

Implementation of the Asthma Control Test in Primary Care to Improve Patient Outcomes

Nancy Cantey Banasiak, DNP, PPCNP-BC, APRN

ABSTRACT

Background: Asthma is one of the major chronic diseases in the pediatric population, affecting 9.5% of children. The National Heart, Lung, and Blood Institute recommends the use of the Asthma Control Test (ACT) for periodic assessment of asthma control. The purpose of this evidence-based project was to implement the Asthma Control Test screening tool into the primary care practice to improve management of patients with asthma by more accurately addressing asthma control.

Methods: The project was a pre- and post-implementation study comparing two different groups of patients with asthma seen at the clinic over 5-week periods.

Results: After the implementation of the educational program and project, 82.6% of advanced practice registered nurses and 30.7% of pediatric resident physicians used an Asthma Control Test, resulting in identification of 9 (21%) patients who were considered not well-controlled. All (100%) of those children identified as not well-controlled through the Asthma Control Test received an adjustment in their medication therapy.

Conclusions: The Childhood ACT and ACT are simple, self-administered, validated questionnaires that can easily be incorporated into a primary care practice to assess the level of asthma control and to identify patients with asthma that is not well controlled. *J Pediatr Health Care.* (2018) XX, 1–9

KEYWORDS

Asthma, asthma control test, evidence-based project, pediatric, pediatric nurse practitioner, primary care

INTRODUCTION

Asthma is a major public health concern and, despite advancements in diagnosis and treatment, the burden of asthma has increased. Pediatric asthma is one of the most common chronic diseases, affecting 9.5% of children in the United States, or 7.1 million children, an increase from 8.7% in 2001 (Bloom, Jones, & Freeman, 2013; Centers for Disease Control and Prevention [CDC], 2014a; Loftus & Wise, 2016; Pearson, Goates, Harrykissoon, & Miller, 2014). The highest prevalence of asthma occurs among non-Hispanic Black (16%), mixed race (14.1%), and Hispanic (8.5%) children living below the poverty level (13%) compared with non-Hispanic White children (7.6%; Akinbami et al., 2012; CDC, 2014a; Loftus & Wise, 2016). In 2014, 187 children died from asthma in the United States (CDC, 2014a). The economic burden of asthma is significant, and the estimated costs are \$56 billion per year, or \$3,259 per person (CDC, 2014a). Asthma is the leading cause of school absenteeism, with 13.8 million missed days; accounts for more than 600,000 visits yearly to the emergency department; and is the third leading cause of hospitalization in children (Akinbami, Moorman, Garbe, & Sondik, 2009; CDC, 2014a; Loftus & Wise, 2016).

Scope of the Problem

Asthma is a variable disease that can affect individuals differently, and treatment needs to be altered as warranted (Global Initiative for Asthma [GINA], 2017; National Heart, Lung and Blood Institute [NHLBI], 2007). Uncontrolled asthma in the pediatric population continues to be a concern even with improved treatment options (Dombkowski, Hassan, Wasilevich, & Clark, 2010; NHLBI, 2007; Schifano,

Nancy Cantey Banasiak, Associate Professor, Yale University School of Nursing, West Haven, CT.

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Correspondence: Nancy Cantey Banasiak, Associate Professor, Yale University School of Nursing, P.O. Box 27399, West Haven, CT 06516; e-mail: nancy.banasiak@yale.edu

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Hollenbach, & Cloutier, 2014). As defined by the NHLBI, asthma control is “the degree to which the manifestations of asthma (symptoms, functional impairments, and risks of untoward events) are minimized and the goals of therapy are met.” (NHLBI, 2007, p. 36). After treatment has been initiated, asthma control is measured by the number of daytime and nighttime awakenings due to cough, the number of days requiring short-acting beta agonist (SABA; i.e., albuterol) for symptom relief, pulmonary function testing in children older than 5 years, and any limitations of daily activity (NHLBI, 2007). The NHLBI also recommends the assessment of risk for future exacerbations and the progressive loss of lung function, minimizing emergency department visits and hospitalizations, and optimizing medications with minimal or no adverse effects (NHLBI, 2007). Periodic assessment of control is recommended with a careful history of the symptoms of asthma, pulmonary function testing, quality of life, history of asthma exacerbations, medication use, and patient satisfaction with therapy (NHLBI, 2007). The most current national asthma expert panel and the GINA guidelines both recommend the use of a standardized self-assessment questionnaire to help determine the patient and/or family’s assessment of control (NHLBI, 2007). For the purpose of this study, the Childhood Asthma Control Test (C-ACT; for children ages 4–11 years) and the Asthma Control Test (ACT; for children age 12 years and older) were chosen because they are self-administered, validated tools used to assess the patient and/or parent’s viewpoint of the asthma symptoms and because they give the provider a reference point for controlled or not controlled asthma (Deschildre et al., 2014; GINA, 2017; NHLBI, 2007). The NHLBI (2007) defines *well-controlled asthma* with a score of 20 or greater, *not-well-controlled asthma* with a score from 16 to 19, and *very poorly controlled asthma* with a score of 15 or lower.

Study Purpose

The purpose of this evidence-based project was to implement the C-ACT or the ACT screening tools into the primary care practice to improve management of patients with asthma by more accurately addressing asthma control. The anticipated outcomes of this project were improved identification of asthma control from the patient and/or family’s perspective in accordance with the national guidelines and optimization of asthma management based on the level of control.

The aims and objectives of this project were as follows.

- To develop and implement an educational program for the providers and nursing staff at the primary care center to increase their knowledge about the C-ACT and the ACT.
- To increase compliance with the use of either the validated C-ACT or the ACT during well-child and asthma visits.
- To prompt providers to adjust asthma treatment based on the C-ACT or ACT score as recommended by the national guidelines.

Evidence-Based Practice Framework

The Iowa Model was chosen for this project because the clearly defined steps are easy to follow, allowed for a pilot of the practice change, and provided evaluation of the change before instituting the change throughout the system (Iowa Model Collaborative, 2017). The Iowa Model Revised: Evidence-Based Practice to Promote Excellence in Health Care was recently revised to improve piloting of the project and sustainability of the project (Iowa Model Collaborative, 2017). The model continues to be a multistep process to put research into practice (Iowa Model Collaborative, 2017). The framework is used to guide the identification of triggering issues or opportunities and state the question or purpose of the evidence-based practice (EBP) change to improve care (Iowa Model Collaborative, 2017). The organization needs to recognize the identified problem as a priority, and a multidisciplinary team needs to be selected. Review of the literature is performed to identify whether a practice change is reasonable based on the research. If sufficient evidence is found, a pilot of the practice change is performed followed by an evaluation. The process has multiple phases to evaluate and modify based on evaluation data (Iowa Model Collaborative, 2017).

Review of the Literature

The NHLBI expert panel (2007) and GINA (2017) both recommend periodic assessment of control by either an asthma diary or a self-report questionnaire. Despite the national asthma guidelines, patients continue to be underdiagnosed and undertreated and fail to achieve asthma control (Barnes, Casale, Dahl, Pavord, & Wechsler, 2014; Schifano et al., 2014). The current research recognizes the importance of identifying patients with uncontrolled asthma (Voorend-van Bergen, Vaessen-Verberne, de Jongste, & Pijnenburg, 2015). Research has suggested that patients, parents, and providers overestimate asthma control and that this is a major factor contributing to failure of successful management of asthma (Carroll, Wildhaber, & Brand, 2012; duRivage et al., 2017; Garbutt et al., 2007; Shefer et al., 2014; Voorend-van Bergen et al., 2015; Voorend-van Bergen et al., 2013). A study by Hammer et al. (2008) examined level of asthma control and possible reasons for uncontrolled asthma. They suggested that children were unable to perceive differences in airway obstruction, symptoms, and control and underestimated the severity of asthma or the variation of the disease over time (Hammer et al., 2008).

The International Primary Care Respiratory Group identified reasons for poorly controlled asthma including the wrong diagnoses of asthma; poor inhaler technique; exposure to smoke; comorbid conditions, especially allergic rhinitis; responses to medication that can vary in individuals; and altered patient belief and adherence (Haughney et al., 2008).

A self-reported survey of pediatricians found that most were familiar (48%, very familiar; 48%, somewhat familiar) with the national guidelines but that only 19% reported spirometry use, 63% reviewed asthma action plans, 86% of asked about daytime asthma symptoms, 83% asked about

nighttime symptoms, 58% asked about missed days from school, and 41% observed inhaler technique (Garbutt et al., 2007). The researchers recommended opportunities for improvement of asthma control by using brief questionnaires to avoid missing key components of evaluating asthma control, medication adherence, regular monitoring of asthma control, goal setting with patients and families, and self-management techniques (Garbutt et al., 2007). Delayed diagnosis and treatment can result in altered lung function (Dombkowski et al., 2010; Schifano et al., 2014). Poorly controlled asthma can affect quality of life of both the patient and family (Molzon et al., 2013).

Asthma Control Tools

Nathan et al. (2004) recognized the importance of asthma control and developed the ACT to identify patients age 12 years and older with uncontrolled asthma (2004). The purpose was to create a short questionnaire that mirrors the complex nature of asthma control, is reliable and valid, and is simple to use in practice (Nathan et al., 2004). Through a regression analysis, five items were selected from the 22-item survey with an internal consistency reliability of 0.84 (Nathan et al., 2004).

The C-ACT was developed to assess asthma control in children ages 4 to 11 years (Liu et al., 2007). The purpose of the C-ACT was to assess asthma control in the clinic or at home, by using input from both the parent and child, in an easily administered questionnaire (Liu et al., 2007). Through a cross-sectional nonrandomized study, seven items were selected with a score of 19 or less indicating uncontrolled asthma with a specificity of 74% and sensitivity of 68% (Liu et al., 2007).

Several studies have suggested different scores for not-well-controlled asthma (Deschildre et al., 2014; Ito et al., 2011; Voorend-van Bergen et al., 2014). In 2011, Ito et al. suggested that a cutoff score of 23 for the C-ACT would be valuable in identifying children who had well-controlled asthma and had normal lung function (Ito et al., 2011). Another study suggested that the optimal C-ACT score was less than or equal to 21 according to the GINA guidelines (sensitivity = 76%, specificity = 81.5%), NHLBI (sensitivity = 81%, specificity = 70%), and physician assessment (sensitivity = 71.5%, specificity = 83%; Deschildre et al., 2014). The researchers also recommended the use of the C-ACT as a supplemental tool for assessment that it should be performed at every visit (Deschildre et al., 2014). A study by Voorend-van Bergen et al (2014) suggested the best cutoff scores for well-controlled asthma 22 or greater for the C-ACT and 23 or greater for the ACT (Voorend-van Bergen et al., 2014).

Three levels of control were identified in the new asthma guidelines: well controlled, not well controlled, and very poorly controlled (NHLBI, 2007). In accordance with the new asthma guidelines and to better identify patients with poorly controlled asthma, Liu et al. (2010b) identified an additional score of 12 or less as indicative of poorly controlled asthma (Liu et al., 2010b). Children with poorly

controlled asthma are at high risk for poor outcomes, including increased emergency department visits, hospitalizations, and missed days from school (Liu et al., 2010b).

METHODS

This quality improvement project was a pre- and post-implementation study comparing two separate groups of patients with asthma treated over two discrete 5-week periods. A retrospective chart review was conducted on the same 5-week period in 2016 (pre-intervention) and 2017 (post-intervention).

After receiving support from the medical director of the primary care center and approval from the institutional review board at both the university and hospital, the pilot study was implemented.

Practice Setting/Population

Participants in this quality improvement project were a convenience sample of children, ages 4 to 14 years of age, with provider diagnosis of asthma as defined by the NHLBI and GINA, seen in the primary care center at a hospital in the Northeastern United States for either well-child care or an asthma visit. Patients were excluded from this study if they were in foster care, parents were unable to read and communicate in English or Spanish, or the child was younger than 4 years old. Adolescents older than 14 years were also excluded because they transition to the adolescent clinic for care.

Intervention

Educational changes

An educational intervention was developed by the investigator in consultation with an attending pediatrician for the providers (resident physicians and advanced practice registered nurses [APRNs]) and nursing staff to ensure that they understood the importance of the assessment of asthma control using the C-ACT or ACT questionnaires. The content for the educational program was based on the national asthma and GINA guidelines (GINA, 2017; NHLBI, 2007).

Systematic changes

Before a clinical session began, upon review of individual charts, each provider was asked to make a notation of "AA" in the note section of the electronic medical record (EMR) of children with a diagnosis of asthma. This notation alerted the administrative assistant to distribute an English or Spanish validated asthma control questionnaire to the guardian of each child with provider-diagnosed asthma after registration at the front desk of the primary care center. Questionnaire forms were also available in each hallway in case the questionnaire was not handed out to the patient or caregiver in the waiting room. After the patient and/or guardian completed the questionnaire, the provider reviewed and scored the responses in the examination room to determine the status of the patient's asthma control and entered the results into the EMR.

Instruments

The ACT and the C-ACT are reliable, validated, self-administered tools for children 4 to 11 years old (C-ACT) and children age 12 years and older (ACT) to assess asthma control (Liu et al., 2007; NHLBI, 2007; Schatz et al., 2006). Both questionnaires were developed to determine asthma control by focusing on symptoms reported by the child (ACT) and child and parent/guardian (C-ACT). The questionnaires take about 5 minutes for the parent/guardian and/or child to complete. The parents/guardians and children ages 4 to 11 years completed the C-ACT. The C-ACT (available at <https://www.gsksource.com/pharma/content/dam/GlaxoSmithKline/US/en/Common/gsksource/PatientEducation/DiseaseState/Asthma/604601R0.pdf>) is a seven-item questionnaire evaluating the effect of asthma and frequency of asthma symptoms for the previous 4 weeks and is divided into two sections. The child answers the first four questions with the guide of a visual scale assessing his/her asthma today, limitations with activities, coughing, and nighttime symptoms from asthma using a 4-point Likert scale (0 = *very bad*; 3 = *very good*; Lui et al., 2007). The parent/guardian answers the last three questions about daytime and nighttime symptoms. The answers are based on a Likert scale of 5 points (0 = *every day*; 5 = *not at all*; Lui et al., 2007). The parent/guardian and the child scores are added together. The score ranges between 0 and 27, with score of less than 20 indicating not—well-controlled asthma and a score less than 12 poorly controlled (Liu et al., 2007). Children 12 years and older completed the ACT (available at https://www.asthma.com/content/dam/NA_Pharma/Country/US/Unbranded/Consumer/Common/Images/MPY/documents/816207R0_asthmacontroltest_printable.pdf). The questionnaire consists of five questions focusing on the recall of the patient for the previous 4 weeks evaluating symptoms including how asthma interfered with work, school, or at home; wheezing; shortness of breath; awakenings at night due to cough, shortness of breath, or chest tightness; use of rescue inhaler; and how patients rate their asthma (Nathan et al., 2004). The score is based on a 5-point Likert scale with 1 being *all the time* to 5 being *not at all*. Score of 19 or less indicates not—well-controlled asthma (Nathan et al., 2004; Schatz et al., 2006). The validity of the ACT and C-ACT have been well documented (Leung et al., 2009; Liu et al., 2007; Nathan et al., 2004; Schatz et al., 2006). A score of less than 20 identifies patients with asthma that is not well controlled with 74% sensitivity and 68% specificity (Liu et al., 2007). As recommended by the national guidelines and for the purpose of this project, a score of less than 20 was considered not—well-controlled asthma (NHLBI, 2007).

Permission to use both the ACT and C-ACT was obtained from GlaxoSmithKline after a brief request form was completed online.

Evaluation

The hospital's EMRs for both groups were reviewed. Demographic and clinical data were retrieved and entered

on the data collection form including age, sex, race, asthma classification, asthma medications, comorbid conditions, if an asthma specialist was consulted, and spirometry results if completed. The recorded data also included how providers assessed for asthma control with questions related to clinical symptoms and/or the use of a questionnaire including the use of the C-ACT or ACT. The C-ACT or ACT score (if completed) and any change in therapy with a score of less than 20 was also documented. All data were entered into an Excel spreadsheet and reviewed. Patients meeting the exclusion criteria as described were excluded from the study.

RESULTS

Process Outcomes

Formal education for the residents was completed, with 28 (52%) of the 54 resident physicians reviewing the presentation. The same 30-minute education program was presented to the nursing staff and APRNs during their noon staff meeting. Three of the APRNs (75%) and five registered nurses/licensed practical nurses (72%) attended the session. The researcher met individually with all providers as they started their rotations in the clinic to answer any questions regarding the study, procedure, or questionnaires. A copy of the PowerPoint presentation was e-mailed to all the providers/staff. In March 2017, a separate in-service was also provided to all the administrative staff ($n=4$) regarding appropriate distribution of the questionnaires.

In the month after implementation of the educational program to the provider staff, a retrospective chart review was conducted, reviewing the EMRs of children seen before implementation (April 1–May 6, 2016) and after implementation (April 3–May 5, 2017). All patients with a diagnosis of asthma on their problem list seen for either a well-child or asthma follow-up visit and who met the other inclusion criteria were included in this pilot study.

This yielded two groups: 101 patients in the pre-implementation group and 98 patients in the post-intervention group. Patients meeting the exclusionary criteria were removed from any additional analysis.

Demographic Findings

The number of patients contained in the pre-intervention group was 101, including 49 (48.5%) females and 52 (51.5%) males (Table 1). The children ranged in age from 4 to 14 years, with a mean of 7.48 years. The post-intervention group included 98 patients, 43 (43.9%) females and 55 (56.1%) males, with a mean age of 8.67 years. Overall, the number of patients in both groups was similar. The post-intervention group had slightly fewer females (4.6%), and the mean age was 1.17 years older than in the pre-intervention group. Patients' ethnicity and race were abstracted from the EMR and are described in Table 1. In the pre-implementation and post-intervention groups, the overwhelming majority of children were identified as either African American/Black (45% and 56%, respectively) or Hispanic/Latino (41% and 33%, respectively). However, although 41% of children in the pre-implementation group were identified as

TABLE 1. Comparison of patient demographics and classification before and after the intervention

Characteristics	Before intervention (n = 101)	After intervention (n = 98)
Age in years, mean (range)	7.48 (4–14)	8.67 (4–14)
Sex, n (%)		
Female	49 (48.5)	43 (43.9)
Male	52 (51.5)	55 (56.1)
Ethnicity/race, n (%)		
Non-Hispanic		
African American/Black	45 (45)	55 (56)
Asian	2 (2)	0 (0)
White	0 (0)	2 (2)
Hawaiian or Pacific Islander	0 (0)	1 (1)
Hispanic or Latino	41 (41)	32 (33)
Mixed race	13 (13)	8 (8)
Asthma severity, n (%)		
Intermittent	48 (47.5)	43 (43.8)
Mild persistent	35 (34.6)	35 (35.7)
Moderate persistent	15 (14.8)	16 (16.3)
Severe persistent	3 (2.97)	4 (4.1)

Hispanic/Latino, 1 year later this number had dropped to 33%, and the percentage of African American/Black children had increased from 45% to 56% in the following year. Using the NHLBI asthma severity guidelines, classification of severity of asthma was nearly identical for both groups with the exception of those classified as having intermittent asthma, the mildest form. Although 47.5% ($n = 48$) of the pre-intervention patients had intermittent asthma, 1 year later the intermittent asthma group included only 43.8% ($n = 43$). There was one additional child ($n = 4$) diagnosed with severe persistent asthma (the most severe) in the post-implementation group versus three children the preceding year. The two intermediate-severity asthma classifications (mild persistent and moderate persistent) were very similar: 34.6% vs. 35.7% for mild persistent and 14.8% vs. 16.3% for moderate persistent (Table 1).

Clinical Outcome Measures

Providers' Use of the C-ACT and ACT

The results of the EMR review found that APRNs marked 21 out of 23 patients with asthma on their problem list with AA and that resident physicians marked 57 out of 75 patients' EMR note sections with AA designating that the patients had asthma and required a C-ACT or ACT to be completed in the waiting room (Table 2). In the 2016 pre-implementation cohort, one C-ACT/ACT was completed by an APRN. After implementation, the questionnaires were completed and documented for a total of 42 (42.8%) patients (Table 2). The nurse practitioners reviewed and documented the C-ACT or ACT score on 82.6% ($n = 19$) of patients they had seen with asthma, and the resident physicians examined and recorded the C-ACT/ACT on 30.7% ($n = 23$) of patients they had seen with asthma (Table 2).

TABLE 2. Clinical outcome measures: Use of the C-ACT and ACT

Measures	Before intervention (n = 101)	After intervention (n = 98)
Type of provider, n (%)		
APRN	21 (20.8)	23 (23.5)
Resident physician	80 (79.2)	75 (76.5)
Marked AA in the Note section of EMR, n (%)	—	
APRN		21 (91.3)
Resident physician		7 (76)
C-ACT/ACT performed and documented, n (%)		
APRN	1 (1)	19 (82.6)
Resident physician	0 (0)	23 (30.7)
Total number of C-ACT/ACT questionnaires performed and documented, n (%)	1 (1)	42 (42.8)

Note. AA, diagnosis of asthma; ACT, Asthma Control Test; APRN, advanced practice registered nurse; C-ACT, Childhood Asthma Control Test; EMR, electronic medical record.

C-ACT/ACT Scores and Treatment Adjustment

In 2016 in the pre-implementation cohort of 101 patients, one C-ACT/ACT was completed by an APRN with a score of 20 or greater, or well controlled, not requiring change in therapy (Table 3). In Cohort 2, after implementation, 42 C-ACT/ACTs were completed and documented out of the 98 patients seen with asthma noted on their problem list during the 5-week pilot project (Table 4). The questionnaire identified 33 patients, or 79%, with well-controlled asthma and 9 (21%) patients with a score of less than 20, which was the reference point identified for having not—well-controlled asthma (Table 3).

Most patients with well-controlled asthma were classified as having intermittent asthma (60.6%), and 39.4 % were classified as either mild persistent (27.2%), moderate persistent (9.1%), or severe persistent asthma (3.1%; Table 4). Of the nine patients with a score less than 20, four had asthma that was not well controlled (score = 16–19) and five had asthma that was poorly controlled (score ≤ 15 ; Table 4). Most patients, 89% ($n = 8$), with asthma not controlled were classified with persistent asthma, and 45% had either moderate ($n = 2$) or severe persistent asthma ($n = 2$). Eight of the nine (89%) patients had allergic rhinitis compared with 18 (55%)

TABLE 3. Result of the C-ACT/ACT

Result	Before intervention	After intervention
C-ACT/ACT scores, n (%)		
≥ 20	1 (1)	33 (79)
< 20	0 (0)	9 (21)

Note. ACT, Asthma Control Test; C-ACT, Childhood Asthma Control Test.

TABLE 4. Results of C-ACT/ACT with classification post-intervention (N = 42), n (%)

C-ACT or ACT score	Well controlled (score ≥ 20)	Not well controlled (score = 16–19)	Poorly controlled (score ≤ 15)
Overall	33 (78.6)	4 (9.5)	5 (11.9)
Intermittent	20 (60.6)	1 (25)	0 (0)
Mild persistent	9 (27.2)	2 (50)	2 (40)
Moderate persistent	3 (9.1)	1 (25)	1 (20)
Severe persistent	1 (3.1)	0 (0)	2 (40)

Note. ACT, Asthma Control Test; C-ACT, Childhood Asthma Control Test.

TABLE 5. Targeted questions assessing asthma control

Targeted questions on degree of asthma control	Before implementation (n = 78), n (%)	After implementation (n = 45), n (%)
SABA use	44 (57)	17 (38)
Frequency of daytime symptoms	10 (13)	4 (8)
Frequency of nighttime symptoms	17 (22)	7 (16)
Interference with normal activity because of asthma	15 (19)	5 (11)
No questions regarding asthma control	22 (22)	11 (20)
Patients identified with not–well-controlled asthma because of questions, n	5	4

Note. SABA, short-acting beta agonist.

in the well-controlled group. All nine patients with C-ACT/ACT score less than 20 had an adjustment made in their asthma therapy, and one patient was also referred to a pulmonary medicine specialist for further evaluation, as recommended by the national guidelines (NHLBI, 2007; Table 4).

Other Methods of Evaluation of Asthma Control

Although the questionnaire was developed to standardize the assessment of impairment and to make sure all the appropriate questions were asked, a careful targeted history evaluating the degree of asthma control over the preceding 4 weeks can be used (NHLBI, 2007). Questions measured by the number of days per week include the use of SABAs, day or nighttime cough, and interference with activity, are also acceptable (NHLBI, 2007). Of the 101 pre-intervention patients, 78 patients' records had documented some of the carefully recommended targeted questions assessing patients' asthma control, including frequency of SABA use for symptom control ($n = 44$, 57%), daytime cough ($n = 10$, 13%), nighttime awakenings due to cough ($n = 17$, 22%), and interference with normal activity ($n = 15$, 19%; Table 5). Twenty-two patient records had no questions documented to assess the patient's asthma control. The results of the questioning identified five patients with uncontrolled asthma requiring an escalation in therapy. After the implementation of the study, 45 patient records documented specific asthma control questions instead of using the questionnaire, including the use of SABA for symptom control ($n = 17$, 38%), daytime symptoms ($n = 4$, 8%), nighttime symptoms ($n = 7$, 16%), and interference with normal activity ($n = 5$, 11%; Table 5). Eleven patient records had no questions documented assessing asthma control. This questioning

identified four patients with uncontrolled asthma requiring an adjustment of their asthma therapy.

In the pre-implementation cohort, 5 patients out of 101 were identified as having uncontrolled asthma through the targeted questions. In the post-implementation cohort of 98 patients, a total of 13 patients were identified as having uncontrolled asthma, including 9 patients identified through the C-ACT/ACT questionnaire and 4 patients identified with the targeted questions.

Additional Noted Findings

Data were also collected on comorbid conditions affecting asthma control, completion or referral for spirometry for children 5 years of age and older, and referral to asthma specialists. All these factors can influence asthma control. As noted in Table 6, 82.2% (pre-intervention) and 91.8% (post-intervention) of patients had either allergic rhinitis or

TABLE 6. Comorbid conditions

Conditions	Before intervention (n = 101)	After intervention (n = 98)
Atopy diseases/comorbid conditions, n (%)		
Allergic rhinitis	45 (44.6)	54 (55.1)
Eczema	38 (37.6)	36 (36.7)
Allergic rhinitis and eczema	18 (17.8)	22 (22.4)
Food allergies	13 (12.9)	11 (11.2)
GERD	2 (1.9)	0 (0)
Obesity	25 (24.7)	26 (26.5)
Snoring/OSA	9 (8.9)	8 (8.1)

Note. GERD, gastroesophageal reflux disease; OSA, obstructive sleep apnea.

eczema, with 18.8% (pre) and 22.4% (post) having all three atopy diseases (asthma, allergic rhinitis, and eczema). Approximately 50% of patients in this study experienced allergic rhinitis, which is similar to other studies (Amaral, Carneiro, Wandalsen, Fonseca, & Sole, 2017; Sari, Aydogan, Gulec, Doganer, & Yavuz., 2017). Allergic rhinitis is a common trigger of asthma symptoms and is important to consider when controlling asthma (Amaral et al., 2017; Sur & Plesa, 2015).

DISCUSSION

Asthma is a complex, chronic illness that requires frequent follow-up and assessment of asthma control. The prevalence of asthma has increased over time (Loftus & Wise, 2016). Recent studies have suggested that long-term uncontrolled asthma can lead to a decline in lung function over time and may lead to chronic obstructive pulmonary disease in adulthood (Guerra et al., 2008; McGeachie et al., 2016). Primary care providers play an important role in assessing and maintaining asthma control, along with patients and their families. Multiple studies have shown high rates of uncontrolled asthma in primary care and the under- or overestimation of asthma control from the patient, parent, or provider perspective (Alzahrani & Becker, 2016; Carroll, Wildhaber, & Brand, 2012; Liu et al., 2010a; Shefer et al., 2014; Voorend-van Bergen et al., 2015). The C-ACT and ACT questionnaires are two tools for assessing asthma control, identifying patients with not-well-controlled asthma, and changing medication therapy as indicated. In this study, 13% were identified as having uncontrolled asthma with either the ACT (9%) or careful history (4%).

Asthma is a complex, chronic illness that requires frequent follow-up and assessment of asthma control.

In 2016, before the implementation of this pilot study, only one APRN provider had completed and documented the ACT in the EMR, which was recommended by the NHLBI asthma guidelines (2007). As noted in the project, providers who used targeted questions during the history instead of the C-ACT/ACT did not include all the recommended questions, with fewer than 40% of the providers asking about SABA use (38%) and fewer than 15% of providers asking about daytime (8%) or nighttime (15%) cough or interference with normal activity (11%). In addition, 22 providers failed to record any recommended targeted questions. Of the providers who documented questions rather than using a tool to assess their patients' asthma control, five (5%) patients were identified as having not-well-controlled asthma that required escalation in therapy.

After implementation of the study, 42 (43%) providers completed the questionnaire, resulting in identification of nine (21%) patients who were considered to have not-well-controlled asthma, with 100% of those patients receiving an

adjustment in their medication therapy and one a referral to a pulmonary medicine specialist. Similarly, after implementation, 46 providers documented specific, targeted asthma control questions, resulting in the identification of four additional patients with not-well-controlled asthma who required a change in their step therapy. Eleven providers failed to document any targeted questions regarding asthma control. The use of the questionnaire identified more patients with uncontrolled asthma (21%) versus use of a careful history (9%).

The ACT, as a numeric score, may be a useful way to track asthma control over time to determine if therapy has optimized asthma control. In the future, allowing the patient/family to complete the questionnaire

on a mobile application, which could be directly uploaded into the medical record, would save the provider time by having only to verify the answers.

Asthma control needs to be addressed at every opportunity. The findings of this study suggest that there are different approaches to assessing asthma control. Using a simple, validated, parent/patient-completed questionnaire in primary care can assist the provider in the assessment of the patient's asthma and improving compliance with the national asthma guidelines. Another benefit of using the questionnaire may improve the patient's/parent's knowledge related to symptom monitoring and improve self-management skills.

The Iowa model is an important framework for implementing evidence-based practice (Iowa Model Collaborative, 2017). This step-by-step, approach along with a piloting the practice change, identified important obstacles in implementing this practice change. The lack of participation by the resident physicians is important to reevaluate to ensure compliance with the implementation of the tool. Because of the constant changing of the residents, including the attending physicians in the education could have improved compliance.

Limitations

Several unanticipated limitations were noted for this pilot project. A significant limitation was the biweekly change in the resident staff clinical rotations in the primary care center. In hindsight, it was an omission not to include the attending staff and chief residents who were precepting the residents in the educational program.

Another limitation of this project was not measuring providers' knowledge and understanding of the educational program and the EBP before the start. Asthma control can also be assessed without the C-ACT or ACT questionnaire

The ACT, as a numeric score, may be a useful way to track asthma control over time to determine if therapy has optimized asthma control.

by asking several targeted, specific questions. One provider asked all the appropriate questions, marked the EMR with AA, but did not complete the C-ACT/ACT.

This EBP was limited to English and Spanish speaking patients only, with other patients excluded from this study because of language barriers. This study did not consider the ability of the parents or child to understand the questions in the questionnaire, even though an abnormal finding could have prompted the provider to ask more questions. Although it was recognized as a potential limitation, in practice, steps should be taken to ensure parents' adequate literacy levels, regardless of tool language.

CONCLUSION

The NHLBI and GINA guidelines recommend close regular monitoring of asthma control (GINA, 2017; NHLBI, 2007). Maintaining asthma control is central to achieving the goals of asthma treatment (NHLBI, 2007). Uncontrolled asthma can negatively affect a patient's quality of life, school attendance, and work performance. Every patient visit, regardless of the reason, is an opportunity to assess asthma control using a standardized tool. The C-ACT or ACT are simple, inexpensive, self-administered, validated questionnaires that can be incorporated into a primary care practice to assess the level of asthma control and to identify patients with not-well-controlled asthma. The C-ACT/ACT scores can be used to track patients' control over time. This tool may also improve parents' assessment skills in evaluating their child's asthma control. Adjustments in asthma management depend on the level of asthma control and are key to achieving treatment goals and improving patient outcomes. Integration into the EMR may improve compliance with the recommendations.

The results of this EBP suggest that the use of the C-ACT/ACT tool is one important component of assessing asthma control. The importance of achieving asthma control through appropriate evaluation and treatment management is needed to reduce the burden of asthma and long-term morbidity.

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