2020

# Increasing Medication Compliance in Pediatric Asthma Patients by Implementing a Home Medication Dosing Chart

Lindsey K. Shader
lindsey.vowels@gmail.com

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The document mentioned above has been reviewed and accepted by the student’s advisor, on behalf of the advisory committee, and by the Assistant Dean for MSN and DNP Studies, on behalf of the program; we verify that this is the final, approved version of the student's DNP Project including all changes required by the advisory committee. The undersigned agree to abide by the statements above.

Lindsey K. Shader, Student

Dr. Leslie Scott, Advisor

Increasing Medication Compliance in Pediatric Asthma Patients by Implementing a Home Medication Dosing Chart

Submitted in Partial Fulfillment of the Requirements for the Degree of Doctor of Nursing Practice at the University of Kentucky

By

Lindsey Shader RN, BSN

Shelbyville, KY

2020

## Abstract

**Background:** There are 6.2 million children under the age of 18 years who have an asthma diagnosis (Center for Disease Control and Prevention, 2017). Only 60% of children ages 7-17 years with persistent asthma maintain their prescribed inhaled corticosteroid (ICS) controller medication regimen (Arnold, Bixenstine, Cheng, & Tschudy, 2018). The purpose of this paper is to discuss a practice inquiry project that incorporated the implementation of an asthma medication dosing chart to increase compliance in pediatric asthma patients.

**Method:** The quasi-experimental pretest-posttest design evaluated the daily use of a medication dosing chart, which was to serve as a physical reminder for children and their families to take their daily inhaled corticosteroid as prescribed. Emergency room visits, hospital admissions, missed ICS doses, rescue inhaler and oral steroid use were measured to determine if increased dosing compliance influenced how well the pediatric patient's asthma is controlled.

**Results:** Of the pre-intervention group (n=27), only 13 attended the follow-up visit and completed the post-intervention survey. There was statistical significance (p=.002) with missed ICS doses, it decreased from an average of 1.7 missed doses per week to an average of .31 doses. A decrease in ED visits (p=.226), decrease in hospitalizations (p=.393), and oral steroid courses from (p=.730) were noted but not deemed statistically significant. Rescue inhaler use decreased from an average of 1.89 times per week to 1.08 times (p=.254).

**Conclusion:** Having a decrease in the number of missed ICS doses per week is the most significant measure that demonstrated improved compliance. While all other measures had notable decreases, based on the small post-intervention sample size (n=13) there was not statistical significance seen with improved compliance based on the use of the medication dosing chart. Further studies on a larger scale over a longer period are recommended.

**Acknowledgements**

I acknowledge and thank my advisor and committee chair member, Leslie Scott PhD, APRN, for her complete and total support through this process. Without her guidance, my DNP project would not have been successful or possible.

I grant a huge thank you to Morgan Chojnacki, DNP, APRN for her assistance and support. Thank you being an important part of my committee and helping guide me through this arduous process.

I also want to acknowledge Brittany Kurtz, MSN, APRN for her immense support during the development and implementation of my project. Without her assistance, it would have been nearly impossible for me to complete the ultimate task of attending follow-up appointments for each of the study participants. I cannot thank her enough for her supervision and mentorship throughout clinical rotations, as well as her participation as a doctoral committee member. Thank you for everything! I literally could not have done this without you.

Aaron Shader, my husband, deserves acknowledgement for his unwavering support from the day I said I was going to apply to graduate school. He never let me give up during the difficult times and repeatedly told me, "it will all be okay." His commitment to helping me achieve my goal of becoming a Nurse Practitioner is what has kept me going the last three years. I love you and can't wait to enjoy our married life without having to study!

My parents, Pete and Dianne, also deserve recognition for their never-ending love and support from the day I said I wanted to become a nurse in 2008. Thank you for being a sounding board during the development and implementation of my project, the stress of clinical rotations, and the

tearful study sessions. Thank you for teaching me to persevere during the moments that felt impossible. Love you guys!

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# Background and Significance

## Problem Identification

As of 2017, there are 6.2 million children under age 18 years who have asthma which makes this the most common chronic condition among the pediatric population (American Lung Association, 2018; Center for Disease Control and Prevention, 2017). Medication adherence is a common denominator for why children are hospitalized for asthma exacerbations. Only 60% of children ages 7-17 years with persistent asthma maintain their prescribed inhaled corticosteroid (ICS) controller medication regimen (Arnold, Bixenstine, Cheng, & Tschudy, 2018). Due to poor medication adherence, asthma is the third-ranked cause for hospitalization in children under the age of 15 years (Nurmagambetov, Kuwahara, & Garbe, 2017).

## Context of Problem

Asthma is an obstructive pulmonary disease that makes it difficult to move air in and out of the lungs (American Lung Association, 2018). In individuals with asthma, the airways are always inflamed. Airway muscles become more swollen and constricted when in contact with environmental triggers, making it more difficult to breathe (American Academy of Allergy, Asthma, and Immunology, 2019). Asthma causes wheezing, chest tightness, increased mucus production, and trouble breathing especially early or late in the day (American Academy of Allergy, Asthma, and Immunology, 2019). When taken daily as prescribed, ICS controller medications can inhibit the inflammatory process caused by asthma symptoms and decrease chronic inflammation in the lungs over time. Beta-2 agonists, commonly referred to as rescue medications are used during an exacerbation of symptoms or to pre-treat prior to exercise (American Academy of Allergy, Asthma, and Immunology, 2019). Children with poor medication compliance often experience more asthma-related symptoms and are more likely to need oral steroids, visit the emergency department, and/or be hospitalized due to their asthma (CDC, 2018).

**Scope of Problem**

There are intentional and non-intentional barriers to asthma medication adherence in children. Intentional barriers include illness perception, medication beliefs, and deliberately choosing not to take the medications (Klok, Kaptein, & Brand, 2015). Non-intentional barriers include family routine, child-raising issues, and social issues such as poverty (Klok et al., 2015). Race, education and poverty levels severely effect asthma medication adherence in children (Arnold et al., 2018). At Children's Hospital of Michigan- Detroit, 35.5% of the children admitted for asthma exacerbations reported to not having their asthma medications, specifically their beta-2 agonist (Poowuttikul, Hart, Thomas, & Secord, 2017). Teenagers are most likely to lack their asthma medication supplies at home (55.6%) compared to toddlers (~17%). Those with severe persistent asthma (31.8%) were also more likely to be lacking their asthma medication supplies (Poowuttikul et al., 2017). Understanding why children do not have their asthma medications is a start to better address gaining control of their disease.

**Consequences of Problem**

Poor asthma control can cause severe and/or potential life-threatening exacerbations. During an exacerbation, the airway can constrict to the point that other vital organs do not receive the oxygen required to function properly (American Academy of Allergy, Asthma, and Immunology, 2019). In 2013, only 54.5% of children were taking their asthma controller medications as prescribed, a significant decrease over the previous decade (CDC, 2018).

Between 2013 and 2016, of the 54% of children reported having at least one asthma exacerbation during that time frame, 4.7% were hospitalized and 16.7% visited the emergency department (ED) or urgent care (UC) for asthma-related symptoms (CDC, 2018). Younger children with asthma (0-4 years) have higher rates of exacerbation, hospitalizations, and ED/UC visits often due to their exclusive reliance on caregivers for their medication (CDC, 2018). Using the ED to "manage" asthma versus attending routine follow-up appointment with a pediatric specialist or their primary care provider (PCP) is another known issue that contributes to poor asthma control (Kwok et al., 2018). Developmentally, children ages 6-11 years are learning to think in concrete ways. During this stage of cognitive development, school-age children learn to combine, order, separate, and transform objects and actions (Cincinnati Children's , 2017). It is not until adolescence that children are able to process formal logical operations such as the ability to think abstractly and reason through problems which can make having the sole responsibility of managing a chronic disease difficult in the younger age groups (Cincinnati Children's , 2017). Children ages 6-11 years have not cognitively developed in a way that allows them to understand the importance of medication compliance and management on their own.

## Evidence-Based Intervention

A visual tool was developed for use by the families of medically diagnosed, asthma patients age 6-11 years. The tool will be introduced and distributed to children with asthma during routine, follow-up visits at University of Louisville, Pediatric Pulmonology Clinic. On a laminated sheet there will be boxes labeled with each day of the week, Sunday through Saturday. The goal is for a family member, or the child (if age appropriate), to "check off" the daily boxes when they take their medications as prescribed each day, with the provided dry-erase marker. There will be a set of boxes on the bottom left of the tool with each box representing a week, so that each week can be “checked off” during the three to four months in between their scheduled, follow-up appointments. The family is encouraged to hang the tool somewhere in plain view, so it isn’t overlooked. Upon their return for their follow-up visit, within the 3-4 month time frame, it will be determined if the chart was helpful for the child or family in remembering to administer asthma medications, if the medications were administered as prescribed, and whether they felt their child’s overall health had improved due to increased compliance.

**Purpose of Project**

The purpose of this project was to evaluate the use of a medication dosing chart in increasing the daily use of their ICS controller medication as prescribed to children with asthma, thus reducing the need for oral steroids, usage of rescue medications, hospitalizations and ED/UC visits.

## Theoretical Framework

Albert Bandura’s self-efficacy theory is pertinent to asthma compliance. Bandura (1994) determines that perceived self-efficacy is one’s belief about their capabilities to perform tasks that influence and affect their life events. If an individual has a high assurance of their abilities, they will take on the difficult task with a goal of mastering it (Bandura, 1994). Those with low assurance perceive difficult tasks as personal threats, have low aspirations, and weak commitments to their goals (Bandura, 1994). The motivational processes of the self-efficacy theory help individuals form beliefs about what they can do and anticipate outcomes of future actions (Bandura, 1994). It is important to provide education and resources to children and families that are seeing asthma as difficult to manage so they can develop a high assurance for the disease and want to manage it well. This theoretical framework determined the need and guided the development of the asthma medication compliance chart.

## Literature Review

Being one of the most common chronic conditions in children, asthma has a significant impact on this vulnerable population. Asthma contributes to millions of lost school days each year and is the third leading cause of hospitalization in the younger population (American Lung Association, 2019). Poor asthma medication compliance often contributes to missed school days and hospitalizations. There are many reasons attributing to poor management and poor compliance. Intentional and non-intentional barriers to asthma medication regimens result in emergency department (ED) visits for asthma exacerbations or asthma-related problems. Evidence shows that non-Hispanic black families living in poverty have the highest incidence of asthma-related problems in children due to poor medication adherence (Arnold, Bixenstine, Cheng, & Tschudy, 2018, Pertzborn et al., 2018, & Kwok et al., 2018). Poverty is one non-intentional barriers families face when it comes to poorly managed diseases. Family routine, child-rearing issues, and limited access to education are additional non-intentional barriers (Klok et al., 2015). Illness perception, medication beliefs, and deliberately choosing not to take medication are examples of intentional barriers caregivers of children with asthma should be cognizant of when learning to care for their child's disease (Klok, Kaptein, & Brand, 2015). Arnold et al., 2018 found that forgetfulness was another barrier to adequately managing a child's asthma. The children with asthma are not placing blame on others for forgetting their medications, but rather their caregivers blame the child for forgetting their medications (Arnold et al., 2018). The inappropriate lack of responsibility by caregivers is putting children at risk for increased asthma exacerbations and ED visits.

There is evidence that caregivers are interested in learning about how controller medications work, when to initiate rescue medications based on known triggers, and the safety profile of each asthma medication (Kwok et al., 2018). Caregivers and children should equally understand their roles in managing asthma, so all parties are aware of triggers, when to use appropriate medications, and when to seek help. The need for increased awareness of patient-centered communication by physicians is key in helping caregivers and their children learn these concepts to help better manage the disease (Klok et al., 2015).

School-age children need a sense of purpose; help them by giving them goals to use their energy toward achievement (American Academy of Pediatrics [AAP], 2009). During this stage of life, it is equally important for children with asthma to develop a personal competence and sense of pride (AAP, 2009). Allowing them to begin participating in managing their disease with the help of their caregivers can allow them to develop their sense of purpose, competence, and pride. Gaining more independence at this age is also especially important, as school-age children are spending more time away from their parents (AAP, 2009). The average age of asthma diagnosis has dropped to 2.6 years-old, which allows many children several years of learning about their disease and time to understand how its managed (Radhakrishnan et al., 2014). School-age children should be engaging in shared asthma management responsibility with their caregivers, especially during times they are not at home (Sonney, Segrin, & Kolstad, 2018). Family dynamics should be considered when discussing shared asthma management. Shared management can assist the child in the development and feeling a sense of inclusion and accomplishment with their care (Sonney et al., 2018).

There are several different mediums used to manage asthma medication adherence in young patient populations. Adult studies have been a guide to learning barriers of asthma control in the pediatric population (Anderson III & Szefler, 2015).  Electronic Monitoring Devices (EMD) have gained popularity over the last few years for achieving disease control and medication adherence (Anderson III & Szefler, 2015). While this type of monitoring system gives the impression of having few flaws, there are several to consider. EMDs have associated costs, technology needs, significant patient education, and potential device failure (Anderson III & Szefler, 2015). EMDs can also provide reminders to patients to take their medications and provide information about upcoming appointments (Arnold et al., 2018). Reminders about upcoming appointments can be beneficial for families who have a busy and/or difficult family routine. Electronic monitoring is considered a "gold standard" for disease control but cost and access is a major concern for some families (Boutopoulou, Koumpagiot, Matziou, Priftis, & Douros, 2018). Even during the technology boom the world is experiencing, not every individual has access to a smart phone (Statista, 2019). It is important to consider ease of access, ease of use, and cost when providing a "device" designed to help with disease control and medication adherence. Diary cards or self-reporting devices provide a way to subjectively measure data; they are inexpensive, convenient, relatively unobtrusive, and should not suffer from technologic difficulties (Anderson III & Szefler, 2015 & Boutopoulou et al., 2018). However, like EMDs, self-reporting devices come with their own set of flaws. Accuracy and adherence can demonstrate that this device is not necessarily the best choice for each family (Boutopoulou et al., 2018). If the family is already having difficulty adhering to their current asthma medication regimen, they may not want to adhere to a diary card or self-reporting device in addition to the medication which could then lead to filling out false information to give the impression they participated (Boutopoulou et al., 2018). Self-reporting is an excellent medium to incorporate use in school-age children. The caregiver or parent can support shared management with the child to fulfill everyone’s needs. The child may be motivated to see success on their diary card, and feel like they have achieved a goal each time they “check” a box for taking a medication or completing another week of adhering to their regimen (AAP, 2009). The caregivers will play an active role in monitoring the child’s use of the diary card to ensure medications are taken as prescribed while allowing the child to participate in “checking off” boxes. The advantages of using self-reporting devices in the school-age population outweighs the disadvantages compared to EMDs (Boutopoulou et al., 2018).

There are pros and cons for each monitoring device and the literature shows that a more targeted, personalized method of assessment of disease control and medication adherence are required to achieve adequate management (Boutopoulou et al., 2018). The provider-chosen monitoring device is advantageous for a caregiver and their child to help gain better control of their child’s asthma. Knowing the needs of any targeted population is significant for achieving success.

## Project Design

The design used for this project was a quasi-experimental pretest-posttest research design. One group will be assessed on two separate occasions. This type of study design works best with projects in which interventions are implemented over longer periods of time and uses pretest and posttest to assess the intervention.

## Project Methods

### Agency Description

University of Louisville Physicians (ULP) pediatric pulmonology office is the location in which this project was implemented. This facility is in downtown Louisville inside the brand-new Novak Center for Children's Health, where all other University of Louisville pediatric specialty offices are also located. ULP Pediatric Pulmonology is made up of four physicians, one nurse practitioner, two respiratory therapists, and one medical assistant. This group of healthcare professionals uses practice recommendations from the American Board of Pediatrics, American Academy of Pediatrics, and the American Thoracic Society to provide comprehensive care to the various lung and respiratory diseases found in the pediatric population (University of Louisville Physicians Pediatric Pulmonology, 2013).

**Setting**

The implementation of the asthma medication dosing chart took place in the exam rooms at the ULP Pediatric Pulmonology office during the study participant's appointment time. ULP Pediatric Pulmonology is located on the fifth floor in the Novak Center for Children's Health in downtown Louisville, KY.

**Sample**

The sample population for the project was children ages 6-11 years living in Kentucky, with an asthma diagnosis, and a prescribed daily inhaled corticosteroid (ICS). Participants were evaluated for inclusion and exclusion criteria and recruited during their routine, follow-up appointment where asthma medication compliance is evaluated and discussed. Children meeting inclusion criteria and interested in participating were identified. The project was presented, and parent consent/child assent was obtained prior to enrollment in the study.

**Inclusion and Exclusion Criteria**

Inclusion criteria for the participants included being between the ages of 6-11 years, living in the state of Kentucky, having an asthma diagnosis, and be prescribed an inhaled corticosteroid.

Exclusion criteria consisted of being younger than 6 years and older than 11 years at time of recruitment, living outside of Kentucky, not having a prescribed ICS controller medication, and requirement of an interpreter. Missed ICS doses, rescue inhaler usage, ED visits, hospitalizations, and oral steroid use were the variables measured on the survey

**Congruence of DNP Project**

This DNP project is in congruence with ULP Pediatric Pulmonology's mission, goal, and strategic plan. Their mission is to "help patients breathe more easily and to deliver exceptional, state-of-the-art medical care" and their goal is to "improve quality of life, as well as preserving and restoring respiratory health" (University of Louisville Physicians Pediatric Pulmonology, 2013). The project goal was to evaluate the use of a dosing tool to increase medication compliance in children with asthma who use a daily ICS for maintenance control of their asthma. Tool effectiveness is measured in number of exacerbations requiring ED/UC visits, hospitalizations, and the need for oral steroids in the interim between follow-up visits. This activity aligns with ULP's goal of improving quality of life and preserving lung health in the pediatric population and their mission of helping patients breathe easier (University of Louisville Physicians Pediatric Pulmonology, 2013). Creating a plan to assist medication compliance may contribute to a reduction in exacerbations, ED visits/hospital admissions, or need for oral steroid use on a regular basis.

**Stakeholders**

The stakeholders involved in the implementation of this project are children with asthma, prescribed an ICS controller medication. The participant's parents/caregivers were also an extremely important stakeholder because the participants are too young to assume full responsibility with their care and participation in the study. Parent/caregiver involvement was essential for the success of their children. Other important stakeholders were the nurse practitioner and respiratory therapists who were necessary to identify eligible participants, access data, and provide expert care and information on asthma throughout the recruitment, implementation, and evaluation process. The healthcare professionals in the clinic were more familiar with the patients and families typically seen 3-4 times per year and were able to guide the project. Having the involvement of these key stakeholders was essential to collecting accurate data in a timely manner and the ability to provide the participants and families with an alternative to assist in their current medication dosing compliance.

**Facilitators and Barriers**

Some of the facilitators encountered within the agency was the availability of a colored guide of all respiratory medications, available in each exam room to inquire about the patient's knowledge of which medications are taken and whether they can differentiate between their ICS controller and their beta-2 agonist, rescue inhalers. The nurse practitioner also had access to medication samples for patients having issues acquiring or purchasing their medications. Having immediate access to the pulmonary function testing results during the initial visit and the follow-up visit helped measure how the patient's lung function changed over the four-month study. Being familiar with the office staff and other healthcare professionals helped facilitate patient recruitment, enrollment, data collection, and a follow-up data collection at the end of the study.

Barriers encountered with the implementation of the project included not having direct access to patient clinic charts, contact information, and the need to have the office personnel determine eligible enrollees. Other barriers included some participants' inability to maintain use of the given materials. Participants failing to follow-up as scheduled was an additional barrier for follow-up data collection at the end of the study. The limited number of eligible participants due to time constraints and unqualified participants was an additional barrier impacting overall enrollment into the study.

**Description of Project**

The asthma medication dosing chart (Appendix C) was created to allow participants and families to physically see when and how often medications were being taken. The horizontal chart has a row of seven boxes, labeled for each day of the week, that are designed to be "checked off" each day the ICS is taken as prescribed, with the provided dry erase marker. The daily boxes were designed to be wiped off and restarted at the end of each week. Below the daily row to the left is the section of "weeks completed". This section was designed to help families keep track of how many weeks were tracked between appointments. These boxes were also designed to be "checked off" with the provided dry erase marker. To the right of the "weeks completed" section is the "rescue inhaler used" section. This section is to allow participants and families to make tally marks showing how often the rescue inhaler was needed between appointment times. It is not designed to be wiped off and restarted each week. A silicone pen holder was applied to the laminated chart in hopes of helping the provided dry erase marker to stay with the chart during the several months between appointments.

The pre- and post-intervention asthma questionnaire (see Appendix B) was completed at the initial visit after legal documents were signed. This questionnaire collected the specific data that was used to analyze the helpfulness of the asthma medication dosing chart. At the final appointment, the questionnaire was supplied again with the exact same questions to determine if ED visits, steroid use, rescue inhaler use, and number of times forgetting to take the ICS on a weekly basis differed from the initial appointment.

## Procedure

### IRB Approval

Obtaining IRB approval for this project occurred in two stages. Initial approval came from the University of Kentucky IRB. Further approval from the University of Louisville IRB was needed due to the location of project implementation. The project implementation was initiated following approval from both institutions.

### Sample

A convenience sample of twenty-seven children ages 6-11 years with an asthma diagnosis and a prescribed daily inhaled corticosteroid was obtained at random based on the clinical schedule of the nurse practitioner and availability of the PI to collect necessary data. Initially, a manual search was done on the individual patients on the nurse practitioner's schedule by the nurse practitioner. The process of the manual search began with patients selected by age, then their home address (must live in Kentucky) was verified, followed by asthma diagnosis, and ICS prescription on their medication list. Individuals that met the inclusion criteria were given a flyer (Appendix D) by the nurse practitioner at the beginning of their appointment. At the conclusion of the appointment, the nurse practitioner inquired the patient and family about interest and willingness to participate in the study. If willing to participate, the nurse practitioner informed the PI to enter the exam room, and provide a brief, detailed description of the study and its purpose. If the patient and family were still interested in participating in the study, then the legal documents to obtain informed consent, assent, and HIPAA guidelines were signed and dated by the primary investigator and participant and their family.

## Measures and Instruments

See Appendices A, B, and C. The instrument used to measure the demographics, ICS and rescue inhaler information, and asthma diagnosis was obtained from chart review of the study participant's medical records. The asthma medication survey created was administered pre-intervention and post-intervention to collect information on the outcomes of ED visits, hospitalizations, oral steroid need, daily ICS use, and rescue inhaler use before and after medication dosing chart usage. The asthma medication dosing chart and pre/post questionnaires were reviewed by an asthma expert, the nurse practitioner working for ULP Pediatric Pulmonology, for content validity. These tools were not in existence prior and were created specifically for this practice inquiry project. There is not any validity or reliability data associated with these tools at this time.

## Implementation

Implementation of the asthma medication-dosing chart began once informed consent, assent, and HIPAA documents were signed and dated by all parties. The parent/legal guardian was provided with copies of consent documents to participate in the study. Assent was also obtained from each child after informing them of how they were expected to participate and with their agreeance to enroll in the study. Parents and legal guardians were also presented with a HIPAA document explaining that their child's personal health information would not be used or be identifiable in the study. The child's age, FEV1 results, and answers to the asthma questionnaire were the only information being used for the study and would not be able to be tracked back to the individual participants. After each of the three consents were signed and dated, the participant and the parent/guardian were given the asthma medication dosing chart. They were shown how to "track" their daily ICS use by using the dry erase marker provided with the chart. After the participant's ICS was taken each day, they were to put a "check" or "X" in the correlating day of the week box. Once the week was complete, they were to erase and start over, while also putting a check in the "weeks completed" box below. The participants were instructed to continue repeating this weekly until they returned for their next appointment. They were also informed to put tally marks under the "rescue inhaler used" section so families could see a general idea of how much their child was needing extra help. Instructions were also reviewed with the parent/legal guardian as they still have a significant obligation to remind the child to take their medication.

**Results**

A total of 27 patients met the inclusion criteria for this study within the project timeline and were enrolled in the study. Pre-intervention survey was completed, and each participant received the asthma medication dosing chart with a dry erase marker. A total of 13 participants attended their follow-up appointment and completed the post-intervention survey.

Of the 27 pre-intervention participants (Appendix E, Table 1), there were 8 (29.6%) that required at least one ED visit and one participant visiting the ED 10 times (12.5%) for asthma-related issues. Post-intervention, there was only one participant (7.7%) that required two ED visits. Using Chi-Square and Fisher's Exact Testing, a p value of $p=.226$ was obtained and determines there is not a statistically significant difference in ED visits with the use of the asthma medication chart.

Out of the 27 pre-intervention participants, there were six (22.2%) that required hospitalizations due to an exacerbation. Each participant only required one hospitalization for asthma complications in a four-month period. There was only one (7.7%) post-intervention participant that required one hospitalization on one occasion. With the Chi Square and Fisher's Exact Testing, a p value of $p=.393$ was obtained and shows that there is not a statistically significant difference in hospitalizations based on the use of the asthma medication chart.

Oral steroid use for the 27 pre-intervention patients was 40.7% with 11 participants needing steroids prior to receiving the medication chart. The number of steroid courses needed for these participants ranged from one to five. After the chart was implemented, there were only four (30.8%) participants who required oral steroids for an asthma exacerbation. The post-intervention steroid courses needed ranged from one to two which shows a decrease in need. A p value of $p=.730$ was obtained and shows there is no statistical significance related to oral steroid use after the asthma medication chart was implemented. Chi Square and Fisher's Exact Testing were also utilized for this analysis.

The mean number of times the participants missed their inhaled corticosteroid pre-intervention was 1.7 times per week with a standard deviation of 1.938. Post-intervention, the participants improved their missed ICS doses to .31 times per week and a standard deviation of .63. There was improvement in the doses of ICS missed per week after the intervention was implemented into daily routine. With a p value of $p=.002$ it shows this data is statistically significant using Levene's Test for Equality of Variances where equal variances were not assumed.

Rescue inhaler use had a mean of 1.89 times per week pre-intervention with a standard deviation of 2.1. Post-intervention, the rescue inhaler usage decreased to 1.08 times per week with a standard deviation of 2.019. The number of times the rescue inhaler was needed post-intervention was half of what was needed pre-intervention but is not considered statistically significant with *p=.254* using Levene's Test for Equality of Variances where equal variances were assumed.

Additional data for another variable was collected for the interest of the project. FEV1% (forced expiratory volume) is indicative of lung function and was monitored to determine if there was any improvement related to using the chart. This variable specifically measures how much air can be exhaled in one second after a significant inhalation (Stanojevic, et al., 2008). Normal reference range for FEV1 is considered to be between 70-79% (Stanojevic, et al., 2008). While FEV1% was not a specific variable being analyzed to determine the efficacy of the asthma medication chart for the purpose of this project, it was collected to see if there was an overall increase in lung function with improved medication compliance. Pre-intervention, the mean FEV1% for all participants was 82.11%. After the chart was implemented, the mean FEV1% increased to 86.9%. There was a small improvement in lung function noted but according to Levene's Test for Equality of Variances when variances were not assumed it showed *p=.327* which determines this data is not statistically significant.

Lastly, on the post-intervention survey, a question was asked about whether the asthma medication chart was helpful. This question was asked to get a consensus of how the participants and their families felt about implementing the chart into their daily routine. Of the 13 post-intervention participants, 11 (84.6%) participants thought the medication chart was helpful while the remaining two (15.4%) did not think it was helpful but were "already compliant" and "already had a routine".

SPSS Version 25 and Microsoft Excel were used to analyze, and display collected data. See tables in Appendix E.

## Discussion

The goal of this project was to help improve medication compliance and lung function in pediatric asthma patients who take a daily ICS by decreasing missed medication doses; lowering the need for rescue inhaler use; decreasing ED visits, hospitalizations, and need for oral steroids by implementing a medication chart into their daily routine.

The results came out as relatively expected. Each measure saw improvement or decrease where warranted but after analysis, most measures were not shown to be statistically significant except for missed ICS doses per week. Ultimately, decreasing the number of missed ICS doses per week is the most important measure where change is needed in order to decrease all other measures subsequently. By adhering to the prescribed medication regimen, participants decrease their likelihood of needing to visit the ED, be hospitalized, and require a course of oral steroids.

## Implications

This study could be used in future practice as it showed to have a statistically significant effect on the number of missed ICS doses per week by the pediatric asthma patients. By decreasing missed doses of a participant's ICS, they are less likely to need to visit the ED, be hospitalized, and require oral steroids. While these measures (ED visits, hospitalizations, and oral steroids) did not present statistically significant data, there was a notable decrease in numbers comparing pre-intervention to post-intervention measures. More in depth research with closer participant follow-up is recommended on a larger scale to determine if the asthma medication chart could have a more successful impact on medication compliance while improving lung function.

## Limitations

There were several limitations to this project. The participants were not assigned an identifier during the pre-intervention appointment which would allow for easier pairing of before and after results during the post-intervention appointment. Due to not having an identifier, it was difficult to pair pre-intervention numbers with post-intervention numbers demonstrating individual evaluation of the use of the asthma medication dosing chart on ED visits, hospitalizations, oral steroids use, and/or missed ICS doses.

The participant's asthma diagnoses, gender, and ethnicity were not identified which could indicate the severity of each participant's asthma disease. The severity of asthma could likely influence the number of ED visits, hospitalizations, and oral steroid courses needed overall (Poowuttikul et al., 2017). In addition, it would have been beneficial to identify which ICS each participant was administering related to their asthma diagnosis. If one participant is requiring a stronger medication or dosing of several asthma-related medications, their degree of control may impact the outcomes related to ED visits, hospitalizations, and oral steroid courses needed. These outcomes may not be influenced by use of the asthma medication dosing chart use, but rather their disease severity.

Not only are specific diagnoses important to include for each participant, it should be mentioned that when their FEV1 percentages were measured at each appointment, there were several variables to be noted that influenced initial measurements. During pre-and post-intervention appointments, some participants were amid an undiagnosed exacerbation while some were actively taking oral steroids. These variables, exacerbations and steroids, affect FEV1% both negatively and positively, respectively. This provided inaccurate data at the time of the appointment so without doing a more in-depth chart review on every participant to determine their average over the previous year, it is difficult to say which participants truly improved their lung function. This is one of the reasons why there was not a significant emphasis put on the FEV1% measured and why they were analyzed as a more general variable to see an overall improvement or decline.

Another limitation noted for this project was having participant's which have a history of being non-compliant with appointment attendance. For the interest of this project, non-compliant patients were not excluded as there was a possibility, they might be more compliant with implementation of the asthma medication dosing chart. The medication dosing chart was designed to encourage and assist with compliance and may assist those who struggle with medication dosing compliance on a regular basis. During chart review to determine participant eligibility, reviewing past appointment history may have assisted with identification of participants less likely to complete the study. If the traditionally non-compliant participant presented on a day of data collection and met inclusion criteria, they were still approached about participating in the study. This may have affected the number of follow-up participants. The sample size of (n=27) was affected by many who fulfilled inclusion criteria not showing up for their appointment. With more time for data collection, it is possible a larger sample size of patients could have been collected which may have yielded more accurate results.

Another important limitation to be discussed is that the primary investigator did not have contact with any participants or families during the four-month follow up window which could have allowed for more engagement between the participant and the intervention and potential for more post-intervention surveys to be completed.

Lastly, as a comment per one of the post-intervention surveys, one participant stated "[his] marker dried out". This was a limitation noted prior to the start of the project but with few resource options available, it was the most cost effective and best overall option to ensure the medication charts were able to be re-used over a 4-month period.

## Conclusion

The goal for this project was to decrease the number of ED visits, hospitalizations, oral steroid courses, missed ICS doses, and the need for excess rescue inhaler use in pediatric asthma patients by implementing an asthma medication chart to assist with compliance. While the data from this project did not identify many statistically significant changes, it is possible that if this project were carried out on a larger scale over a longer period, findings could have differed. Most importantly, missed ICS doses showed to have a statistically significant association with use of the asthma medication chart and could therefore subsequently decrease the need for ED visits, hospitalizations, oral steroid and rescue inhaler usage which would ultimately improve lung function for pediatric asthma patients. Despite an overall decrease in all measures, a larger post-intervention sample size would be beneficial to validate the data collected. Further studies are needed on a larger scale to improve post-intervention sample size.

## References


American Academy of Allergy, Asthma, and Immunology. (2019). https://www.aaaai.org/conditions-and-treatments/asthma

American Academy of Pediatrics. (2009). Helping Your Child Develop A Healthy Sense of Self Esteem. Retrieved from https://www.healthychildren.org/English/ages-stages/gradeschool/Pages/Helping-Your-Child-Develop-A-Healthy-Sense-of-Self-Esteem.aspx

American Lung Association. (2018). https://www.lung.org/lung-health-and-diseases/lung-disease-lookup/asthma/learn-about-asthma/asthma-children-facts-sheet.html

American Lung Association. (2019, July 10). *Impacts of Asthma*. Retrieved from https://www.lung.org/lung-health-and-diseases/lung-disease-lookup/asthma/learn-about-asthma/impact-of-asthma.html

Anderson III, W. C., & Szefler, S. J. (2015, August). New and future strategies to improve asthma control in children. *Journal of Allergy and Clinical Immunology*, *136*, 848-859. https://doi.org/dx.doi.org/10.1016/j.jaci.2015.07.007

Arnold, C. M., Bixenstine, P. J., Cheng, T. L., & Tschudy, M. M. (2018). Concordance among children, caregivers, and clinicians on barriers to controller medication use. *Journal of Asthma*. https://doi.org/10.1080/02770903.2018.1424188

Bandura, A. (1994). Self-efficacy. *Encyclopedia of human behavior*, *4*, 71-81. Retrieved from https://www.uky.edu/~eushe2/Bandura/Bandura1994EHB.pdf

Boutopoulou, B., Koumpagiot, D., Matziou, V., Priftis, K. N., & Douros, K. (2018, August). Interventions on Adherence to Treatment in Children With Severe Asthma: A Systematic Review. *Frontiers in Pediatrics*, *6*(232), 1-8. https://doi.org/10.3389/fped.2018.00232

Center for Disease Control and Prevention. (2017). https://www.cdc.gov/nchs/fastats/asthma.htm

Centers for Disease Control and Prevention. (2018, February 9). Vital Signs: Asthma in Children - United States, 2001-2016. *Morbidity and Mortality Weekly Report*, *67*. Retrieved from https://www.cdc.gov/mmwr/volumes/67/wr/mm6705e1.htm?s_cid=mm6705e1_w

Cincinnati Children's . (2017, April). *Cognitive Development*. Retrieved from https://www.cincinnatichildrens.org/health/c/cognitive

Klok, T., Kaptein, A., & Brand, P. L. (2015). Non-adherence in children with asthma reviewed: The need for improvement of asthma care and medical education. *Pediatric Allergy and Immunology*, *26*, 197-205. https://doi.org/10.1111/pai.12362

Nurmagambetov, T., Kuwahara, R., & Garbe, P. (2017). The Economic Burden of Asthma in the United States, 2008–2013. *Annuals of the American Thoracic Society*, *15*. Retrieved from https://www.atsjournals.org/doi/abs/10.1513/AnnalsATS.201703-259OC

Pertzborn, M. C., Prabhakaran, S., Hardy, A., Baker, D., Robinson, M. A., & Hendeles, L. (2018, September). Direct Observed Therapy of Inhaled Corticosteroids for Asthma at School or Daycare. *Pediatric Allergy, Immunology, and Pulmonology*, *31*, 226-229. https://doi.org/10.1089/ped.2018.0912

Poowuttikul, P., Hart, B., Thomas, R., & Secord, E. (2017). Poor Adherence With Medication Refill and Medical Supplies Maintenance as Risk Factors for Inpatient Asthma Admission in Children. *Global Pediatric Health*, *4*(), 1-5. https://doi.org/10.1177/2333794X17710588

Sonney, J., Segrin, C., & Kolstad, T. (2018). Parent- and Child-Reported Asthma Responsibility in School-Age Children: Examining Agreement, Disagreement, and Family Functioning. *Journal of Pediatric Health Care*, *000*(000), 1-8. https://doi.org/doi.org/10.1016/j.pedhc.2018.11.005

Stanojevic, S., Wade, A., Stocks, J., Hankinson, J., Coates, A. L., Pan, H., . . . Cole, T. J. (2008, February). Reference Ranges for Spirometry Across All Ages. *American Journal of Respiratory and Critical Care Medicine, 77*(3), 1-8. doi:10.1164/rccm.200708-1248OC

Statista. (2019). https://www.statista.com/statistics/330695/number-of-smartphone-users-worldwide/

University of Louisville Physicians Pediatric Pulmonology. (2013). www.uoflphysicians.com/pediatric-pulmonology

## List of Tables

**Table 1.** Percentage of ED visits, hospitalizations, and oral steroids courses

| | Pre-intervention (n=27) n (%) | Post-intervention (n=13) n (%) | *p* |
|---|---|---|---|
| ED visit | | | |
| Yes | 8 (29.6%) | 1 (7.7%) | *p=.226* |
| No | 19 (70.4%) | 12 (92.3%) | |
| Hospitalization | | | |
| Yes | 6 (22.2%) | 1 (7.7%) | *p=.393* |
| No | 21 (77.8%) | 12 (92.3%) | |
| Oral Steroids | | | |
| Yes | 11(40.7%) | 4 (30.8%) | *p=.730* |
| No | 16 (59.3) | 9 (69.2%) | |

**Table 2.** Average number of missed ICS and rescue inhaler doses

| | Time | N | Mean | *p* |
|---|---|---|---|---|
| Missed ICS | Pre-intervention | 27 | 1.70 | |
| | Post-intervention | 13 | .31 | *p=.002* |
| Rescue Use | Pre-intervention | 27 | 1.89 | |
| | Post-intervention | 13 | 1.08 | *p=.254* |

**Table 3.** Average FEV 1%

| | Time | N | Mean | *p* |
|---|---|---|---|---|
| FEV 1% | Pre-intervention | 27 | 82.11 | |
| | Post-intervention | 13 | 86.92 | *p=.327* |

**Appendix A. Measures and Instruments**

| Measures | Description | Level of Measurement | Data Source |
|---|---|---|---|
| Demographics | | | |
| Age | Age in years | Interval/Ratio | Medical Records |
| Diagnosis/Medication Information | | | |
| Severity of Asthma | Mild, moderate, severe persistent asthma diagnosis | Nominal | Medical Records |
| Inhaled Corticosteroid (ICS) | Specific ICS prescribed to patient | Nominal | Medical Records |
| Rescue Inhaler | Specific rescue inhaler prescribed to patient | Nominal | Medical Records |
| Outcome | | | |
| Daily ICS use | How often patient/family remember to take daily ICS per month | Interval/Ratio | Asthma medication pre and post-intervention survey |
| Rescue Inhaler use | Number of times rescue inhaler used over a 4-month period | Interval/Ratio | Asthma medication pre and post-intervention survey |
| Hospital Admissions | Number of times patient was admitted to hospital for breathing problems during 4-month period | Interval/Ratio | Asthma medication pre and post-intervention survey |
| Emergency Department visits | Number of times patient visited ED during 4-month period for breathing problems | Interval/Ratio | Asthma mediation pre and post-intervention survey |
| Oral steroid needs | Number of times patient needed oral steroids in a 4-month period | Interval/Ratio | Asthma medication pre and post-intervention survey |
| Pulmonary Function tests (PFT) | Whether PFTs were improved, decreased, or stayed the same from initial appointment to final appointment. | Nominal | Medical Records |

| | | | |
|---|---|---|---|
| Usefulness of the asthma medication chart | Whether or not the asthma medication chart was useful for helping patients remember to take their daily ICS | Nominal | Asthma medication post-intervention survey |

**Appendix B. Asthma Survey**

1. How many days do you use your inhaled corticosteroid per week? _______
2. How many times have you needed to use your rescue inhaler in the last week? ______
3. Have you had to visit the Emergency Department for breathing problems over the last 4 months? Yes or No
   a. If yes, how many times? ______
4. Have you had to be hospitalized for breathing problems over the last 4 months? Yes or No
   a. If yes, how many times? ______
5. Have you needed oral steroids for breathing problems over the last 4 months? Yes or No
   a. If yes, how many times? ______
6. *Post-survey only* Did you feel the medication chart was helpful for remembering to take your inhaled corticosteroid daily? Yes or No

Comments:

______________________________________________________________________
______________________________________________________________________
______________________________________________________________________
______________________________________________________________________
______________________________________________________________________

**Appendix C. Asthma Medication Chart**

| | Sunday | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday |
|---|---|---|---|---|---|---|---|
| *Inhaled Corticosteroid name & dosage* | | | | | | | |

<u>Weeks completed</u>

| | | | |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |

<u>Rescue Inhaler Used</u>

**Appendix D. Recruitment Flyer**

# Does your child have asthma?

**LOOKING FOR CHILDREN WITH ASTHMA TO PARTICIPATE IN A RESEARCH STUDY**

**Cost to participate is $0. You or your child will not be compensated for participating.**

**KEY INFORMATION**

**Your child may qualify if he/she:**

**-Age 6-11 years**
**-Asthma diagnosis**
**-Prescribed an inhaled steroid**
**-Lives in Kentucky**

University of Kentucky, Department of Nursing

powered by PIKTOCHART