



Predicting future emergency department visits and hospitalizations for asthma using the Pediatric Asthma Control and Communication Instrument – Emergency Department version (PACCI-ED)

Dominic J. Wu BS, Evelyn Hipolito BS, Andrew Bilderback MS, Sande O. Okelo MD & Aris Garro MD, MPH

To cite this article: Dominic J. Wu BS, Evelyn Hipolito BS, Andrew Bilderback MS, Sande O. Okelo MD & Aris Garro MD, MPH (2016): Predicting future emergency department visits and hospitalizations for asthma using the Pediatric Asthma Control and Communication Instrument – Emergency Department version (PACCI-ED), Journal of Asthma, DOI: [10.3109/02770903.2015.1115520](https://doi.org/10.3109/02770903.2015.1115520)

To link to this article: <http://dx.doi.org/10.3109/02770903.2015.1115520>



Accepted author version posted online: 14 Dec 2015.
Published online: 22 Jan 2016.



Submit your article to this journal [↗](#)



Article views: 18



View related articles [↗](#)



View Crossmark data [↗](#)

ORIGINAL ARTICLE

Predicting future emergency department visits and hospitalizations for asthma using the Pediatric Asthma Control and Communication Instrument – Emergency Department version (PACCI-ED)

Dominic J. Wu, BS¹, Evelyn Hipolito, BS², Andrew Bilderback, MS³, Sande O. Okelo, MD⁴, and Aris Garro, MD, MPH⁵¹W. Alpert Medical School of Brown University, Providence, RI, USA, ²Lifespan Hospitals, Providence, RI, USA, ³Johns Hopkins University, Baltimore, MD, USA, ⁴University of California Los Angeles, Los Angeles, CA, USA and ⁵Rhode Island Hospital and Brown University, Providence, RI, USA**Abstract**

Objective: Emergency departments (EDs) are potential settings for interventions to improve asthma outcomes. Screening tools can identify children at risk of future morbidity. Our objective was to determine the predictive validity of the Pediatric Asthma Control and Communication Instrument – Emergency Department version (PACCI-ED) for future asthma-related ED visits and hospitalizations. **Methods:** This was a retrospective cohort study of 108 children 1–17 years old who visited an ED for asthma and completed the PACCI-ED. The PACCI-ED queries parents about prior 12-month ED visits, hospitalizations, steroid use, perceived asthma morbidity and burden, and asthma control (over prior 1–2 weeks). The primary outcome was subsequent ED visits and hospitalizations within 1 year of enrollment. Poisson regression was used to model PACCI-ED questions for future ED visits controlling for age and socioeconomic status. **Results:** Reported ED visits predicted future ED visits (adjusted incidence rate ratio (aIRR) 3.1, 95% confidence interval (CI): 1.3–7.2) but not future hospitalizations. Reported hospitalizations predicted future ED visits (aIRR 3.3; 95% CI 1.7–6.3) and hospitalizations (aIRR 6.4; 95% CI 2.3–17.6). The remaining PACCI-ED questions did not predict future ED visits or hospitalizations. **Conclusions:** The PACCI-ED risk domain was the only domain that predicted future asthma ED visits and hospitalizations. Questions about previous ED visits and hospitalizations are the most effective questions when screening children with asthma in EDs for the risk of future health-care use.

Keywords

Child, emergency medicine, risk, validation, survey

History

Received 26 January 2015

Revised 23 October 2015

Accepted 28 October 2015

Published online 21 January 2016

Introduction

Asthma is one of the most common presenting diseases among children seeking emergency department (ED) care in the United States [1,2]. A significant portion of patients may preferentially seek asthma care in the ED. These patients are at higher risk of poor outcomes because they often have less access to primary care, worse asthma control, and lower adherence to asthma controller medications [3–10]. Therefore, EDs have been recognized as important locations for potentially implementing longer-term interventions to improve care and outcomes in high-risk children with asthma (e.g. initiation of inhaled corticosteroids) [11–14].

One barrier faced by ED clinicians interested in initiating inhaled corticosteroids and other preventative interventions is the lack of validated clinical tools available to identify those

children most in need (i.e. at highest risk of future poor outcomes). An ideal clinical tool can be disseminated and is easy to use. Additionally, templated tools used for asthma visits provide more complete and less variable historical data [15], which have been shown to be problematic in many ED settings [16].

The Pediatric Asthma Control and Communication Instrument – Emergency Department version (PACCI-ED) is a validated asthma morbidity questionnaire [17,18]. The online version of the PACCI-ED can be accessed at <https://www.uclahealth.org/Mattel/Pediatric-Pulmonology/Documents/Dept-Pediatrics/Asthma-Questionnaire-NP-English.pdf>. Note that the first two pages of this document are those used at the point-of-care in the clinical setting.

Goals of this investigation

The purpose of this study was to determine the predictive validity of individual PACCI-ED questions in identifying children seen in an ED setting who may be at risk of future ED visits or hospitalizations due to asthma.

Correspondence: Aris Garro, MD, MPH, Rhode Island Hospital and Brown University, 125 Whipple Street, 3rd floor/UEMF suite, Providence, RI 02908, USA. Tel: 401-480-8682. E-mail: agarro@lifespan.org

Methods

Patient recruitment and setting

This was a retrospective cohort study of participants originally enrolled in the PACCI-ED validation study [19]. Participants were eligible for the original validation study if they were 1–17 years old, had physician-diagnosed asthma, and visited the ED for an acute asthma exacerbation. Participants were excluded if they had a major co-morbid illness, if the child and/or parents were not English speaking, if the child was medically unstable, or if they had previously participated in the study. There were no requirements for preexisting asthma morbidity to participate in the study. Since the study institution's ED captures 85% of all local asthma ED visits, we anticipated a broadly representative sample of asthma severity among the participants. A waiver of informed consent for this secondary analysis of the original study was granted by the study institution IRB.

Data collection and processing

Primary outcomes included ED visits and hospitalizations for asthma within 12 months following enrollment in the original PACCI-ED validation study. Participant identification numbers were matched to individual electronic medical records to allow for data abstraction of ED visits and hospitalizations. To maintain blinding during data abstraction, investigators did not have access to the previously collected participant demographic, clinical, or PACCI-ED data. ED visits and hospitalizations were included if the child presented with respiratory symptoms including cough, wheeze, or tachypnea, and (1) received bronchodilators as part of their therapy, or (2) had a primary diagnosis code for asthma as the reason for visit. Data abstraction for all participants was performed by two of the authors (D.J.W., E.H.). When a visit met the first criteria but did not have a primary diagnosis code for asthma, the abstractor categorized the visit as asthma-related or not asthma-related based on a review of the presenting complaint, discharge diagnosis, medications administered, and medical decision-making sections of the chart. Ten percent of abstracted medical records were reviewed by two abstractors to determine inter-observer agreement. All disagreements were resolved by a third abstractor (A.G.). Demographic, clinical, and PACCI-ED data were then merged with the abstracted ED visit and hospitalization data.

Instrument development and content

The PACCI-ED is adapted from the PACCI, an asthma questionnaire validated among a diverse pediatric patient population [17,18,20]. The PACCI-ED shares the same conceptual domains as the PACCI, is also written at a 5th grade reading level, and is intended to help clinicians better utilize patient/parent reported information to guide asthma treatment. The development of the PACCI has been described previously [18,21].

The PACCI-ED is a 12-item parent-completed questionnaire that assesses five conceptual domains of asthma status:

- (1) *Direction* – parent-reported changes in asthma status over the prior 12 months (better, same, or worse);

- (2) *Bother* – parent reported disease burden over the prior 12 months (not bothered, somewhat bothered, very bothered by the child's asthma);
- (3) *Risk* – reports of ED visits, hospitalizations, and oral steroid use over the prior 12 months (0–1, 2, 3, 4 or more);
- (4) *Adherence* – to prescribed daily controller medications;
- (5) *Control* – frequency of daytime symptoms, short-acting beta₂ agonist use, asthma attacks, activity limitation, and nocturnal symptoms (i.e. guideline-based measures of impairment) over the prior 1–2 weeks (also referred to as “sub-acute asthma control”).

The 12th item is an open-ended question designed to enhance patient-centered communication with the clinician. The PACCI-ED Control domain may be scored in three ways:

- (1) *Sum score* is a summation of the score assigned to each response option (0–5 for questions 7, 8, 10, 11; 0–4 for question 9), ranging from 0 (best asthma control) to 19 (worst asthma control).
- (2) *Problem index* dichotomously scores each of the five control items as zero (controlled) or one (not controlled), which are then summed, ranging from 0 (no control problems) to 5 (five control problems).
- (3) *Categories* uses a classification scheme based on National Institutes of Health asthma guideline assessments by categorizing patients into four severity/control categories (intermittent/controlled; mild persistent/partly controlled; moderate persistent/uncontrolled; severe persistent/poorly controlled) or into two categories (controlled vs. uncontrolled).

Statistical analysis

We performed all statistical analyses using Stata 13.1 (StataCorp. 2013, College Station, TX). Standard descriptive statistics were used to summarize the study cohort. Kappa statistics were used to describe inter-observer agreement of asthma as the primary reason for ED visits and hospitalizations. Poisson regression was used to evaluate the association between each PACCI-ED question and the two outcomes of interest, ED use and hospitalization for asthma in the year following completion of the PACCI-ED at enrollment. All PACCI-ED domain questions were evaluated for use in the multivariable models. Variable selection was done using a forward stepwise procedure. Separate models were constructed for future ED use and future hospitalizations. Results are presented as adjusted incidence rate ratio (aIRR) with 95% confidence intervals (CI).

In a sub-analysis, we compared children with higher pre-enrollment ED use for asthma to children with lower pre-enrollment ED use for asthma. This was done by abstracting visit data for the 12-month preceding enrollment in the original PACCI-ED validation study. Participants in the upper quartile for number of ED visits in the year before participation were categorized as “higher ED use”, while participants in the lower three quartiles were categorized as “lower ED use”. PACCI-ED responses for these two groups were then compared using chi-squared tests and Student's *t*-tests as appropriate.

Results

Descriptive demographic and clinical characteristics

From the original PACCI-ED validation study, 108 children were included in the current study (Table 1). There was nearly equal representation of males and females. No individual ethnic group accounted for more than 50% of the participants. A slight majority of participants had moderate or severe persistent asthma. The average number (range) of ED visits and hospitalizations in the year prior to enrollment was 1 (range 0–9) and 0.4 (range 0–5), respectively.

In the year following PACCI-ED assessment, 37% of children had an ED visit for asthma, and 17% were hospitalized for asthma. In total, there were 74 ED visits (mean 0.7 visits per child, range 0–6 visits) and 22 hospitalizations (mean 0.2 hospitalizations per child, range 0–2 hospitalizations) for the study cohort in the year following enrollment. Interobserver agreement of asthma as the primary reason for ED visits was 97% ($K=0.93$). Interobserver agreement of asthma as the primary reason for hospitalizations was 82% ($K=0.49$).

Predicting future ED visits and hospitalizations for asthma

The association between each PACCI-ED question and ED use and hospitalization for asthma are presented in Table 2. In multivariate Poisson regression modeling, we observed associations between PACCI-ED risk domain questions and future acute health-care use (Table 3). Specifically, future ED visits for asthma were significantly predicted by a PACCI-ED-reported ED visits (aIRR 3.1, 95% CI: 1.3–7.2) and hospitalization (aIRR 3.3, 95% CI: 1.7–6.3). Future hospitalizations were significantly predicted by PACCI-ED-reported hospitalization (aIRR 6.4, 95% CI: 2.3–17.6). Direction, bother, and control domains of the PACCI-ED did not significantly predict future ED visits or hospitalizations.

Table 1. Demographic and clinical characteristics of study population by child ($n=108$).

Gender (% male)	53%
Age in years – mean (SD)	7.8 (4.5)
Race/ethnicity	
White	40%
African American	14%
Latino	23%
Mixed race/ethnicity	14%
Other	9%
Parental education level	
Some high school	15%
Graduated high school	39%
Some college	22%
Graduated college	24%
Asthma control	
Intermittent	8%
Mild persistent	37%
Moderate persistent	35%
Severe persistent	19%
ED visits in the year preceding completion of the PACCI-ED, median (range)	1.0 (0–9)
Hospitalization – in the year preceding completion of the PACCI-ED, median (range)	0.0 (0–5)

Comparing participants with higher pre-study ED use versus lower ED use

The higher ED use group, defined as the upper quartile of ED visits prior to enrollment, included participants with 3 or more visits. The lower ED use group included participants with ≤ 2 visits. In the higher ED use group, 24 (100%) of children reported prednisone use compared to 56 (67%) of lower use group ($p=0.001$). Twenty-one (91%) of the higher use group reported they were bothered by their child’s asthma compared to 59 (72%) of the lower use group ($p=0.05$). Only 2 (8%) of the higher use group said they were not on a daily medication as compared to 36 (43%) of the lower use group ($p=0.002$). The chronic asthma control scores (higher scores = worse control) were higher in the higher use group (mean 4.3; SD 1.1) than the lower use group (mean 2.8; SD 1.5) ($p<0.0001$). There were no significant differences between higher and lower use groups for individual symptom scores, reported reliever use, activity limitations, or nighttime awakenings.

Discussion

A previous study showed that ED clinicians can use the PACCI-ED to more accurately assess asthma control, trajectory, burden experienced by parents, and asthma medication adherence [19]. In the current study, we examined the predictive validity of the PACCI-ED for two cost-driving asthma-related outcomes; ED use and hospitalization. The risk domain of the PACCI-ED with questions pertaining to previous ED visits and hospitalizations was predictive of future ED visits and hospitalizations. Other PACCI-ED questions pertaining to oral steroid use, parent-perceived changes in asthma morbidity and disease burden, and asthma control did not predict future asthma-related ED visits and hospitalizations. This suggests that in the ED environment, where clinician time is limited, historical questions focused on identification of previous asthma-related ED visits and hospitalizations are useful in identifying children at highest risk of future asthma-related acute health-care use. This finding has important implications for development of screening tools in the ED setting, demonstrating that measures of previous health-care use may be most valuable, obtained via parent history, or ideally by reviewing an electronic medical record. The poor performance of items that have shown predictive validity in other settings needs to be examined in the context of application in the new ED setting.

ED physicians are under significant time-constraints, and work flow can be improved by strategies that expedite the retrieval of relevant clinical information from patients, and facilitate evidence-based clinical decisions. In some ED settings, electronic medical records facilitate history-taking. In these EDs, this study suggests that previous ED visits and hospitalization for asthma should be included in history templates to help identify children in need of disease management education and interventions. In EDs that use traditional forms of history taking (e.g. paper documentation), risk domain questions modeled after the PACCI-ED questions can be encouraged as part of the asthma risk assessment. Tools using patient-provided historical data have been developed in adult populations to predict risk of ED visits

Table 2. Poisson regression models for ED visits and hospitalizations based on PACCI-ED (unadjusted incidence rate ratios (95% CI)).

PACCI-ED domain	PACCI-ED parent response	Future ED visits IRR (95% CI)	Future hospitalizations IRR (95% CI)
Direction	Child's asthma is getting better?	0.96 (0.46–2.0)	0.47 (0.14–1.6)
	Child's asthma is getting worse?	0.48 (0.24–0.99)	0.36 (0.11–1.2)
Bothered Risk	Somewhat/very bothered	1.3 (0.54–3.0)	1.4 (0.48–4.1)
	Has had at least 1 prior ED visit	4.8 (2.26–10.2)	3.2 (0.94–10.7)
	Has had at least 1 prior hospitalization for asthma	4.1 (2.2–7.7)	6.7 (2.4–18.5)
	Has had at least 1 prior course of oral steroids for asthma	2.5 (1.2–5.2)	2.2 (0.66–7.4)
Control	Sum score	0.96 (0.88–1.0)	0.91 (0.79–1.0)
	Problem index	0.82 (0.56–1.2)	0.64 (0.36–1.1)
	Categories	0.89 (0.61–1.3)	0.64 (0.40–1.0)

Table 3. Multivariable Poisson regression models for ED visits and hospitalizations (adjusted incidence rate ratios (95% CI)), N= 101.

PACCI-ED domain	PACCI-ED parent response	Future ED visits aIRR (95% CI)	Future hospitalizations aIRR (95% CI)
Risk	Has had at least 1 prior ED visit	3.1 (1.3–7.2)	–
	Has had at least 1 prior hospitalization for asthma	3.3 (1.7–6.3)	6.4 (2.3–17.6)

and hospitalizations [22], but to our knowledge no tools have been developed for use in pediatric populations.

This study indicated that many questions on the PACCI-ED that demonstrated predictive validity when used in other ambulatory settings did not perform as well in the ED setting. We believe that parents of children visiting EDs for an asthma exacerbation may perceive their child's asthma as being worse because of the acute, salient manifestations of the exacerbation, especially as it pertains to symptoms scores and activity limitations. This could result in patient misclassification into a worse control category based on these relatively subjective questions which would overestimate future risk of ED visits and hospitalizations. If this is true, it may account for why the more objective measures of asthma morbidity such as ED visits and hospitalizations were predictive of future asthma-related morbidity.

Paradoxically, a parent's perception that a "child's asthma is getting worse" was associated with decreased likelihood of future ED visits in the bivariate analysis. We hypothesize that the acuity of the asthma exacerbation at the enrollment visit may have served as a sentinel event for recognizing the severity of their child's asthma. Parents' acknowledgment that the asthma is worsening may prompt changes in disease management, either by increased vigilance to disease management techniques or advocacy for escalating therapy with medical providers. Both actions could translate into fewer ED visits. This bolsters the idea that ED visits may be teachable moments when the asthma manifestations are most salient and may result in increased receptiveness to interventions to improve disease management.

The sub-analysis comparing PACCI-ED responses in the higher vs. lower pre-enrollment ED use groups provided evidence that the PACCI-ED had face validity for previous asthma-related morbidity when applied in the ED. More specifically, the higher use group scored higher on PACCI-ED measures of oral steroid use, parental bother due to asthma, controller medications prescribed, and asthma control summary scores.

There were several limitations to this study. First, this was a relatively small study, which may have underpowered its ability to detect associations, especially for the future hospitalization outcome for which there were fewer overall numbers of events. This is reflected in the relatively larger CIs for regression coefficients for the hospitalization Poisson regression models. Second, ED visits and hospitalizations for asthma were limited to those that were captured at the primary study institution. It was possible that ED visits and hospitalizations could have occurred at other institutions. This is likely a small source of error though, as the Rhode Island Department of Health has reported that >80% of ED visits and 96% of hospitalization for asthma in the state of Rhode Island occur at the study institution. These percentages are likely even higher in our study population as the index visit for enrollment occurred at the study institution and the population served is an urban population unlikely to travel to other institutions. Third, inclusion of children <2 years old could result in ambiguity between ED visits for bronchiolitis and asthma. This was unlikely to be a factor because none of the children enrolled in December through March, when bronchiolitis is most common, were less than 2 years old. Lastly, there may be relevant questions predictive of future acute health-care use not captured in the PACCI-ED (e.g. lack of insurance).

It is also important to note that asthma-related ED visits and hospitalizations are only two measures of morbidity, although they are the primary drivers of asthma-related health-care costs in young children [23]. It is possible that the PACCI-ED may have greater predictive value for other future asthma-related outcomes when applied in the ED, including symptom control, activity limitation, missed work and school, and quality of life.

Conclusions

The risk domain of the PACCI-ED was predictive of future asthma-related ED visits and hospitalizations. This suggests

that history taking in the ED should focus on previous ED visits and hospitalizations as the best risk predictors for future ED visits and hospitalizations. For children who present to the ED with asthma exacerbation, history taking in the ED should include and especially focus on previous ED visits and prior hospitalization as the best risk predictors for future ED visits and hospitalizations.

Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

References

- Chen H, Gould MK, Blanc PD, Miller DP, Kamath TV, Lee JH, Sullivan SD, TENOR Study Group. Asthma control, severity, and quality of life: quantifying the effect of uncontrolled disease. *J Allerg Clin Immunol* 2007;120:396–402. doi: 10.1016/j.jaci.2007.04.040.
- Akinbami LJ, Moorman JE, Bailey C, Zahran HS, King M, Johnson CA, Liu X. Trends in asthma prevalence, health care use, and mortality in the United States, 2001–2010. *NCHS Data Brief* 2012;94:1–8.
- Miller MK, Lee JH, Miller DP, Wenzel SE, Group TS. Recent asthma exacerbations: a key predictor of future exacerbations. *Resp Med* 2007;101:481–489. doi: 10.1016/j.rmed.2006.07.005.
- Crain EF, Kerckmar C, Weiss KB, Mitchell H, Lynn H. Reported difficulties in access to quality care for children with asthma in the inner city. *Arch Pediatr Adolesc Med* 1998;152:333–339.
- Dinkevich EI, Cunningham SJ, Crain EF. Parental perceptions of access to care and quality of care for inner-city children with asthma. *J Asthma* 1998;35:63–71.
- Farber HJ, Johnson C, Beckerman RC. Young inner-city children visiting the emergency room (ER) for asthma: risk factors and chronic care behaviors. *J Asthma* 1998;35:547–552.
- Kelly KJ, Walsh-Kelly CM, Christenson P, Rogalinski S, Gorelick MH, Barthell EN, Grabowski L. Emergency Department Allies: a web-based multihospital pediatric asthma tracking system. *Pediatrics* 2006;117:S63–S70. doi: 10.1542/peds.2005-2000C.
- McDaniel M, Paxson C, Waldfogel J. Racial disparities in childhood asthma in the United States: evidence from the National Health Interview Survey, 1997 to 2003. *Pediatrics* 2006;117:e868–e877. doi: 10.1542/peds.2005-1721.
- Miller JE. The effects of race/ethnicity and income on early childhood asthma prevalence and health care use. *Am J Pub Health* 2000;90:428–430. PubMed PMID: 10705865.
- Sills MR, Ginde AA, Clark S, Camargo Jr CA. Multicenter study of chronic asthma severity among emergency department patients with acute asthma. *J Asthma* 2010;47:920–928. doi: 10.3109/02770903.2010.504878.
- Doing the most to ensure the least emergency department asthma visits: asthma experts consider preliminary project findings. *Pediatrics* 2006;117:S159–S166. doi: 10.1542/peds.2005-2000N.
- Kellermann AL. Emergency medicine and public health: stopping emergencies before the 9-1-1 call. *Acad Emerg Med* 2009;16:1060–1064. doi: 10.1111/j.1553-2712.2009.00567.x.
- Rachelefsky GS, Kennedy S, Stone A. Enhancing the role of the emergency department in the identification and management of childhood asthma. *Pediatrics* 2006;117:S57–S62.
- Rhodes KV, Gordon JA, Lowe RA. Preventive care in the emergency department, Part I: clinical preventive services – are they relevant to emergency medicine? Society for Academic Emergency Medicine Public Health and Education Task Force Preventive Services Work Group. *Acad Emerg Med* 2000;7:1036–1041.
- Beck AF, Sauers HS, Kahn RS, Yau C, Weiser J, Simmons JM. Improved documentation and care planning with an asthma-specific history and physical. *Hosp Pediatr* 2012;2:194–201.
- Teo S, Hanson R, Van Asperen P, Giles H, Fasher B, Davis AM, Kristidis P. Improving asthma documentation in a paediatric emergency department. *J Paediatr Child Health* 1995;31:130–133.
- Okelo SO, Eakin MN, Patino CM, Teodoro AP, Bilderback AL, Thompson DA, Loiaza-Martinez A, et al. The Pediatric Asthma Control and Communication Instrument asthma questionnaire: for use in diverse children of all ages. *J Allerg Clin Immunol* 2013;132:55–62. doi: 10.1016/j.jaci.2013.01.007.
- Patino CM, Okelo SO, Rand CS, Riekert KA, Krishnan JA, Thompson K, Quartey RI, et al. The Asthma Control and Communication Instrument: a clinical tool developed for ethnically diverse populations. *J Allerg Clin Immunol* 2008;122:936–943. doi: 10.1016/j.jaci.2008.08.027.
- Goldberg EM, Laskowski-Kos U, Wu D, Gutierrez J, Bilderback A, Okelo SO, Garro A. The Pediatric Asthma Control and Communication Instrument for the Emergency Department (PACCI-ED) improves physician assessment of asthma morbidity in pediatric emergency department patients. *J Asthma* 2014;51:200–208. doi: 10.3109/02770903.2013.859267.
- Okelo SO, Eakin MN, Riekert KA, Teodoro AP, Bilderback AL, Thompson DA, Loiaza-Martinez A, et al. Validation of parental reports of asthma trajectory, burden, and risk by using the pediatric asthma control and communication instrument. *J Allergy Clin Immunol Pract* 2014;2:186–192. doi: 10.1016/j.jaip.2013.10.005.
- Okelo SO, Patino CM, Riekert KA, Merriman B, Bilderback A, Hansel NN, Thompson K, et al. Patient factors used by pediatricians to assign asthma treatment. *Pediatrics* 2008;122:e195–e201. doi: 10.1542/peds.2007-2271.
- Peters D, Chen C, Markson LE, Allen-Ramey FC, Vollmer WM. Using an asthma control questionnaire and administrative data to predict health-care utilization. *Chest* 2006;129:918–924. doi: 10.1378/chest.129.4.918.
- McQuaid EL, Garro A, Seifer R, Hammond SK, Borrelli B. Integrating asthma education and smoking cessation for parents: financial return on investment. *Pediatr Pulmonol* 2012;47:950–955. doi: 10.1002/ppul.22559.