P. (2008) Importance of inhaler devices in the management of airway disease. *Respiratory Medicine*, 102 (1), 10-19.