CLINICAL INVESTIGATION

A Retrospective Study Evaluating the Effectiveness of an Asthma Clinical Pathway in Pediatric Inpatient Practice

Elisa Edwards, PharmD and Kristie Fox, PharmD

Department of Pharmacy, Wolfson Children's Hospital, Baptist Health, Jacksonville, Florida

OBJECTIVE To determine if the asthma clinical pathway implemented at Wolfson Children's Hospital reduces the length of hospital stay. To determine if pathway use affected the use of asthma education, the use of appropriate discharge medications based on asthma classification, and readmission rates.

METHODS A list of patients aged 2 to 18 years discharged from Wolfson Children's Hospital between September 1, 2004 and August 31, 2006 with the diagnosis of asthma was generated. Medical records of eligible patients were reviewed for demographic information, asthma pathway use, duration of hospital stay in days, readmission rates, receipt of asthma education, and medications prescribed upon discharge. Patients placed on the asthma clinical pathway were compared to a control group with asthma who were matched based on age and discharge date. Length of stay was averaged for each group. Asthma education, discharge medications, and readmission rates were compared between the two groups.

RESULTS Forty-three patients placed on the asthma clinical pathway were compared to a 43 patients in the control group that were matched for age and discharge date. Use of the asthma clinical pathway reduced hospital stay by 0.372 days (P = .0373). Receipt of asthma education (P = .3864), the use of appropriate drug therapy prescribed upon discharge (P = .1398), and readmission rates (P = .5486) were unaffected by pathway use.

CONCLUSIONS The asthma clinical pathway used at Wolfson Children's Hospital reduces length of hospital stay, but has no bearing on receipt of asthma education, use of appropriate drug therapy upon discharge, or readmission rates.

KEYWORDS asthma, clinical pathway, medication education, pediatrics

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INTRODUCTION

As of 2005, asthma was estimated to affect 6.5 million children in the United States.[1] It is the most common chronic disease of childhood and accounts for about 190,000 pediatric hospitalizations yearly in the United States, making asthma is the leading cause of pediatric hospitalizations.[1,2]

Address correspondence to: Elisa Edwards, PharmD, Pediatric Clinical Pharmacist, Department of Pharmacy, 800 Prudential Drive, Jacksonville, FL 32207, email: elisa.edwards@bmcjax.com

Asthma clinical pathways are defined as "the optimal sequencing and timing of interventions by physicians, nurses, and other staff for a particular diagnosis or procedure, designed to minimize delays and the use of resources, and to provide the best possible care."[3] They are evidence-based, typically developed by a multidisciplinary team and are aimed at improving patient outcomes and costs.[4]

ABBREVIATIONS ED, emergency department; NAEPP, National Asthma Education and Prevention Program; PICU, pediatric intensive care unit; RR, respiratory rate

The use of asthma clinical pathways ef-

fectively reduces the length of hospital stay, improving asthma education, and reducing hospitalization costs associated with asthma.[2,3,5] Unfortunately, the use of these clinical pathways has not affected readmission rates or clinical outcomes such as prescribing controller medications, peak flow meter and spacer use, providing patient education, providing a written action plan, and scheduling follow-up appointments.[2,5]

The primary objective of this study was to determine if the asthma clinical pathway implemented at Wolfson Children's Hospital reduced the length of hospital stay. Secondary objectives included evaluating the use of asthma education, the use of appropriate discharge medications based on asthma classification, and readmission rates.

MATERIALS AND METHODS

In September 2005, Wolfson Children's Hospital, a private, 180 bed, not for profit teaching hospital, began hospital wide use of an asthma clinical pathway (Figure 1). The pathway was developed by a multidisciplinary team consisting of general and academic pediatricians, pediatric pulmonologists, nurses, respiratory therapists, pharmacists, and administrators and was based in part on the recommendations by Smith et al.[6] The goal of the pathway was to streamline care provided to patients who are admitted with asthma. Our institution admits an average of 280 patients for asthma exacerbations each year, and all physicians are encouraged to use the clinical pathway for any patient admitted with a diagnosis of asthma exacerbation, regardless of the patient's asthma classification. The only area that does not use the pathway is the pediatric intensive care unit, since patients requiring this level of care are typically placed on continuous albuterol rather than hourly treatments.

Prior to the implementation of the asthma clinical pathway, bronchodilator nebulized treatments (e.g., albuterol and levalbuterol) were started upon admission and tapered off at inconsistent intervals when a physician was able to assess the patient, and an order was provided to respiratory therapy. The implementation of the pathway has allowed for more standardized care with routine discharge counseling and follow-up. Using the pathway, patients received an initial assessment to include listing equipment used at home (e.g., nebulizer, inhaler, spacer, peak flow meter), home medications, trigger identification (e.g., pets, smoke, allergies), treatments tried prior to admission, past receipt of asthma education, and use of an asthma action plan. Physicians then ordered bronchodilator nebulized treatments based on patient weight. Based on physician judgment and the clinical severity of asthma, there were options for the addition of ipratropium bromide, intravenous and oral corticosteroids and intravenous fluids. Once ordered, the respiratory therapist was permitted to adjust the inhaled bronchodilator treatments as necessary, per the asthma pathway protocol based on a pulmonary score (Table 1). As the pulmonary score improved, the respiratory therapist was free to taper treatments without having to wait on physician assessment and approval. This has allowed for timelier adjustments of bronchodilator nebulized treatments and possibly shorter lengths of hospitalization. The pathway protocol also includes asthma education and standardized discharge instructions for each patient.

A retrospective chart review was conducted on patients discharged between September 1, 2004 and August 31, 2006. Children 2 to 18 years of age who were discharged from the hospital with the primary diagnosis of asthma were eligible for inclusion. Patients with an intensive care unit admission and patients discharged from the emergency department were excluded. This study was approved by the Baptist Health System Institutional Review Committee and informed consent was not required.

Medical records were reviewed for demographic data including age, race, gender, and pre-existing conditions. Patients placed on the asthma clinical pathway were constituted the study treatment group, and will be referred to as the clinical pathway group. The control group was randomly chosen from those patients who were not placed on the asthma clinical pathway. The control and clinical pathway groups were matched based on patient age. In order to control for seasonal variations between the two groups, groups were also matched for

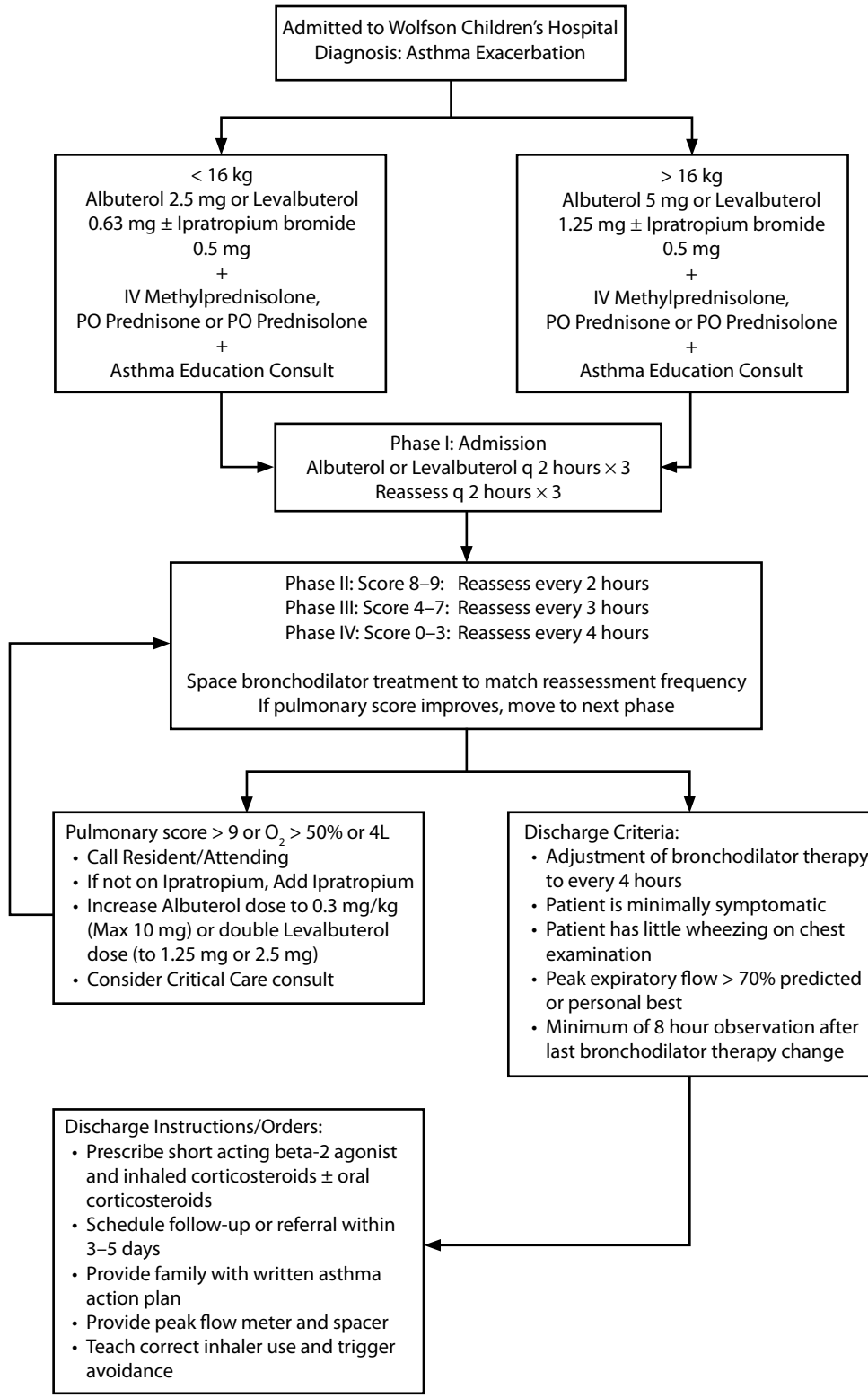

Figure 1. Algorithm of Asthma Clinical Pathway.

Table 1. Clinical Pathway Pulmonary Score and Phases

Score	RR 1-3 years old	RR ≥ 4 years old	Wheezing	Accessory Muscle Use	SpO_2
0	Less than 30	Less than 24	None	No apparent activity	> 94% without O_2
1	31-40	24-30	End expiratory	Mild intercostals	> 94% with O_2 ≤ 50% or 4L nasal cannula
2	41-50	31-40	Entire expiration and rare inspiration	Moderate intercostals and subcostal	90-93% with O_2 ≤ 50% or 4L nasal cannula
3	> 50	> 40	Inspiratory and expiratory wheeze and/or decreased air exchange	Severe intercostals, subcostal and supraclavicular	> 50% O_2 or 4L to keep sats > 90%

Phase I: Admission, reassess every 2 hrs
Phase II: Score 8-9, reassess every 2 hrs
Phase III: Score 4-7, reassess every 3 hrs
Phase IV: Score 0-3, reassess every 4 hrs

discharge date within the study period. For example, a 4 year old clinical pathway patient discharged in March 2006 would be matched to a 4 year old control patient discharged in March 2005.

Classification of asthma, discharge medications, admission orders including/excluding the use of the asthma pathway, chart documentation of asthma education (i.e., received/not received), number of days hospitalized, and readmission for asthma were factors noted in the study. Regardless of time since study enrollment, readmission rates were determined for patients readmitted for asthma during the period of September 1, 2004 to August 31, 2006. All hospital stays were rounded to the nearest full day and averaged for each group. Receipt of asthma education, appropriate prescribing of discharge medications, and readmission rates were compared between the two groups. Classification of asthma, based on National Asthma Education and Prevention Program (NAEPP) guidelines, was used in determining appropriate prescribing of discharge medications.

No clinical pathway patient or control patient was excluded from analysis. Demographic data and length of stay differences between groups were compared by using a paired t-test. Receipt of asthma education, appropriate prescribing of discharge medications per current NAEPP guidelines, and readmission rate differences between groups were compared by using the Fisher's exact test. All tests were two-tailed, and a P value of ≤ .05 was considered statistically significant.

RESULTS

During the study period, 380 patients were discharged from our institution with the diagnosis of asthma, with 223 patients meeting the inclusion criteria. The primary reason for exclusion was admission with asthma as the secondary admitting diagnosis. Other reasons for exclusion included admission to or intensive care unit stay during admission, and patients falling outside of the age range of the study. Only 43 patients who met the inclusion criteria had been placed on the asthma clinical pathway. A 43 patient control group was derived from patients meeting inclusion criteria but not placed on the asthma clinical pathway.

Demographic information for both groups can be found in Table 2. No statistically significant differences were observed between groups. Asthma classification was documented for 30 of the 43 clinical pathway patients and 20 of the 43 control patients. Patients were classified based on NAEPP guidelines and/or physician judgment at the time of admission (Table 3). No attempt was made to determine asthma classification based on chart data for those patients without asthma classification documentation. Of the 30 clinical pathway patients, 12 were classified as mild intermittent, 6 as mild persistent, 9 as moderate persistent, and 3 with

Table 2. Patient demographics

	Clinical Pathway Group (n = 43)	Control Group (n = 43)	P Value
Age, yrs	6.93 ± 3.69*	6.93 ± 3.69*	1.0000
Race (%)			
Caucasian	17 (39.5)	23 (53.5)	0.2797
African-American	18 (41.9)	17 (39.5)	1.0000
Hispanic	4 (9.3)	0 (0)	0.1162
Other	4 (9.3)	3 (7)	1.0000
Gender (%)			
Male	27 (62.8)	30 (69.8)	0.6487
Female	16 (37.2)	13 (30.2)	0.6487
Pre-existing Conditions (%)			
Asthma	31 (72)	33 (76.7)	0.8052
Wheezing/cough	4 (9.3)	4 (9.3)	1.0000
Bronchitis	3 (6.9)	2 (4.6)	1.0000
Eczema	8 (18.6)	3 (6.9)	0.1951
Allergies	9 (20.9)	7 (16.3)	0.7825

**mean ± SD*

severe persistent. Of the 20 control patients, 10 were classified as mild intermittent, 5 as mild persistent, 4 as moderate persistent, and 1 as severe persistent. Based on classification, 15 of the 30 clinical pathway patients were discharged with appropriate therapy compared with 15 of the 20 control patients (P = .1398).

Results for length of stay are depicted in Figure 2. Length of stay for clinical pathway patients was 2.33 ± 1.06 days (range 1 to 6 days) with an average stay of 2.33 days. Length of stay for control patients was 2.7 ± 1.06 days (range 1 to 7 days) with an average stay of 2.70 days. Use of the asthma clinical pathway reduced length of hospital stay by 0.372 days (P = .0373; 95% confidence interval 0.02 to 0.72).

Of the 43 patients in the clinical pathway group, 22 had medical record documentation that asthma education had been given compared with 17 out of the 43 patients in the control group (P = .3864). Documentation included, progress note written by either the certified asthma educators or nurses, detailing the education received, or education signed off as given on the "Family Centered Education Given" sheet. Patients lacking any of these documentations were considered to have not been educated.

A total of 13 readmissions involving 11 patients occurred during the study period. In the clinical pathway group, 5 readmissions occurred compared with 8 readmissions in the control group (P = .5486). In the clinical pathway group, 2 patients were readmitted but were not placed on the asthma clinical pathway upon readmission. In the control group, 1 patient was readmitted twice, but neither readmission involved use of the asthma clinical pathway.

DISCUSSION

This study has shown that use of an inpatient asthma clinical pathway can decrease length of hospital stay. Unfortunately this study failed to show improved quality of care, such as increased receipt of asthma education, appropriate prescribing of discharge medications based on asthma classification, or a reduced readmission rate.

The asthma clinical pathway in place at our institution is similar to other clinical pathways described in the literature.[3,4,7] Patients are placed in "phases or levels" on the clinical pathway based on a "score" to help guide treatment.[3,5] In addition to including guidelines on intensification of treatment, the pathway also includes diagnostic evaluations that should be included in the patient assessment, guidelines for referral to an asthma specialist, discharge criteria, and discharge instructions/orders (Figure 1). The discharge instructions/orders

Table 3. Use of appropriate discharge therapy based on asthma classification

Asthma Classification	Clinical Pathway Group (n = 30)	Control Group (n = 20)
Mild Intermittent	6/12 (50%)	10/10 (100%)
Mild Persistent	4/6 (67%)	3/5 (60%)
Moderate Persistent	5/9 (56%)	1/4 (25%)
Severe Persistent	0/3 (0%)	1/1 (100%)

help remind the physician to prescribe a short acting beta-2-agonist and oral corticosteroids, schedule adequate follow-up, provide the patient/caregiver with a written asthma action plan (Figure 3), provide a peak flow meter and spacer, and provide teaching on correct inhaler technique and trigger avoidance. It does not remind the physician about adequate controller therapy based on asthma classification as recommended by current NAEPP practice guidelines.[8]

Other studies have documented significant decreases in length of stay as well as cost with improved clinical outcomes.[3,4,6] Our results are consistent with the current literature. Our study looked at length of differences in hospital stays, receipt of education, prescribing of appropriate discharge medications based on asthma classification, and readmission rates. Further study is needed to determine if costs are decreased with the use of the clinical pathway.

Kelly et al. showed a statistically significant decrease in length of stay in the clinical pathway group when compared to the control group during a 4-month prospective study.[3] The pathway group stayed 35 hours less than the control group. They also showed a significant cost savings of $1,144 in the pathway group. Other significant findings included a 47% increase in completion of asthma education, a 35% increase in discharge with appropriate controller medication, and 34% and 29% increases in the availability of peak flow meters and spacer devices respectively in the pathway group. Intensive Care Unit admissions were excluded as well. Readmission rate was determined based on review of hospital records 72 hours after discharge rather than during the entire study period.

Wazeka et al. conducted a retrospective, nonrandomized, controlled trial covering a three year period.[4] They also found a significant reduction in length of stay for the clinical pathway group. The pathway group had a reduction in stay by 1.5 days when compared to the control group. This study also evaluated costs, which decreased by $600,000 in the pathway group. Intensive Care Unit admissions were included in the study. Readmission rate was determined based on a prospective follow-up study. Patients and parents were called 2 weeks after discharge to determine if a readmission had occurred. Clinical outcomes such as receipt of asthma education or appropriate discharge therapy were not addressed.

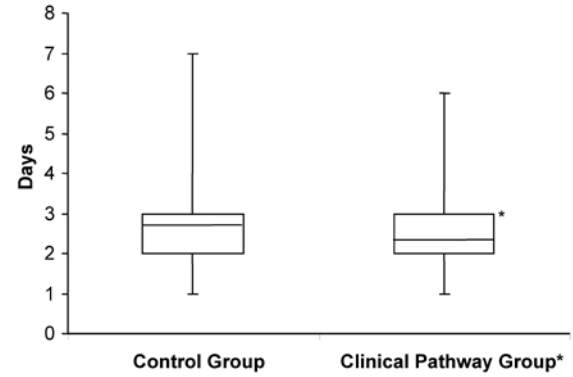

Figure 2. Average length of hospital stay. The first and third quartiles are represented at the ends of each box, the mean is indicated by the line in the interior of the box, and the maximum and minimums for each group are at the ends of the whiskers.
*P = .0373

Johnson et al. conducted a prospective, randomized, controlled trial showing a decreased length of stay by 13 hours in the clinical pathway group when compared to the control group.[6] There was a decrease in room, laboratory and medication administration charges observed for the pathway group. Again, Intensive Care Unit admissions were excluded. Readmission rates were not evaluated, instead patients were followed for 2 weeks after discharge to determine if a health care provider was seen for "worsening asthma."

Unlike the previously mentioned studies,

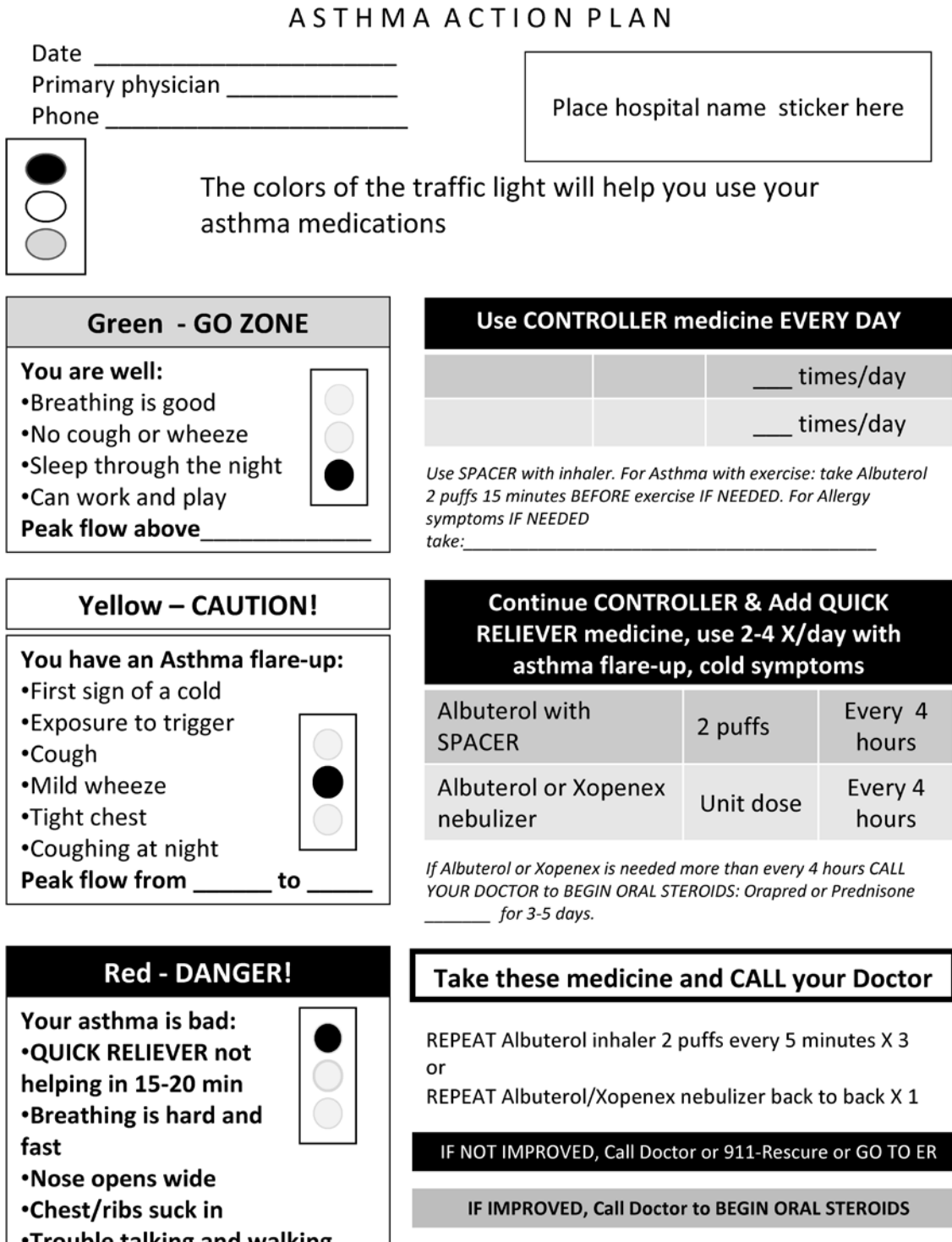

Figure 3. Written Asthma Action Plan.

a retrospective study by Kwan-Get et al. did not show a significant difference in length of stay between the clinical pathway group and the control group.[9] This finding can be due to several factors. For instance, the average length of stay prior to pathway implementation was only 2 days. Another factor could be the study design itself. Due to its retrospective design, the authors acknowledge that the clinical severity of asthma for each child was not determined during the study; therefore, the pathway could have affected length of stay, but the results may have been masked. There were no significant differences observed when comparing total charges either. They did show a significant reduction in average laboratory charges and radiology services. Unfortunately we did not design our study to evaluate these factors and it would be beneficial to include these factors in future research.

There are some limitations to our study. First, it was a retrospective chart review limiting the availability of data to what was written in the chart. There was inconsistent documentation regarding receipt of asthma education and asthma classification. During the study period, there was inconsistent availability of a certified asthma educator onsite at the hospital, which required nurses to provide asthma education in place of the asthma educator prior to discharge. However, if the asthma educator was unable to educate patients prior to discharge, he or she would keep track of all asthmatic patients discharged and attempt to make contact via phone to provide education or follow-up. Unfortunately, since this contact occurred after discharge, follow-up was not reflected in the medical record at the time of chart review and was therefore excluded from our analysis. It was also noticed that receipt of education was documented differently in the medical record by nurses versus the asthma educator; hence, more patients may have received asthma education than properly documented during the medical chart review.

Second, as previously stated, asthma classification was available for only 58% of the patients meeting inclusion criteria. While it is recommended and encouraged for all physicians to determine and record asthma classification on each patient, it was noted that resident physicians documented classification more often than attending physicians. Since resident physicians are not solely responsible for providing care to all admitted patients, this could account for the 42% of patients with undocumented asthma classifications.

Finally, the study was further limited by a small sample size. The asthma clinical pathway is not used by all admitting physicians though its use is recommended, it is not required. We had anticipated greater use of the pathway, allowing for a larger sample size. We hope to increase use by educating all physicians on the availability of the asthma clinical pathway. Perhaps with increased use, we will be able to show a difference in receipt of asthma education, appropriate prescribing of medications upon discharge, and a difference in readmission rates.

CONCLUSION

The asthma clinical pathway currently used at out hospital shows promise. Based on this study, the asthma pathway is not widely used in our hospital. Despite the low usage, this study was able to show pathway use resulted in a decrease in length of stay. We hope to increase pathway use through education of medical residents, general practice and academic pediatricians, and private practitioners on the availability of the asthma clinical pathway. Additional studies of larger groups are needed to further evaluate the hypothesis of increased use of the asthma clinical pathway can affect receipt of asthma education, usage of appropriate discharge medications, and readmission rates.

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