The Allergy and Asthma Task Force Recommendations

The Practical Application of Allergic Trigger Management to Improve Asthma Outcomes

Recommendations to Improve Asthma Outcomes: Work Group Call to Action

S3 The Need to Improve Outcomes for People with Asthma in Primary Care and Health Systems: Beyond Adding More Pharmacotherapy

Barbara P. Yawn, MD, MSc, FAAFP, for the Allergy and Asthma Task Force Members

S5 The Practical Application of Allergic Trigger Management to Improve Asthma Outcomes Step 1: Identify Patients with Allergic Components of Asthma

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The Need to Improve Outcomes for People with Asthma in Primary Care and Health Systems: Beyond Adding More Pharmacotherapy

Barbara P. Yawn, MD, MSc, FAAFP, for the Allergy and Asthma Task Force Members

LEARNING OBJECTIVES

What this supplement addresses:

- Asthma inflammation and the role of aeroallergen sensitization in asthma burden
- The groups of people with asthma who are most likely to benefit from evaluation for allergen sensitization
- A practical approach to identifying and caring for those subpopulations who shoulder disproportionate allergy and asthma risk and morbidity
- The 2 readily available methods to assess specific allergen sensitization
- Ways to include allergen evaluation in daily primary care practice
- Potential solutions for the common barriers to patient education regarding trigger avoidance and management
- The role of health systems and payers and the business case for supporting and integrating allergen evaluation and trigger avoidance education in primary care practices.

This supplement is the product of the Allergy and Asthma Task Force convened and supported by Thermo Fisher Scientific. The Task Force met in person and remotely over a period of 20 months to develop and publish its recommendations to identify which patients with asthma are of highest priority for allergy evaluation, how that evaluation could be done, and how allergy evaluation can be incorporated into primary care.

The expertise in the Task Force includes: primary care (family medicine and pediatrics); specialists in allergy and pulmonology, nursing, respiratory therapy, asthma education, laboratory medicine, and health systems design; and the perspectives of quality experts, medical directors, and patients. Members' travel expenses were covered by the sponsor, as was the editorial support of Sarah Staples.

Task Force members (in alphabetical order) are: Randall Brown MD, MPH, AE-C; Michael D. Cabana, MD, MPH; Steve Clark; Ivor Emanuel, MD; Len Fromer, MD, FAAFP; Andrew Liu, MD; Brad Lucas, MD; Allan Luskin, MD; Suzanne Madison, PhD; and Christine W. Wagner, APRN, MSN, AE-C. Task Force Chair is Barbara Yawn, MD, MSc, FAAFP.

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Dr. Yawn is a paid consultant and has an ongoing relationship with Thermo Fisher Scientific.

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Asthma is a common and increasingly prevalent chronic respiratory condition that affected 25 million Americans in the United States in 2007.[1] Most people with asthma receive their asthma care within primary care practices.[2] People with asthma and their families continue to experience significant asthma-related disease burden, with over 10.5 million office visits a year, most of which are unscheduled and in primary care offices.[1,2] These visits often focus on dealing with acute symptoms or exacerbations, with little time and attention available for prevention of the next exacerbation and the daily ongoing burden of asthma symptoms.

Added to unscheduled office visits, 3 of every 5 children with asthma[3] and more than half of working adults with asthma[4] have their life disrupted by the need to seek urgent or emergency care for their asthma each year.[5] Asthma is the reason for over 1.8 million emergency department (ED) visits and more than 400,000 hospitalizations each year.[5] About 10% of people with asthma have severe asthma, resulting in several urgent care and emergency care visits and a high risk of asthma-related hospitalization, in addition to missed school, work and activity days.[6-8]

Much of this burden is potentially preventable. However, several studies have demonstrated that this continuing asthma burden is not simply a need to prescribe more inhaled corticosteroids and bronchodilators.[9] Other factors must be considered, including triggers, medication adherence, and comorbid conditions.[10] Most people with asthma

have hypersensitivity that includes "allergic" reactions to environmental exposures. Such environmental exposures are common, with over 90% of homes having at least 3 detectable common aeroallergens and 73% having 1 or more at an elevated level.[11] The presence of an allergen in the home will not trigger asthma symptoms or exacerbations in a person without sensitization to that allergen. The study authors confirmed that in many sensitized people, the presence of common allergens at home is associated with increased asthma burden.

ASTHMA IS NOT WELL-CONTROLLED FOR MOST PRIMARY CARE PATIENTS

In a recent study of over 1200 family medicine patients with asthma, 56% of children, 52% of adolescents, and 63% of adults had uncontrolled asthma, with over 20% making 1 or more visits to the ED or hospital in the previous 6 months.[12] Several studies confirm that most Americans with asthma continue to have suboptimal control of symptoms, periodic asthma exacerbations, or both.[7,13,14] Widely disseminated asthma-treatment guidelines are available, along with a variety of generally effective pharmacotherapies.[15,16] Those guidelines highlight the need to supplement existing pharmacotherapy with attention to triggers that include irritants and allergens.

WHAT ARE NEXT STEPS IN DECREASING ASTHMA BURDEN?

Asthma is a condition of hypersensitivity to common exposures, associated with chronic airway inflammation, hyperreactivity, congestion, and airflow restriction. Whereas symptoms come and go, inflammation and hyperreactivity of airways are chronic and may be associated with persistent narrowing of the airways, even when the person "feels well." For most people with asthma, that inflammation is triggered or maintained by exposure to allergens to which they are sensitized. It is the need to address the sensitization to those allergens that is the basis for this supplement. ●

REFERENCES

1. Centers for Disease Control (CDC). https://www.cdc.gov/asthma/most recent data.htm. Accessed 13 July 2018.
2. Kwong KYC, Eghrari-Sabet JS, Mendoza GR, et al. The benefits of specific immunoglobulin E testing in the primary care setting. *Am Manage Care.* 2011;17:S447-S459.
3. Federal Interagency Forum on Child and Family Statistics. Indicators of Well-Being. Washington, DC: Federal Interagency Forum; 2012.
4. Mazurek JM, Syamlal G. Prevalence of Asthma, Asthma Attacks, and Emergency Department Visits for Asthma Among Working Adults - National Health Interview Survey, 2011-2016. *MMWR.* 2018;67(13):377-386.
5. Fuhlbrigge A, Reed ML, Stempel DA, Ortega HO, Fanning K, Stanford RH. The status of asthma control in the U.S. adult population. *Allergy Asthma Proc.* 2009;30(5):529-533.
6. Rank MA, Wollan P, Li JT, Yawn BP. Trigger recognition and management in poorly controlled asthmatics. *Allergy Asthma Proc.* 2010;31(6):99-105.
7. Sullivan SD, Rasouliyan L, Russo PA, Kamath T, Chipps BE. Extent, patterns, and burden of uncontrolled disease in severe or difficult-to-treat asthma. *Allergy.* 2007;62(2):126-133.
8. Yawn BP, Wechsler ME. Severe asthma and the primary care provider: identifying patients and coordinating multidisciplinary care. *Am J Med.* 2017;130(12):1479.
9. Papadopoulos NG, Arakawa H, Carlsen KH, et al. International consensus on (ICON) pediatric asthma. *Allergy.* 2012;67(8):976-997.
10. Lommatzsch M, Virchow JC. Severe asthma: definition, diagnosis and treatment. *Dtsch Arztebl Int.* 2014;111(50):847-855.
11. Salo PM, Wilkerson J, Rose KM, et al. Bedroom allergen exposures in US households. *J Allergy Clin Immunol.* 2018;141(5):1870-1879.e1814.
12. Yawn BP, Rank MA, Cabana MD, Wollan PC, Juhn YJ. Adherence to asthma guidelines in children, tweens, and adults in primary care settings: a practice-based network assessment. *Mayo Clinic Proc.* 2016;91(4):411-421.
13. Colice GL, Ostrom NK, Geller DE, et al. The CHOICE survey: high rates of persistent and uncontrolled asthma in the United States. *Ann Allergy Asthma Immunol.* 2012;108(3):157-162.
14. Yawn BP, Wollan PC, Rank MA, Bertram SL, Juhn Y, Pace W. Use of asthma APGAR tools in primary care practices: a cluster-randomized controlled trial. *Ann Fam Med.* 2018;16(2):100-110.
15. National Asthma Education and Prevention Program (NAEPP). Guidelines for the Diagnosis and Management of Asthma (EPR-3). https://www.nhlbi.nih.gov/health-pro/guidelines/current/asthma-guidelines/full-report. Accessed 31 May 2018.
16. GINA—Global Initiative for Asthma (GINA). Guidelines 2017. http://ginasthma.org. Accessed 21 May 2018.

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The Practical Application of Allergic Trigger Management to Improve Asthma Outcomes: *Step 1: Identify Patients with Allergic Components of Asthma*

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Kim thought back through her recent asthma visit. She had mentioned her concern about "hay fever" and wondered if anything else was triggering her asthma attacks. She completed the intake sheet and circled some things she thought made her asthma worse—but no one had commented on any of them. Did she have allergies? And were they making her asthma worse? Her asthma was certainly causing problems, including missing sleep and work, and interfering with her ability to care for her children and family. What should she do next?

DISCLOSURES

Dr. Liu discloses that he is a consultant for Thermo Fisher Scientific.

Dr. Luskin has no conflicts to disclose.

Dr. Brown reports that he is on the Board of Directors for Allergy and Asthma Network; an advisor and speaker for AstraZeneca; a speaker for Circassia Pharmaceuticals plc; a speaker for Integrity Continuing Education Inc.; an advisor for Novartis AG; a speaker for Teva Pharmaceutical Industries Ltd.; and an advisor for Thermo Fisher Scientific.

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Christine W. Wagner has an ongoing relationship with Thermo Fisher Scientific.

Dr. Yawn is a paid consultant and has an ongoing relationship with Thermo Fisher Scientific.

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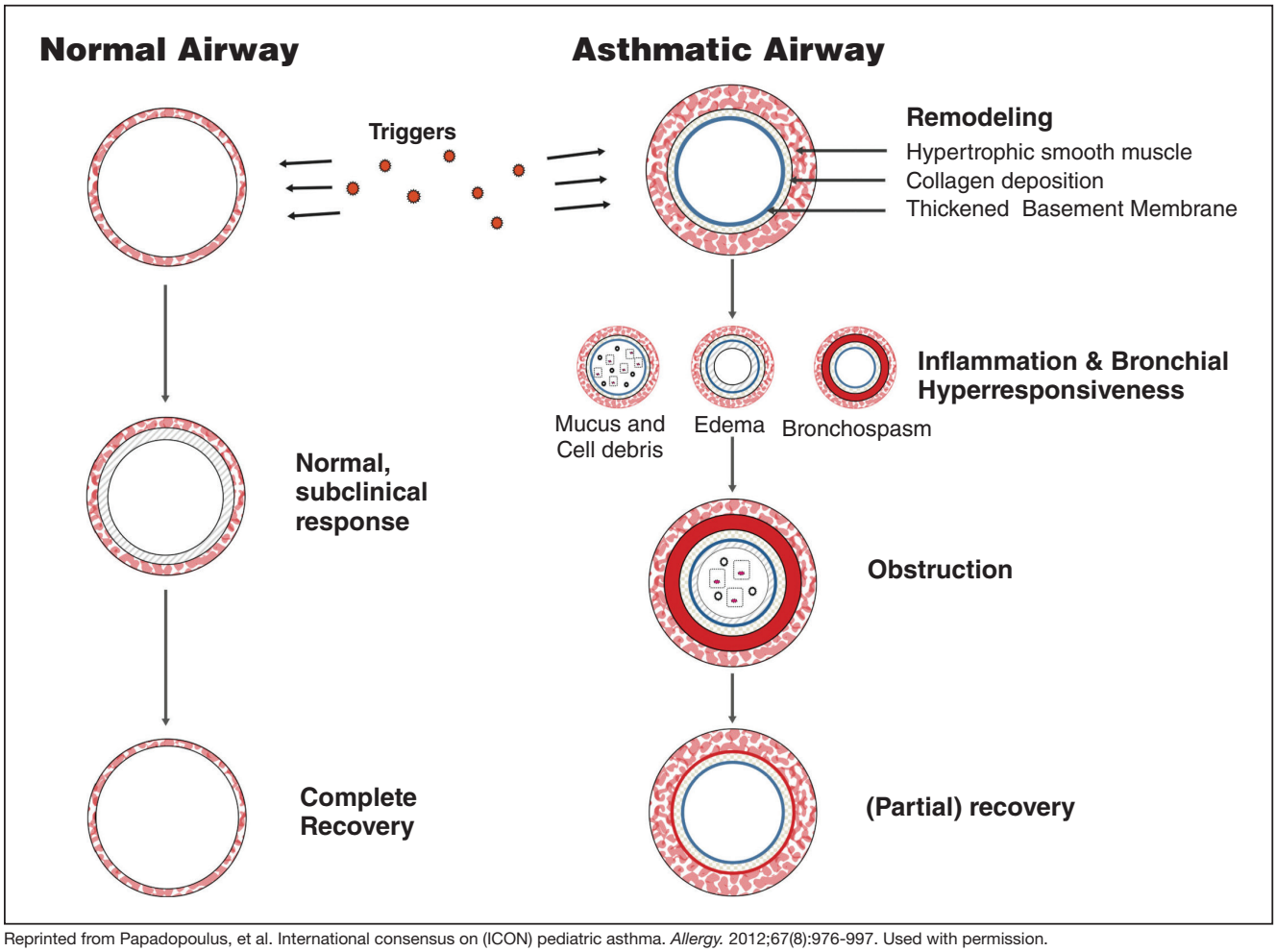
Kim's experience is not unusual. Although widely disseminated asthma-treatment guidelines are available, along with a variety of effective pharmacotherapies, most patients with asthma continue to have symptoms. Across all types of practices, almost half of adults with asthma (47%) report very poorly controlled asthma and another 24% report not well-controlled asthma.[1] Similarly, the prevalence of uncontrolled asthma in children with asthma in all practices is 46%.[2] In primary care practices, 63% of adults, 52% of adolescents, and 56% of children with asthma have inadequate asthma control.[3] Most people with asthma receive their care in a primary care setting, and most continue to have suboptimal control of symptoms and exacerbations.[3-7]

National and international guidelines strongly support the importance of evaluating and addressing environmental triggers that can make asthma worse and cause exacerbations.[8,9] The 2007 National Asthma Education and Prevention Program (NAEPP) US guidelines recommend evaluating the potential role of allergens, particularly indoor inhalant allergens.[8] This recommendation is considered "Evidence Category A" (ie, strong evidence from randomized controlled trials with a rich body of supportive data).[8] Since publication of these guidelines, additional compelling evidence has been published on the importance of recognizing and treating the allergic components of asthma.[10,11]

> Given the importance of allergens to asthma morbidity and asthma management, patients with persistent asthma should be evaluated for the role of allergens as possible contributing factors. —NAEPP. GUIDELINES FOR THE DIAGNOSIS AND MANAGEMENT OF ASTHMA (EPR-3)[8]

FIGURE 1 **Airway remodeling caused by asthma-associated inflammation[12]**



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ASTHMA AND INFLAMMATION

Asthma is a condition of hypersensitivity to common exposures, associated with chronic airway inflammation, bronchial hyperreactivity with increased mucus, and airway edema, obstruction, and narrowing. Symptom frequency and severity are variable, but the underlying inflammation and hyperreactivity of the airways are chronic and present even when a person "feels well." Over time, these symptoms may be associated with persistent narrowing and remodeling of the airways (**FIGURE 1**[12]).

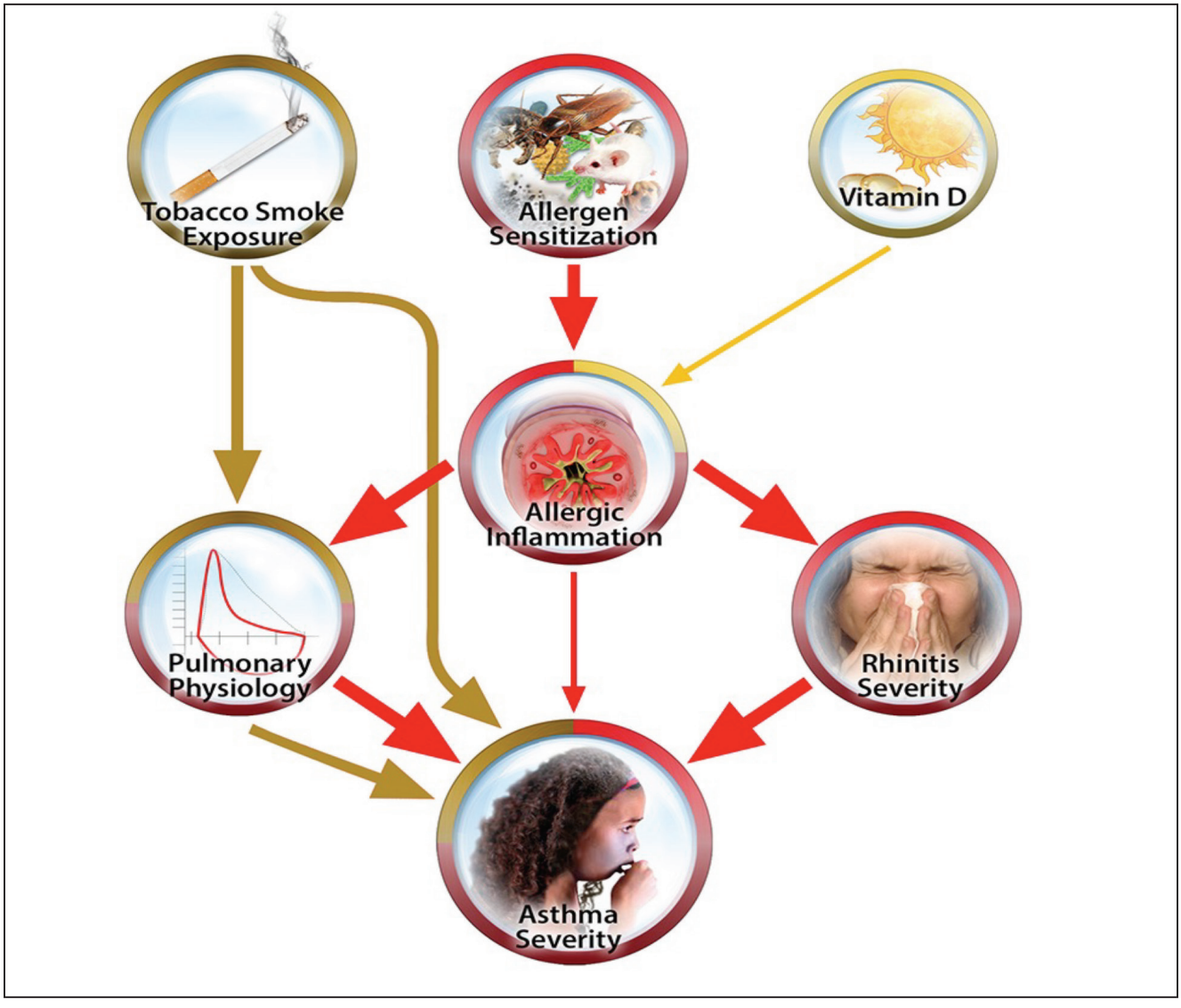
Sensitization

More than 80% of children and adolescents and 60% of adults[13,14] with asthma are sensitized to inhaled environmental allergens. Among all ages, 70% of patients with severe asthma are allergic.[15-17] There is a direct and causal relationship between allergic sensitization and asthma control and exacerbations.[18] For most people with asthma, hypersensitivity includes reactions to environmental exposures. Liu and colleagues summarized multiple pathways linked to asthma severity, including allergen sensitization (**FIGURE 2**).[19]

Long-term implications of inhaled allergen sensitization and exposure

In children, allergy is also a risk factor for asthma persistence (**FIGURE 3**[20]). Only 10% of children with nonallergic asthma at age 5 years continue to have asthma by age 12 years. In contrast, approximately 50% of children with allergic asthma continue to have symptoms at age 12 years.[20] Early sensitization to multiple inhalant allergens[21-23] and sensitization combined with perennial exposure in the home in early life[24] predict asthma persistence, exacerbation, and lung dysfunction.

FIGURE 2 **Pathways by which asthma risk factors contribute to asthma severity[19]**



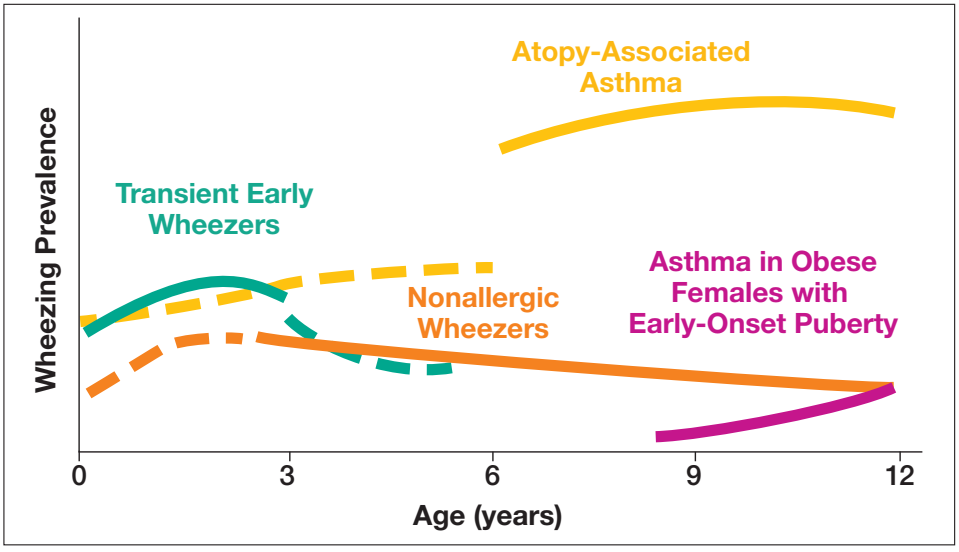
Red arrows indicate how allergy acts through multiple pathways (allergen sensitization, allergic inflammation, pulmonary physiology, and rhinitis severity) to affect asthma severity. The negative effect of tobacco smoke exposure is partially mediated by pulmonary physiology (olive arrows). Vitamin D is inversely associated with inflammation (yellow arrow) but its overall effect on asthma severity is insignificant.

Reprinted from Liu et al. Pathways through which asthma risk factors contribute to asthma severity in inner-city children. *J Allergy Clin Immunol.* 2016;138(4):1042-1050. ® 2016 with permission from Elsevier.

In sensitized children, adolescents, and adults, exposure to allergic triggers is associated with an increase in asthma symptoms, decreased lung function, and recurring asthma exacerbations. In addition, those with multiple inhaled allergen sensitizations are at increased risk of worse control, often resulting in sick visits to the office and visits to urgent care and the emergency department (ED),[25] as well as hospitalizations (**FIGURE 4**).[26] The number of asthma triggers a patient has is associated with the risk of exacerbations, more severe exacerbations, and poorer quality of life.[18]

Although viral infection is a common trigger for asthma exacerbations, especially in younger children, recent data demonstrate that allergen sensitization results in a significant increased risk of asthma exacerbation when there is a combination of allergen sensitization, exposure, and viral infection (**FIGURE 4**[26]). The allergic phenotype of asthma is associated with an impaired innate immune response

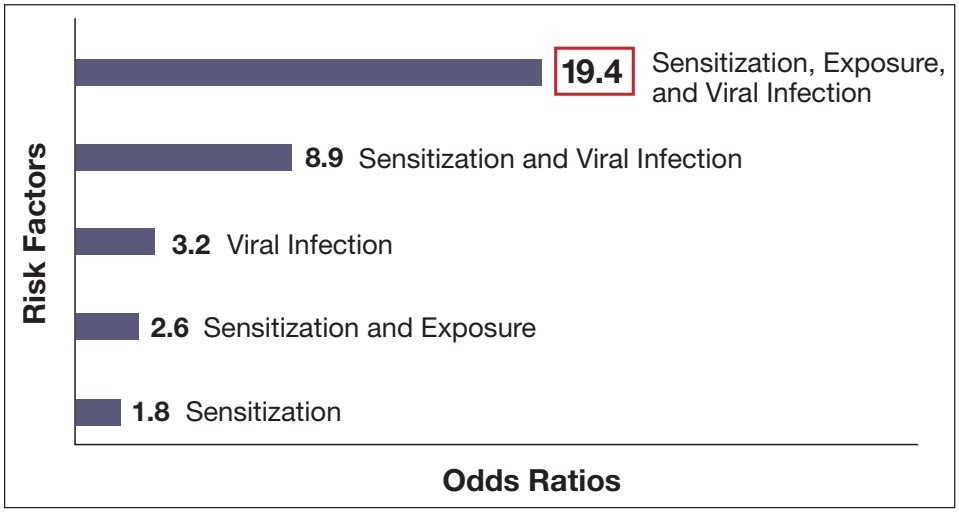
FIGURE 3 Children with persistent wheeze and inhalant allergies in preschool life are more likely to develop persistent asthma[20]



Approximately 50% of children with atopic asthma characterized by wheezing continue to have symptoms at age 12 years. Early sensitization to multiple inhalant allergens and sensitization combined with perennial exposure in the home in early life predict asthma persistence, exacerbation, and lung dysfunction.

Reprinted from Liu & Martinez. Chapter 2: Natural History of Allergic Diseases and Asthma. In: Leung DYM, et al. (eds.). *Pediatric Allergy: Principles and Practice*, 3rd ed. Elsevier, Inc.; 2016. ® 2016 with permission from Elsevier.

FIGURE 4 Allergen sensitization, exposure, and viral infection greatly increase the risk for asthma hospital admissions[26]



The risk (odds ratio) of severe asthma exacerbations resulting in hospitalization increases across groups of patients experiencing allergen sensitization, sensitization with exposure to allergen, viral infection (upper respiratory infection), and combinations of these factors.

to respiratory viral infection, mediated through immunoglobulin E (IgE). The link between viral infections and allergen sensitization is confirmed by the decreased risk of asthma exacerbation due to viral upper respiratory infection (URI) when IgE-directed therapy is prescribed for sensitized or "allergic" children and adolescents.[27,28]

The role of serum IgE

Total IgE levels have been used as an indicator of allergic asthma. Although higher levels of total serum IgE have been associated with poorer asthma outcomes[29,30] and higher health care costs,[31] these levels are variable, affected by genetics, race, cigarette smoking, and steroid use, and are, therefore, not a reliable indicator of allergen sensitization and not a substitute for specific IgE allergen testing. Significant allergy may exist with low or "normal" total IgE levels, and higher total IgE levels may exist without any significant specific allergic sensitization. Increasingly, overall allergen sensitization is being recognized as a major factor in asthma across all age groups and all levels of asthma severity.[32]

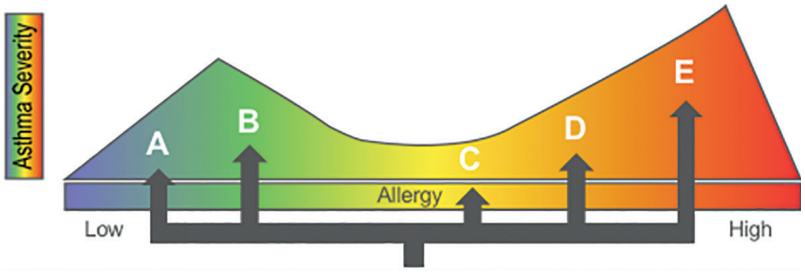
Asthma phenotypes

Recent evidence demonstrates that the common exacerbation-prone phenotype in US inner city children with asthma, representing 16% of these children, included sensitization to most common inhalant allergens for which they were tested (a mean of 14 sensitizations from a 22-allergen panel).[33] This indicates that exacerbation-prone asthmatic children are typically highly allergic to their environment. In the Epidemiology and Natural History of Asthma: Outcomes and Treatment Regimens (TENOR) study, there was a direct relationship between the number of allergens

to which adults, adolescents, and children were sensitized and their rates of exacerbations, the severity of those exacerbations, and the person's asthma-related quality of life.[32]

Zoratti and colleagues distinguished 5 potential asthma phenotypes (A, B, C, D, and E) in US inner city children, with asthma severity burdens ranging from minimal to high (**FIGURE 5**).[33] Children with phenotypes C, D, and E demonstrate progressively greater allergen sensitization and increasingly worse clinical conditions, likely representing classic T-helper type 2-driven allergic asthma. These allergic phenotypes also represent 70% of the study population and exhibit striking parallel relationships between allergic sensitization and indicators of asthma severity. Compatible with this picture of allergen-driven asthma, phenotype A represents the group with low sensitization levels and low asthma burden. Only phenotype B appears to highlight other non-allergic mechanisms of asthma that may result in significant asthma symptom burden.

FIGURE 5 Children with high asthma burden are highly allergic to their environment[33]



Asthma Phenotypes (N=616)					
	A (15%)	B (15%)	C (24%)	D (30%)	E (16%)
Asthma symptoms	Minimal	High	Minimal	Minimal	Highest
Lung function/ impairment	Normal	Mild	Minimal	Intermediate	Most
Allergen sensitization (no. of positive tests in 22-allergen panel)	1	2	9	13	14
Step in asthma medication plan*	1.39	4.2	1.93	3.4	4.7
Rhinitis symptom severity	Minimal	Intermediate	Minimal	High	High

* For a full description of asthma medication steps, refer to pages 46–52 of the EPR–3 Summary Report 2007.[8] The higher the step number (from 1 to 6), the more intense the medication regimen.

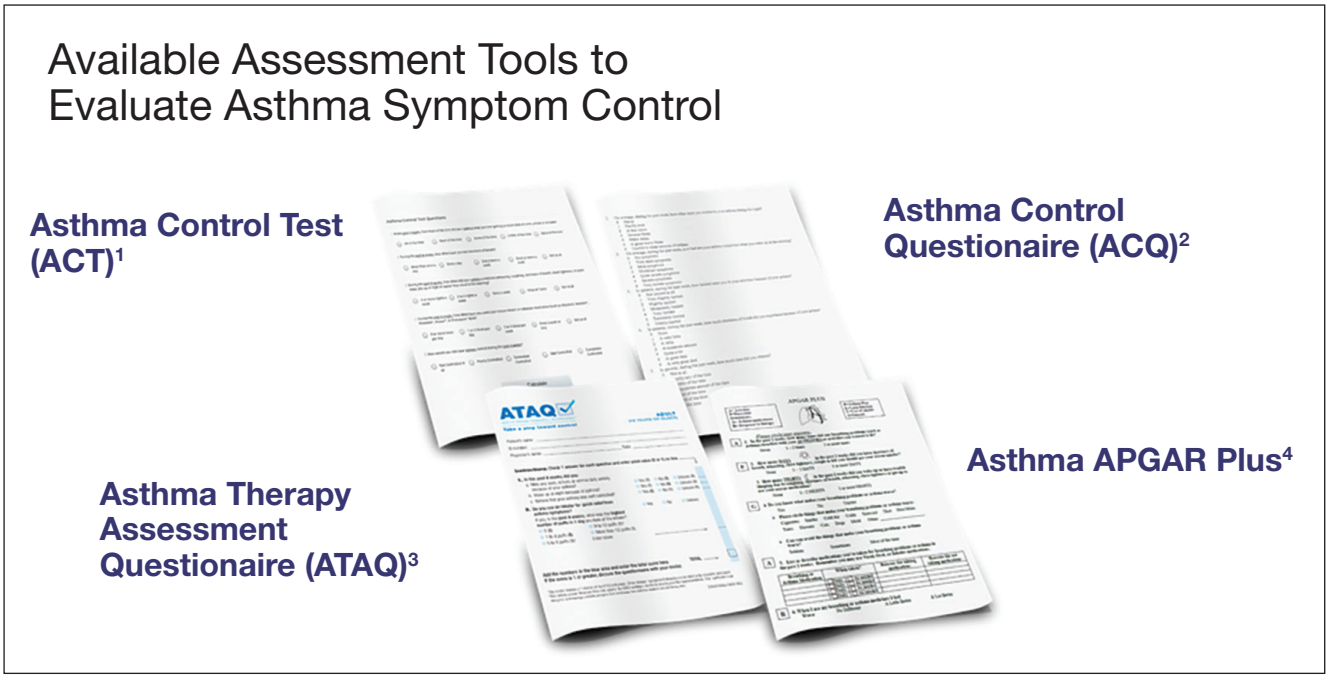
Reprinted from Zoratti, et al. Asthma phenotypes in inner-city children. *J Allergy Clin Immunol.* 2016;138(4):1016-1029. ® 2016 with permission from Elsevier.

THE PRIMARY CARE CHALLENGE

Three-quarters of people with asthma receive care in a primary care practice.[34] These people and their families continue to experience a significant asthma-related disease burden, with over 10.5 million offices visits, most of which are unscheduled and in primary care offices, added to 1.8 million ED visits and more than 400,000 hospitalizations annually.[12,35,36] Three of every 5 children and more than half of adults with asthma have had their life disrupted by the need to seek urgent or emergency care for their asthma each year.[37] About 10% of people with asthma have severe asthma, resulting in several urgent and emergency visits and a high risk of asthma-related hospitalization, in addition to missed school, work, and activity days.[38,39] Several studies have demonstrated that this continuing asthma burden is not simply the basis for prescribing more asthma medications; further evaluation should be undertaken.

Allergen avoidance and abatement (eg, environmental control), as well as allergy treatments such as immunotherapy (subcutaneous or sublingual), require identification of allergen sensitization. Particularly in children, allergy avoidance and immunotherapy have improved asthma control with decreased symptoms, decreased exacerbations, and decreased oral and inhaled corticosteroid(s) use.[40] Yet allergy evaluation was only discussed in about 33% of primary care office visits for asthma, and allergy testing was only documented in 2% of cases of asthma over the course of a year.[3] Several questionnaires to assess asthma control are available (**FIGURE 6**). A newly published study is the first to find that introducing an asthma tool—the Asthma APGAR Plus—into primary care practices improves patient and practice outcomes.[7] The Asthma APGAR Plus is the only tool that includes a brief patient query regarding aller-

FIGURE 6 **Assessment tools for asthma symptom control**



APGAR, Activities, Persistent, triGGers, Asthma medications, Response to therapy.

1. Nathan RA, et al. *J Allergy Clin Immunol*. 2004;113(1):59-65.

2. Juniper EF, et al. *Eur Respir J*. 1999;14(4):902-907.

3. Vollmer WM, et al. *Am J Respir Crit Care Med*. 1999;160(5 Pt 1):1647-1652.

4. Yawn BP, et al. *J Asthma Allergy*. 2008;31(1):1-10.

gies and triggers, designed to facilitate discussion of allergens and need for further allergy evaluation with patients. Using a tool to assess potential "allergies" is the first step in allergy evaluation, which often requires investigation and care over a number of visits, an important hallmark of the continuity of primary care.

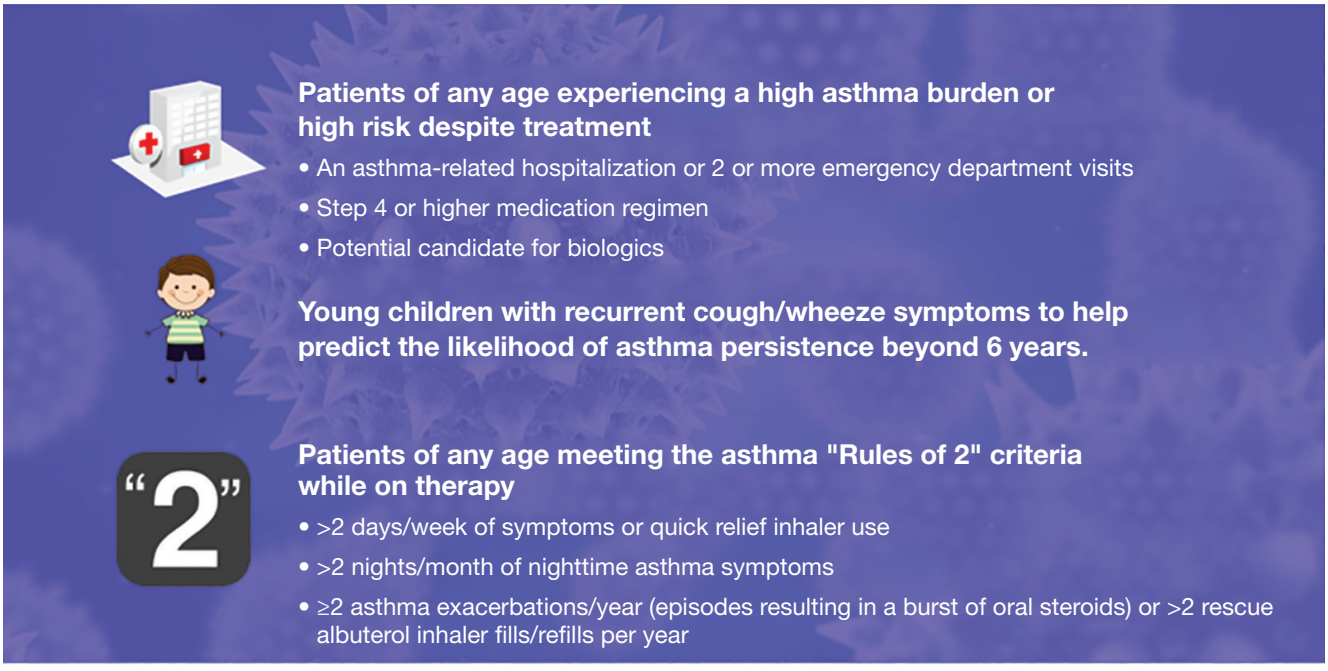
WHO SHOULD BE TESTED FOR INHALANT ALLERGEN SENSITIZATION?

All patients who have been given a diagnosis of persistent asthma should be evaluated to identify their allergic triggers. But this recommendation is not typically implemented in the primary care setting, where there are concerns about limited time, cost, and patient burden. A more practical approach is to identify the specific patient groups most likely to benefit from evaluation of the potential allergic contribution to asthma burden (**FIGURE 7**).

1. Patients of any age who continue to have high asthma burden or high risk despite treatment.
   a. A severe exacerbation requiring hospitalization
   b. Two or more ED asthma visits a year resulting in treatment with systemic corticosteroids, such as prednisone and dexamethasone
   c. Prescribed step-4 or step-5 asthma treatment, which includes high-dose ICS
   d. Those whose primary care clinician may consider them a potential candidate for biologic therapy but who have not yet had an allergy evaluation.

In this high-burden/high-risk asthma group, diagnostic testing for inhalant allergen sensitization can help identify people with high-risk asthma who are highly allergic; identify specific allergen exposures that can underlie their high asthma burden; and identify those who may benefit from specific asthma therapies to reduce their asthma burden, lower the risk of future exacerbation, limit the risk of side effects from high-dose ICS, and limit the morbidity and mortality of future exacerbations and the side-effects of "bursts" of oral corticosteroids (OCS) used to treat them.

FIGURE 7 **Patients in need of an allergy evaluation**



Rules of Two® is a registered trademark of Baylor Health Care System. Adapted from: Millard et al. *Proc (Bayl Univ Med Cent)*. 2014;27(2):79-82.

2. Young children with recurrent cough/wheeze symptoms to help predict their likelihood of persistence of "asthma" beyond age 6 years.

Inhalant allergen sensitization, atopic dermatitis, allergic rhinitis, and parental asthma are key risk factors to predict which preschoolers with recurrent respiratory symptoms, such as cough and wheeze, are most likely to develop persistent asthma. Allergen sensitization cannot be adequately assessed by history and physical exam alone. Diagnosing specific inhalant allergen sensitizations in at-risk children identifies those who are most likely to develop persistent asthma and allows opportunities for designing allergen-avoidance strategies that may improve outcomes.

3. Patients of any age meeting any of the asthma Rules of Two®* criteria while on daily controller or maintenance therapy.
   a. Having >2 days/week of asthma symptoms or quick relief inhaler use
   b. Having >2 nights/month of nighttime asthma symptoms
   c. Having ≥2 asthma exacerbations/year resulting in a burst of OCS
   d. Requiring >2 rescue albuterol inhaler fills/refills a year not when used just to cover different sites such as home/school/daycare/office.

*Registered trademark of Baylor Health Care System. Adapted from: Millard et al. *Proc (Bayl Univ Med Cent)*. 2014;27(2):79-82.

The presence of daytime and/or nighttime symptoms and/or the need for additional medication prompts the need for additional management. Diagnostic testing for inhalant allergen sensitization can identify specific allergen exposures that, when treated, may allow a step-down in high-dosage ICS therapy and may identify patients with asthma who may benefit from specific asthma therapies to reduce their asthma burden and risk of future exacerbations.

CHANGING PRACTICE

When exacerbations or out-of-control symptoms are recognized, a common approach is to simply add more medications, which is often expensive and ineffective.[4] Before considering any additional therapy, it is important that patients are receiving the prescribed therapy at the target site. High asthma burden is not necessarily a deficiency of prescribed pharmacotherapy. Two issues should always be addressed before adding more inhalers:

- *Is the patient taking the medications?*
- *Are the medications getting into the lungs?*

Nonadherence is a common problem that we discuss in the next article. Inadequate inhaler technique is also common and must be addressed by selecting inhaler or drug delivery devices tailored to the patient's age and capabilities.[3,41] After selecting the appropriate device, teaching, observing, and reassessing proper inhaler technique regularly can enhance drug delivery and improve unintentional nonadherence, decreasing symptom and exacerbation burden.

For many people with asthma, addressing adherence and inhaler technique fails to mitigate the underlying cause of bronchial hyperreactivity: the inflammatory response to allergic triggers. Identification of allergens to which the patient is sensitized and attempts to decrease allergen impact are also needed.[3] NAEPP guidelines[8] and the NAEPP Guideline Implementation Panel[42] recommend determining the patient's exposure to allergens, assessing sensitization from the medical history and skin or in vitro testing, and interpreting positive results in the context of the patient's medical history.[8] Accordingly, incorporating allergen identification into routine asthma management is the main goal of this supplement.

CONCLUSIONS

Assessing and dealing with asthma-related allergies can help prevent airway remodeling, reduce children's and adolescents' days of wheezing and asthma-related hospitalizations, and, in adults, reduce the necessity for quick-relief medications and nighttime awakenings. Although all people with asthma may be an appropriate candidate for aeroallergen sensitization assessment, the groups with the highest likelihood of benefit are those with high asthma burden, an uncertain asthma future, and uncontrolled symptoms.

Kim came into the office after another visit to the ED last month, where she was again given a diagnosis of "bronchitis," given oral corticosteroids plus antibiotics, and told to take her asthma medications regularly. The pharmacy filled the prescriptions from the ED, but told her that the usual asthma prescriptions were too old to refill and her children's prescriptions could not be refilled either, so she had no source of medication and is wheezing and short of breath again.

Today, Kim's Asthma APGAR score is 4—confirming her out-of-control asthma. She circled several triggers, including tobacco smoke, pets, and seasonal issues. She noted her incomplete adherence, due primarily to cost and lack of a current prescription for the asthma medications, and further reported that her asthma medications were only "somewhat helpful" even when used. Your diagnosis is difficult-to-control asthma, due to issues of adherence and unidentified triggers that have not been addressed. She asks you about allergies.

Kim and you agree to her continued use of daily moderate-strength ICS, combined with a long-acting beta-agonist bronchodilator. Upon review of inhaler technique, the medical assistant noted some errors that were corrected; final observation demonstrated adequate inhaler technique. Following discussion of Kim's suspected allergies and your expressed concerns about the potential impact of allergies on her asthma symptoms and exacerbations, she agrees to have the blood test for possible allergen sensitization but declines to visit an allergist at this time, due to concerns about getting time off work and visiting yet another physician. As Kim makes an appointment to return to review the allergy test results, she comments to your receptionist, "She is the first doctor who has bothered to listen to me about my asthma and allergies. I will give her another try." ●

REFERENCES

1. Murphy KR, Meltzer EO, Blaiss MS, Nathan RA, Stoloff SW, Doherty DE. Asthma management and control in the United States: results of the 2009 Asthma Insight and Management survey. *Allergy Asthma Proc*. 2012;33(1):54-64.
2. Stanford RH, Gilsenan AW, Ziemiecki R, Zhou X, Lincourt WR, Ortega H. Predictors of uncontrolled asthma in adult and pediatric patients: analysis of the Asthma Control Characteristics and Prevalence Survey Studies (ACCESS). *J Asthma*. 2010;47(3):257-262.
3. Yawn BP, Rank MA, Cabana MD, Wollan PC, Juhn YJ. Adherence to asthma guidelines in children, tweens, and adults in primary care settings: a practice-based network assessment. *Mayo Clinic Proc*. 2016;91(4):411-421.
4. Sullivan SD, Rasouliyan L, Russo PA, Kamath T, Chipps BE; TENOR Study Group. Extent, patterns, and burden of uncontrolled disease in severe or difficult-to-treat asthma. *Allergy*. 2007;62(2):126-133.
5. Fuhlbrigge A, Reed ML, Stempel DA, Ortega HO, Fanning K, Stanford RH. The status of asthma control in the U.S. adult population. *Allergy Asthma Proc*. 2009;30(5):529-533.
6. Colice GL, Ostrom NK, Geller DE, et al. The CHOICE survey: high rates of persistent and uncontrolled asthma in the United States. *Ann Allergy Asthma Immunol*. 2012;108(3):157-162.
7. Yawn BP, Wollan PC, Rank MA, Bertram SL, Juhn Y, Pace W. Use of asthma APGAR tools in primary care practices: a cluster-randomized controlled trial. *Ann Fam Med*. 2018;16(2):100-110.
8. National Asthma Education and Prevention Program (NAEPP). Guidelines for the diagnosis and management of asthma (EPR-3). www.nhlbi.nih.gov/health-pro/guidelines/current/asthma-guidelines/full-report. Accessed June 28, 2018.
9. Global Initiative for Asthma. Pocket guide for asthma management and prevention. https://ginasthma.org/wp-content/uploads/2017/02/wms-Main-pocket-guide_2017.pdf
10. Agency for Healthcare Research and Quality (AHRQ). Topic: Asthma. www.ahrq.gov/topics/asthma.html. Accessed June 28, 2018.
11. European Academy of Allergy and Clinical Immunology. AIT guidelines. www.eaaci.org/resources/guidelines/ait-guidelines-part-2.html. Accessed June 28, 2018.
12. Papadopoulos NG, Arakawa H, Carlsen KH, et al. International consensus on (ICON) pediatric asthma. *Allergy*. 2012;67(8):976-997.
13. Busse PJ, Cohn RD, Salo PM, Zeldin DC. Characteristics of allergic sensitization among asthmatic adults older than 55 years: results from the National Health and Nutrition Examination Survey, 2005-2006. *Ann Allergy Asthma Immunol*. 2013;110(4):247-252.
14. Høst A, Halken S. The role of allergy in childhood asthma. *Allergy*. 2000;55(7):600-608.
15. Wenzel SE. Asthma phenotypes: the evolution from clinical to molecular approaches. *Nat Med*. 2012;18(5):716-725.
16. Arbes SJ Jr., Gergen PJ, Vaughn B, Zeldin DC. Asthma cases attributable to atopy: results from the Third National Health and Nutrition Examination Survey. *J Allergy Clin Immunol*. 2007;120(5):1139-1145.
17. Moore WC, Bleecker ER, Curran-Everett D, et al; National Heart, Lung, and Blood Institute's Severe Asthma Research Program. Characterization of the severe asthma phenotype by the National Heart, Lung, and Blood Institute's Severe Asthma Research Program. *J Allergy Clin Immunol*. 2007;119(2):405-413.

18. Luskin AT, Chipps BE, Rasouliyan L, Miller DP, Haselkorn T, Dorenbaum A. Impact of asthma exacerbations and asthma triggers on asthma-related quality of life in patients with severe or difficult-to-treat asthma. *J Allergy Clin Immunol Pract*. 2014;2(5):544-552.e1-e2.
19. Liu AH, Babineau DC, Krouse RZ, et al. Pathways through which asthma risk factors contribute to asthma severity in inner-city children. *J Allergy Clin Immunol*. 2016;138(4):1042-1050.
20. Liu AH, Martinez FD. Chapter 2: Natural history of allergic diseases and asthma. In: Leung DYM, ed. *Pediatric Allergy: Principles and Practice*. 3rd ed. Atlanta, GA: Elsevier, Inc.; 2016:
21. Simpson A, Tan VY, Winn J, et al. Beyond atopy: multiple patterns of sensitization in relation to asthma in a birth cohort study. *Am J Respir Crit Care Med*. 2010;181(11):1200-1206.
22. Belgrave DC, Buchan I, Bishop C, Lowe L, Simpson A, Custovic A. Trajectories of lung function during childhood. *Am J Respir Crit Care Med*. 2014;189(9):1101-1109.
23. Havstad S, Johnson CC, Kim H, et al. Atopic phenotypes identified with latent class analyses at age 2 years. *J Allergy Clin Immunol*. 2014;134(3):722-727.e2.
24. Illi S, von Mutius E, Lau S, Niggemann B, Gruber C, Wahn U; Multicentre Allergy Study (MAS) group. Perennial allergen sensitisation early in life and chronic asthma in children: a birth cohort study. *Lancet*. 2006;368(9537):763-770.
25. Butz A, Morphew T, Lewis-Land C, et al. Factors associated with poor controller medication use in children with high asthma emergency department use. *Ann Allergy Asthma Immunol*. 2017;118(4):419-426.
26. Murray CS, Poletti G, Kebadze T, et al. Study of modifiable risk factors for asthma exacerbations: virus infection and allergen exposure increase the risk of asthma hospital admissions in children. *Thorax*. 2006;61(5):376-382.
27. Teach SJ, Gill MA, Togias A, et al. Preseasonal treatment with either omalizumab or an inhaled corticosteroid boost to prevent fall asthma exacerbations. *J Allergy Clin Immunol*. 2015;136(6):1476-1485.
28. Gill MA, Liu AH, Calatroni A, et al. Enhanced plasmacytoid dendritic cell antiviral responses after omalizumab. *J Allergy Clin Immunol*. 2018;141(5):1735-1743.e9.
29. Burrows B, Martinez FD, Halonen M, Barbee RA, Cline MG. Association of asthma with serum IgE levels and skin-test reactivity to allergens. *N Engl J Med*. 1989;320:271-277.
30. Borish L, Chipps B, Deniz Y, Gujrathi S, Zheng B, Dolan CM; TENOR Study Group. Total serum IgE levels in a large cohort of patients with severe or difficult-to-treat asthma. *Ann Allergy Asthma Immunol*. 2005;95(3):247-253.
31. Luskin AT, Antonova E, Broder M, Chang E, Omachi TA. Higher immunoglobulin E (IgE) levels are associated with greater emergency care and other healthcare utilization among asthma patients in a real-world data setting. *J Allergy Clin Immunol*. 2016;137(2 Suppl):AB9.
32. Chipps BE, Zeiger RS, Borish O, et al; TENOR Study Group. Key findings and clinical implications from The Epidemiology and Natural History of Asthma: Outcomes and Treatment Regimens (TENOR) study. *J Allergy Clin Immunol*. 2012;130(2):332-342.e10.
33. Zoratti EM, Krouse RZ, Babineau DC, et al. Asthma phenotypes in inner-city children. *J Allergy Clin Immunol*. 2016;138(4):1016-1029.
34. Kwong KYC, Eghrari-Sabet JS, Mendoza GR, et al. The benefits of specific immunoglobulin E testing in the primary care setting. *Am Manage Care*. 2011;17:S447-S459.
35. Asthma. Centers for Disease Control and Prevention; March 31, 2017. www.cdc.gov/nchs/fastats/asthma.htm. Accessed June 28, 2018.
36. Federal Interagency Forum on Child and Family Statistics. America's children in brief: Key national indicators of well-being, 2012. Washington, DC: US Government Printing Office. www.childstats.gov/pdf/ac2012/ac_12.pdf. Accessed June 28, 2018.
37. Most recent asthma data. Centers for Disease Control and Prevention; May 15, 2018. www.cdc.gov/asthma/most_recent_data.htm. Accessed June 28, 2018.
38. Zeiger RS, Schatz M, Dalal AA, et al. Utilization and costs of severe uncontrolled asthma in a managed-care setting. *J Allergy Clin Immunol*. 2016;4(1):120-129.e3.
39. Chipps BE, Haselkorn T, Rosén K, Mink DR, Trzaskoma BL, Luskin AT. Asthma exacerbations and triggers in children in TENOR: impact on quality of life. *J Allergy Clin Immunol*. 2018;6(1):169-176.e2.
40. Lin SY, Azar A, Suarez-Cuervo C, et al. *The Role of Immunotherapy in the Treatment of Asthma. Comparative Effectiveness Review No. 196* (Prepared by the Johns Hopkins University Evidence-based Practice Center under Contract No.290-2015-00006-I). AHRQ Publication No. 17(18)-EHC029-EF. Rockville, MD: Agency for Healthcare Research and Quality; March 2018. https://effectivehealthcare.ahrq.gov/sites/default/files/pdf/cer-196-full-immunotherapy-asthma.pdf. Accessed June 28, 2018.
41. Price DB, Roman-Rodriguez M, McQueen RB, et al. Inhaler errors in the CRITIKAL study: type, frequency, and association with asthma outcomes. *J Allergy Clin Immunol*. 2017;5(4):1071-1081.e9.
42. National Institutes of Health, National Heart Lung and Blood Institute. Guidelines implementationpanelreportfor:ExpertPanelReport3—guidelinesforthediagnosisandmanagementofasthma:Partnersputtingguidelinesintoaction.Bethesda,MD:USDepartmentofHealthandHumanServices;2008Dec.NIHPublicationNumber09-6147. www.nhlbi.nih.gov/guidelines/asthma/gip_rpt.pdf. Accessed June 28, 2018.

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The Practical Application of Allergic Trigger Management to Improve Asthma Outcomes: *Step 2: Identifying and Addressing Allergen Exposure in Daily Practice*

Christine W. Wagner, APRN, MSN, AE-C; Allan Luskin, MD; Len Fromer, MD, FAAFP; Barbara P. Yawn, MD, MSc, FAAFP; Randall Brown, MD, MPH; Andrew Liu, MD

In the previous article, we presented the rationale for allergy testing as part of asthma care and made recommendations for identifying patients with the greatest need for allergy assessment, testing, and interventions. Next, we present suggestions for prioritizing the allergens to be assessed, tests that identify allergen sensitization, and treatments, including avoidance, environmental control, pharmacotherapy, and immunotherapy.

Maristela Nabong-Nillas, MD, Chief of Pediatrics at Little River Medical Center, SC, speaks about asthma and allergy evaluation from firsthand experience:

"When I moved here, I noticed that many patients—perhaps one-third—had atopic problems, including allergy and asthma. During my career, asthma care has unfolded, from simply treating acute exacerbations that required hospitalization to allowing management for most asthma on an outpatient basis.

"Improving outcomes for patients with asthma requires a multicomponent coordinated effort. We were fortunate to be a part of The QTIP project (Quality Through Technology and Innovations in Pediatrics), a Federal CHIPRA (Children's Health Insurance Program Reauthorization Act) Quality Improvement grant in 2011 to address quality measures, including asthma management. We developed system-wide methods to identify people with persistent asthma using daily controller medication to see if they had asthma action plans, and had received evaluation for environmental triggers.

"Initially, we asked parents about suspected triggers and used their responses. At the time, trigger testing required referral to an allergist. Many of our patients did not want to or could not take this step. Now, we identify triggers based on blood work (specific immunoglobulin E [sIgE] testing). Parents are interested in knowing about triggers and like not having skin testing. Patients return after 2 weeks to discuss results. Positive results are followed up with face-to-face education and handouts explaining how to reduce exposure.

"If parents learn that environmental measures will help avoid triggers, they are open to testing. They're the ones who are up at night and they're appreciative if they know what to avoid. Negative results let us focus on nonallergic causes for symptoms. I have not had to admit any patients with asthma for the past 3 years because their asthma symptoms are being controlled."

DISCLOSURES

Christine W. Wagner has an ongoing relationship with Thermo Fisher Scientific.

Dr. Luskin has no conflicts to disclose.

Dr. Fromer has been a consultant and speaker for Thermo Fisher Scientific in the recent past.

Dr. Yawn is a paid consultant and has an ongoing relationship with Thermo Fisher Scientific.

Dr. Brown reports that he is on the Board of Directors for Allergy and Asthma Network; an advisor and speaker for AstraZeneca; a speaker for Circassia Pharmaceuticals plc; a speaker for Integrity Continuing Education Inc.; an advisor for Novartis AG; a speaker for Teva Pharmaceutical Industries Ltd.; and an advisor for Thermo Fisher Scientific.

Dr. Liu discloses that he is a consultant for Thermo Fisher Scientific.

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COMMON TRIGGERS/ALLERGENS AND EFFECTIVE CONTROL MEASURES

There is strong evidence that exposing patients with asthma

FIGURE 1 **Aeroallergen sensitization and exposure to common allergens and asthma severity and exacerbations[7-9]**

	Cat	Dog	Mold	*Alternaria*	Mice/Rat	Cockroach
Prednisone Bursts	↑[8]	↑[8]	↑[8]			
Urgent Care Visits	↑[8]			↑[8]	↑[7,9]	↑[7,9]
Hospitalizations	↑[8]	↑[8]	↑[8]	↑[8]	↑[7,9]	↑[7,9]

Blue arrows show that, for school-age children, sensitization and exposure to multiple allergens, such as mite, cat, dog, *Alternaria*, and cockroach, made asthma worse when they occurred together. Green arrows show that, for US inner-city children, the most important indoor allergens were cockroach and rat, and probably mice.

who are sensitized to certain indoor and outdoor aeroallergens increases symptoms in those with high asthma burden, resulting in frequent exacerbations.[1,2] Identifying sensitization to specific aeroallergens is required to guide appropriate targeted exposure control. The plan for environmental control is often complicated by the frequent presence of multi-sensitization, requiring multiple control measures. The National Asthma Education and Prevention Program (NAEPP) guidelines recommend using allergy testing to educate patients about the role of allergens in their disease and to delineate specific environmental control measures for sensitized patients experiencing symptoms.[3]

Relevance of identifying common allergens

Of all the relevant indoor antigens, house dust mite is the most common. There are very few locations in the United States in which house dust mites are not of concern. Only high altitude (>3,000 feet above sea level) protects against dust mites. Exposure to cockroaches and rodents is also common in certain areas of the United States—such as the Southeast, where cockroaches survive and breed indoors and outdoors. Rodent exposure may be more common in inner-city and rural areas. Strong evidence links indoor mouse allergen exposure in homes and schools to worsened asthma symptoms in sensitized children.[4-6] Sensitization to these indoor allergens is associated with increasing asthma severity and more frequent and severe exacerbations (**FIGURE 1**[7-9]). For school-age children in the Childhood Asthma Management Program (CAMP) study, sensitization and exposure to multiple allergens (mite, cat, dog, *Alternaria* fungi, and cockroach) made asthma worse. For US inner-city children in the National Cooperative Inner-City Asthma Study population, the most important indoor allergens were cockroach and rat, and probably mice. Half of the bedrooms of inner-city children had a high level of cockroach allergen.[7]

Indoor allergen sensitization is known to be greater among minority populations living in urban environments, compared to non-Latino whites.[10,11] In particular, black and Puerto Rican populations carry the highest risk of sensitization to those allergens that are most associated with asthma morbidity. African-American youth are more likely to have a mouse and/or cockroach sensitization profile independently associated with asthma exacerbations, acute care visits, and hospitalizations, compared to non-Latino white youth. So too, Puerto Rican and other Latino ethnic minorities are at higher risk of mouse sensitization and attributable asthma hospitalization compared to those of Mexican heritage.[10,11] This evidence highlights how a simple clinical risk stratification and personalized approach may impact critical outcomes among patients who shoulder disproportionate disease burden.

Although indoor allergens are of prime importance, assessing sensitization to seasonal outdoor allergens can also lead to improved outcomes. Associations exist between peak seasonal pollen and fungi levels and emergency department (ED) visits for asthma exacerbations.[12] Additionally, asthma exacerbations can increase dramatically after thunderstorms that expose sensitized patients to electrostatically fractured pollen and fungi.[13]

How will knowing sensitization affect my practice? Is effective therapy available?

When a person has confirmed sensitization, a history of symptoms, and a reaction compatible with exposure, 2 approaches can be considered:

- Trigger allergen reduction, which has demonstrated efficacy, especially in children

TABLE 1 Studies supporting environmental control measures[15-20]

Study	Results
Parikh (2018)[15]	For children with asthma hospital admissions, post-discharge referral for environmental mitigation programs, as part of comprehensive discharge education, helped reduce the hospital readmission rate.
Murray (2017)[16]	In children with asthma, a year-long study of dust mite-impermeable bed covers found a significant reduction in severe exacerbations requiring hospitalization, but no difference in exacerbations.
Rabito (2017)[17]	In homes of children with asthma, a simple cockroach-specific intervention with insecticide bait reduced asthma severity (eg, symptom burden), and modestly affected exacerbations.
Kercsmar (2006)[18]	In children with asthma, home remediation of dampness and mold demonstrated a significant reduction in exacerbations.
Shirai (2005)[19]	For people of all ages, a small (N=20) study of pet removal from homes of pet-allergic people with asthma demonstrated significant improvement, largely attributable to reduction in pet rodent or ferret exposure, not exposure to cats or dogs.
Morgan (2004)[20]	In inner-city children with asthma who were cockroach-sensitized, a multifaceted intervention, including establishing an environmentally safe sleeping zone, significantly reduced cockroach, dust mite, and cat allergen exposures; significantly reduced asthma symptom days and nights; and decreased missed school days, emergency department visits, and unscheduled office visits. Significantly reduced asthma symptoms continued during the year after the study ended.

- Targeted immunotherapy, which is not available for all allergens but is effective in both children and adults.

Effective exposure control measures

There is evidence that multifaceted environmental control measures are effective in reducing the burden of asthma, but no specific combination of interventions has proved more effective than others[14] (**TABLE 1**[15-20]). This evidence strengthens the imperative to correctly and accurately identify individual allergic sensitization so that appropriate allergen control measures can be initiated.

Patients with asthma who have allergy testing are significantly more likely to employ preventive strategies (an asthma plan, trigger avoidance, and medication adherence) and had fewer days with allergy symptoms than patients who had not been tested.[21] These outcomes were supported by a study of adults with moderately severe asthma,[22] who had an individualized plan, including environmental control based on the results of allergy testing (**FIGURE 2**[22]).

What therapies are available?

The immunoglobulin E (IgE)-directed therapies include environmental control, immunotherapy, and anti-IgE therapy (omalizumab). Environmental control is the initial therapy; particularly in children, simple changes have demonstrated effectiveness.

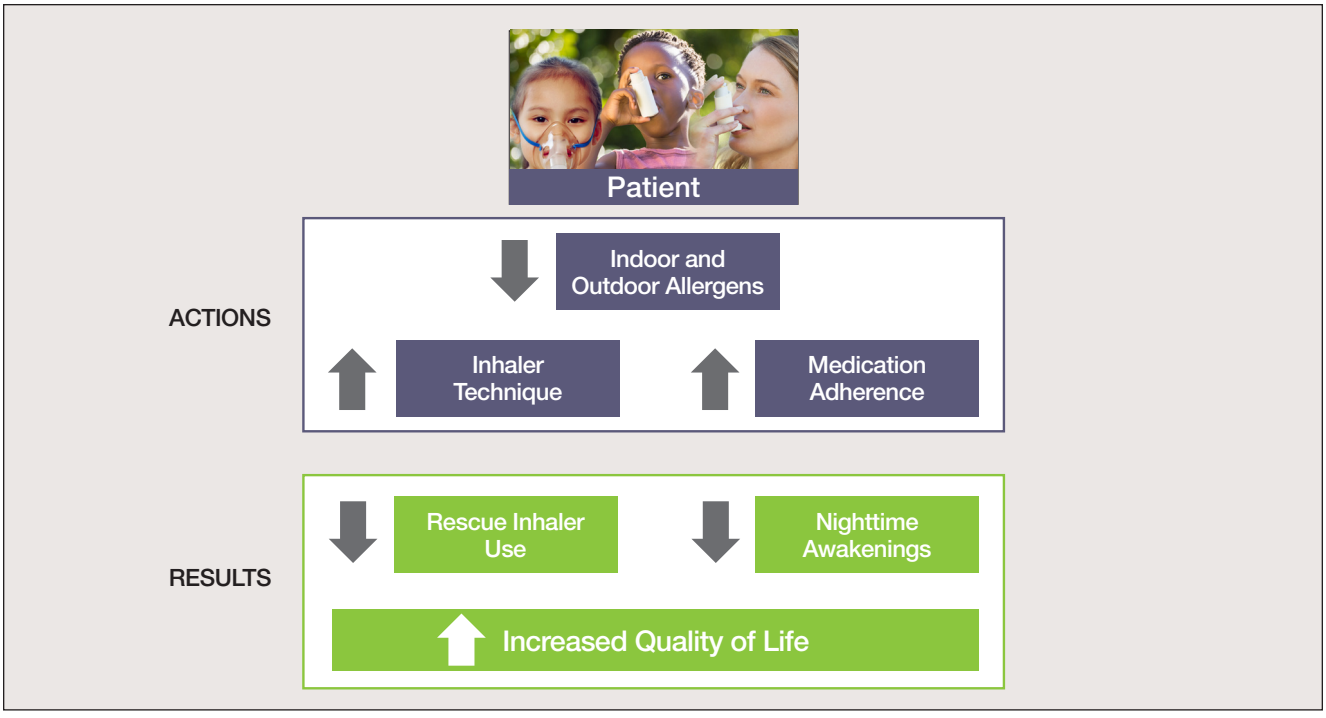
A recent meta-analysis funded by the Agency for Health Research and Quality (AHRQ) supports the value of identifying allergen sensitization to guide potential immunotherapy,[23] which may play an increasing role in allergy and asthma management with the availability of US Food and Drug Administration-approved sublingual immunotherapy (SLIT) for pollen and dust mite allergy. SLIT therapy is easy to administer, has few potential risks, and can be done within primary care practice. SLIT improves asthma symptoms, quality of life (QoL), and FEV_1, and reduces the use of long-term control medications. It may also reduce the use of quick-relief medications. Local reactions to SLIT are common but only infrequently require a change in therapy. Systemic reactions are so uncommon that home administration is recommended, making this therapy convenient.

Subcutaneous immunotherapy (SCIT) reduces use of long-term control medications and may also improve QoL and lung function (eg, FEV_1) and reduce the use of short-acting bronchodilators and systemic corticosteroids. SCIT offers more antigens but its use is limited by the need for office administration with monitoring, due to the potential for systemic, potentially severe, reactions.[23]

IDENTIFICATION OF ALLERGIC SENSITIZATION

The diagnosis of clinically significant sensitization requires both history and testing confirmation.[24] The gold standard for allergy diagnosis is the rarely used allergen exposure challenge. While allergy evaluation begins with a history, even with a structured history, allergy can be difficult to diagnose accurately. A structured allergy history alone can result in false-positives for perennial and seasonal allergens, as outlined in **FIGURE 3**.[25] Combining history with diagnostic

FIGURE 2 **An individualized plan, including environmental control, improves asthma symptoms[22]**



An individualized self-management plan decreased rescue inhaler use and nighttime awakenings and increased quality of life (QoL) among adults with asthma.

Adapted from: Janson et al. *J Allergy Clin Immunol.* 2009;123(4);840-846.

testing "improves the accuracy of an assessment of allergic status based on patient opinion or a structured allergy history alone."[25] Carefully performed skin testing and modern standardized in vitro testing have excellent specificity and sensitivity in the setting of a clinical history suggestive of allergic disease. These tests are not meant to be screening tests for large populations but rather to confirm or exclude the diagnosis of allergic triggers in the setting of clinically relevant symptoms.

How do I obtain the clinical history to suggest a need for testing?

Several questionnaires are available to facilitate the assessment of allergy history and to assist parents and patients, with the highest priority for those with high asthma burden as identified in the previous article: frequent exacerbations, high symptom burden, step-4 or step-5 asthma therapy, and for preschool children when parents want to better understand the risk of continuing asthma. The Asthma APGAR[26] tool combines an asthma "control score," a review of asthma medication adherence, patients' perception of their response to current therapy, and a short list of common triggers (**FIGURE 4**). Question 4 of the Asthma APGAR system is designed to begin a conversation with patients and families regarding potential aeroallergen sensitization. NAEPP guidelines also list questions that clinicians can use to elicit a history.[3]

Even without a specific asthma tool, 2 questions may help initiate this important conversation:

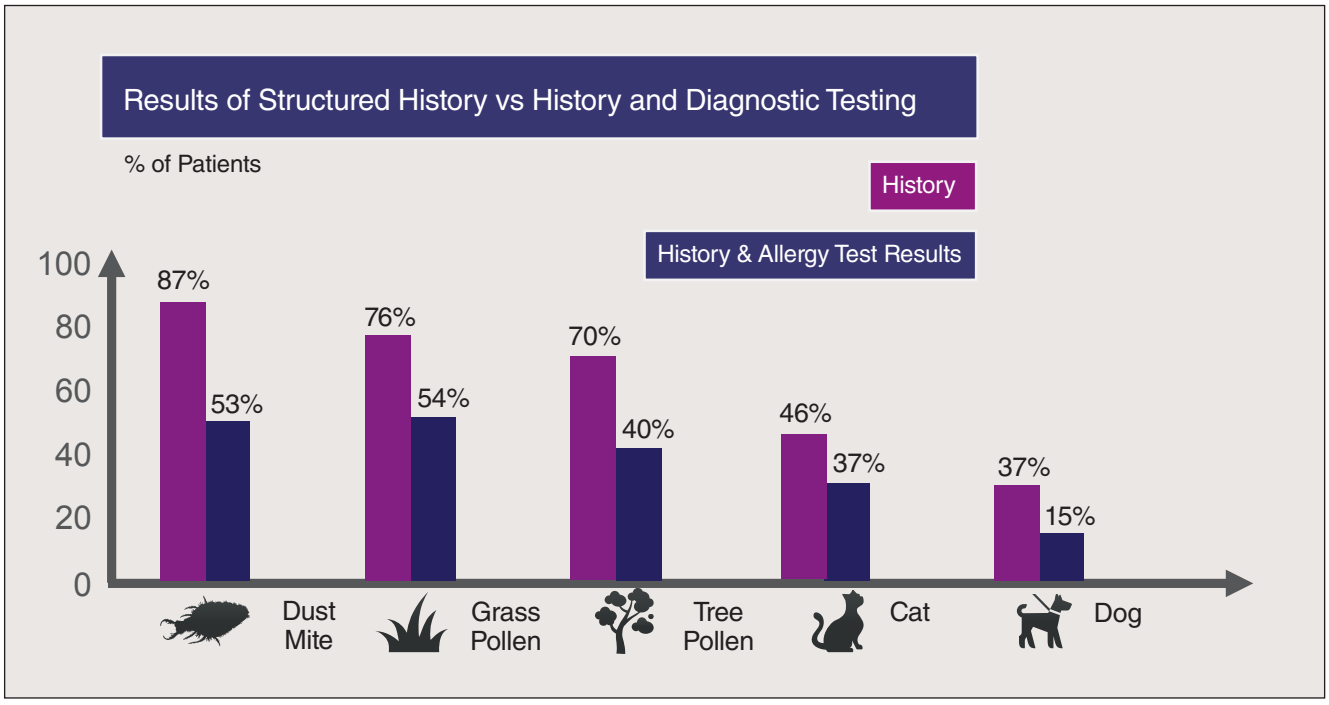
- *Do you know what is triggering your asthma, like smoke, allergies, or cold air?*
- *Have you had any type of allergy testing in the past?*

When the history is suggestive, it is appropriate to proceed to allergen-specific testing.

What testing is available?

Skin testing, either skin prick or intradermal testing, is typically performed by an allergy specialist. Another method of assessing sIgE sensitization is with in vitro diagnostic testing. NAEPP guidelines present the advantages of the 2 types of testing (**TABLE 2**).[3] Opinions on the comparative specificity and sensitivity of skin testing and in vitro testing vary. In general, they are comparable.

FIGURE 3 **History plus diagnostic testing improves diagnostic accuracy[25]**



Diagnoses based on history alone (purple bars) tended to overestimate the occurrence of allergen sensitization. The history confirmed by diagnostic IgE testing (blue bars) improved the accuracy of allergic status assessment.

Smith, el al. Is structured allergy history sufficient. *J Allergy Clin Immunol* 2009. 123 646-50.

Which test do I order?

The American College of Allergy, Asthma & Immunology/ American Academy of Allergy, Asthma and Immunology Specific IgE Test Task Force provides guidance regarding the use of allergy testing.

ACAAI/AAAAI Joint Task Force Recommendation

> Because most allergic patients are sensitized to multiple allergens, the task of determining which ones are of major importance is not a simple task. Because exposure to multiple allergens to which a patient is sensitized is likely to create a synergistic effect, optimal management may require identification and management for each of the relevant allergens. Panels of tests designed for specific seasons and geographical locations are available for this purpose.[27]

The availability of preselected allergen profiles greatly simplifies the task of choosing allergens for testing. For skin testing, the allergist performing the testing is likely to use a battery of common allergen substrates. For in vitro testing, regional respiratory profiles are available that include allergens typical of the geographic region or those known to be associated with allergic asthma. Including key regional allergens maximizes test efficiency without compromising the utility of test results.[27]

How do I interpret test results?

Skin-testing results are interpreted by the clinician supervising the testing. The referring physician or clinician should receive a report outlining the allergens tested and the results (positive or negative), based on the response to the allergen in millimeters and compared to positive and negative controls. Results can be used to guide avoidance or exposure reduction, consideration of immunotherapy, and reassurance when testing is negative.

In vitro testing is also used to confirm the history and to guide therapy, which includes environmental control, allergen avoidance and, if neither is possible or sufficient, to consider pharmacotherapy or immunotherapy. Therefore, the interpretation is based on evidence of sensitization (yes or no). Sharing test results with patients can help them understand the nature of their sensitization and target allergen-control efforts. Similarly, sIgE test results are useful for ruling out sensitization, sparing patients the effort and cost of avoiding allergens that are not causing their symptoms.

FIGURE 4 Asthma APGAR questionnaire[26]

Asthma APGAR

A = Activities
P = Persistent
G = triGGers
A = Asthma medications
R = Response to therapy

P = Asthma Plan
L = Lung fuction
U = Use of inhaler
S = Steroids

Please circle your answers:

A **1. In the past 2 weeks, how many times did any breathing problems (such as asthma) interfere with your ACTIVITIES or activities you wanted to do?**

Never (0) 1 – 2 times (1) 3 or more times (2)

P **2. How many DAYS in the past 2 weeks did you have shortness of breath, wheezing, chest tightness, cough or felt you should use your rescue inhaler?**

None (0) 1 – 2 DAYS (1) 3 or more DAYS (2)

3. How many NIGHTS in the past 2 weeks did you wake up or have trouble sleeping due to coughing, shortness of breath, wheezing, chest tightness or get up to use your rescue medication?

Never (0) 1 – 2 NIGHTS (1) 3 or more NIGHTS (2)

G **4. Do you know what makes your breathing problems or asthma worse?**

Yes No Unsure

- **Please circle things that make your breathing problems or asthma worse**

  Cigarettes Smoke Cold Air Colds Exercise Dust Dust Mites
  Trees Flowers Cats Dogs Mold Other:_____

- **Can you avoid the things that make your breathing problems or asthma worse?**

  Seldom Sometimes Most of the times

A **5. List or describe medications you've taken for breathing problems or asthma in the past 2 weeks: Remember you may use Nasal, Oral, or Inhaler medications.**

Breathing or Allergy Medication	When Taken?	Reasons for taking medication:	Reasons for not taking medication:
	☐ Daily	☐ As needed	
	☐ Daily	☐ As needed	
	☐ Daily	☐ As needed	
	☐ Daily	☐ As needed	

R **6. When I use my breathing or asthma medication I feel?**

Worse No Different A Little Better A Lot Better

TABLE 2 Advantages of skin testing and of in vitro testing[3]

Skin Testing	In Vitro Testing
• Less expensive than in vitro testing • Results are available within 30 min • Equally sensitive as in vitro tests • Results are visible to the patient; this may encourage compliance with environmental control measures	• Does not require knowledge of skin testing technique • Does not require availability of allergen extracts • Can be performed on patients who are taking medications that suppress the immediate skin test (antihistamines, antidepressants) • No risk of systemic reaction • Can be done for patients who have extensive eczema

FIGURE 5 illustrates how sIgE results may be reported. Specific IgE values ≥0.10 kU_A/L indicate sensitization; increasing values have been correlated with increased probability of symptoms. Ranking positive results from high to low specific IgE values helps prioritize targets for environmental control. In the sample report, the 3 highest sIgE values were for ragweed, *Alternaria*, and dog dander. It may be appropriate to focus on mold abatement and keeping the dog out of the bedroom (creating a reduced-allergen sleeping environment) as reasonable first steps in environmental control, in this example. A nonsedating antihistamine could be prescribed to control symptoms during seasons when outdoor allergens are present. A double-blind, randomized controlled trial found that cetirizine delayed or prevented development of asthma in infants who were sensitized to grass pollen.[28]

FIGURE 5 Specific IgE test results

Sample Report

	Results kU_A/L	Reference Range
Ragweed IgE	**23.55**	**<0.10 kU_A/L**
***Alternaria alternata* IgE**	**20.01**	**<0.10 kU_A/L**
Dog Dander IgE	**6.87**	**<0.10 kU_A/L**
Orchard Grass IgE	**1.23**	**<0.10 kU_A/L**
Bermuda Grass IgE	**1.22**	**<0.10 kU_A/L**
Elm Tree IgE	**0.94**	**<0.10 kU_A/L**
June/Kentucky Blue IgE	<0.10	<0.10 kU_A/L
Maple Tree IgE	<0.10	<0.10 kU_A/L
Oak Tree IgE	<0.10	<0.10 kU_A/L
Ash Tree IgE	<0.10	<0.10 kU_A/L
Birch Tree IgE	<0.10	<0.10 kU_A/L
Timothy Grass IgE	<0.10	<0.10 kU_A/L
Cockroach IgE	<0.10	<0.10 kU_A/L
D. farinae IgE	<0.10	<0.10 kU_A/L
D. pteronyssinus IgE	<0.10	<0.10 kU_A/L
Mouse Urine IgE	<0.10	<0.10 kU_A/L
Total IgE	76	<100 kU_A/L

For this patient, *Alternaria* and dog dander should be the targets of environmental control. A nonsedating antihistamine along with exposure reduction methods for pollens, especially during ragweed season, should also be considered.

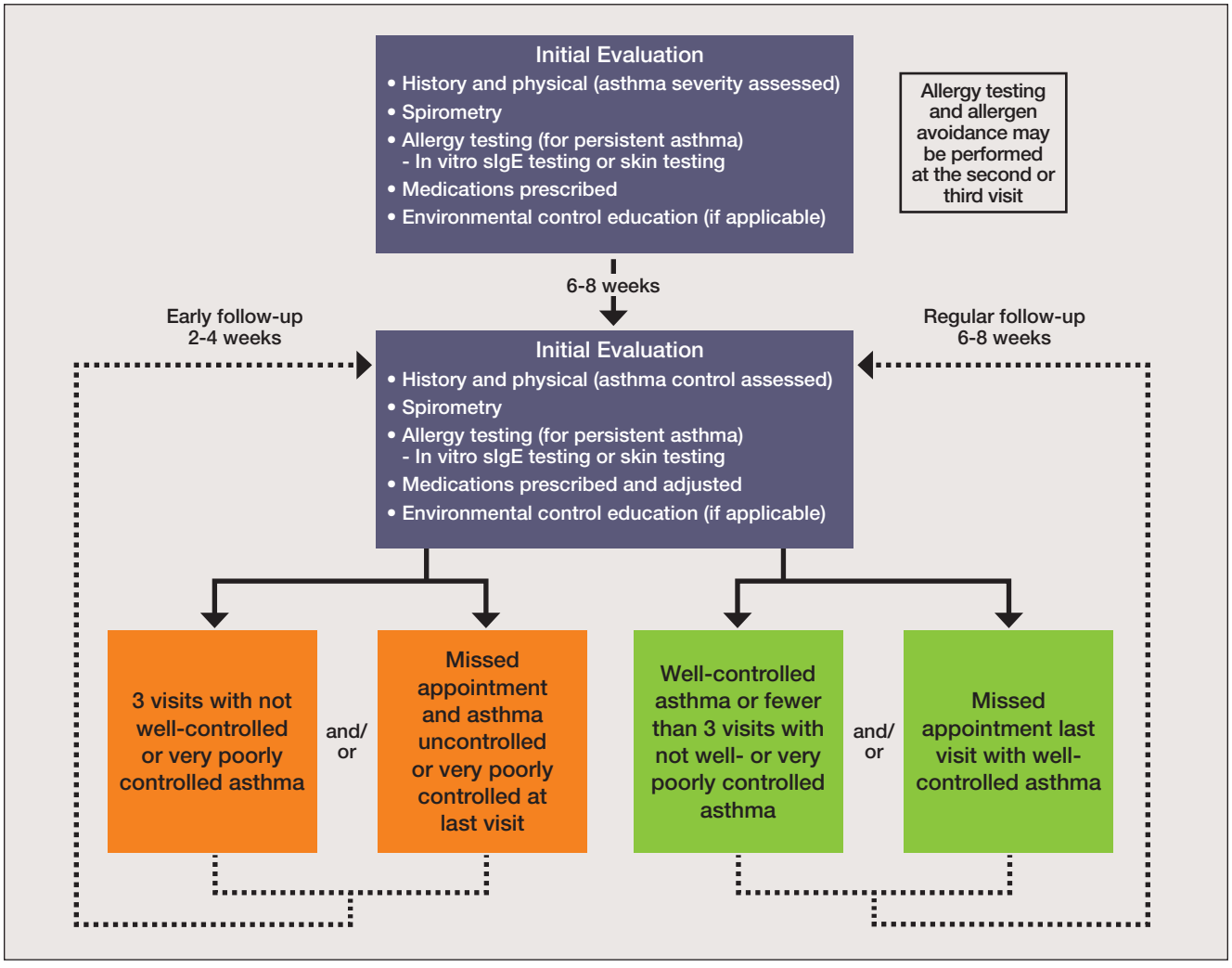
INCORPORATING ALLERGEN TESTING INTO DAILY PRACTICE—MORE THAN ORDERING THE TEST

Even when allergy testing is ordered, environmental control recommendations to address the results are often overlooked. This may be a particular problem for primary care health teams in which time and expertise on allergen avoidance and control are limited. A study by Cabana and colleagues evaluated barriers that pediatricians identified as interfering with their ability to implement NAEPP guidelines.[29] Although broad environmental counseling was not assessed, smoking cessation, 1 component of environmental counseling, was assessed. Lack of time was the barrier most often cited (by approximately 50% of respondents), followed by lack of educational materials, lack of support staff, and lack of reimbursement, all reported by more than 40% of the pediatricians. It is likely that primary care practices experience similar barriers to addressing allergies in people and families affected by asthma and allergies.

The time barrier

Time is a constant issue for enhancing care in clinical practice. For every activity added, some existing activity will have to be dropped or at least shortened. To minimize additional time commitments related to trigger identification, allergy assessment, and testing and teaching avoidance strategies, primary care physicians and practices have tried several methods with varying success. For patients with poorly controlled asthma or disruptive exacerbations, referral to an asthma specialist is possible. In other countries, respiratory practice nurses help educate patients and families suffering the greatest asthma burden. Some large health care systems in the United States have adopted similar systems staffed by registered nurses or nurse practitioners. Regrettably, not

FIGURE 6 Asthma disease-management pathways[34]



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all of these programs include trigger and allergy assessment. The Asthma APGAR system, which does include allergy assessment, is linked to a care algorithm that suggests next steps; practices using the system reported that "it saves time" and improves both patient and practice asthma outcomes.[26]

Staff support

In outpatient settings, few primary care clinics include a certified asthma educator who might have expertise in environmental control. However, it may be possible (for example, through www.naecb.com[30]) to find a certified asthma educator in your area to support these activities and educate your staff. Clinic staff usually includes only 1, if any, nurse and several medical assistants, who likely have had no education or training in environmental trigger avoidance. In some practices, lack of support may be managed by timely referral to an allergist; however, most patients with asthma will never see an asthma specialist. Therefore, primary care practices need support to become better-versed not only in allergy evaluations but also in dealing with evaluation results through trigger management. This requires staff education and access to appropriate educational materials to share with the patient and family.

A comprehensive systematic review of delivery of allergy services noted that primary care physicians do not receive structured instruction in allergy during their training, and few may be familiar with treatment guidelines, yet it concluded that many patients referred to specialists could be

easily managed in primary care if clinicians were appropriately trained.[31] The Physician Asthma Care Education (PACE) program demonstrated that interactive training for primary care physicians improved their patients' outcomes—specifically, asthma care plans, frequency of days with asthma symptoms, and ED utilization.[32] Access to the PACE program is available for primary care clinicians and practices, and group PACE programs may be available in your area.[33]

A simple plan for asthma office visits

Health-care professionals value clinically meaningful, patient-centered outcomes (frequency and severity of asthma symptoms, level of asthma control, QoL), as well as prudent resource utilization (fewer ED visits for asthma, fewer hospitalizations, fewer exacerbations). Instituting a simple plan for an initial asthma evaluation and follow-up visits, such as shown in **FIGURE 6**, may help staff manage patients more efficiently.[34] The pathways are adaptable to small and large practices and achieved good asthma outcomes on a sustainable basis. Repeat or follow-up visits are usually necessary to review key asthma education points and refine an asthma management plan.

Referring patients to allergy specialists

A percentage of patients require referral for subspecialty care. Further work is needed to understand better methods for expediting referral and ensuring that primary care–specialty care communication is timely and bidirectional.[35,36] According to a survey of pediatricians, they consider referral if a child has severe persistent asthma or a single life-threatening asthma event.[36] The top 2 reasons for referral were poor asthma control and unclear diagnosis. There has been increasing use of electronic consultation (eConsult) services to improve communication and access to subspecialists.[37] Initial evaluations also point to improved primary care satisfaction with this approach.[38] There is limited work in assessing the potential effectiveness of eConsults in improving allergen screening, counseling, management, and patient outcomes.

PATIENT ENGAGEMENT

Self-assessment

Given the limited time for patient clinic visits in primary care settings, there is a need to develop more efficient ways for health care providers to interact with patients[39] and counsel patients about how to avoid allergen exposure. Using a simple form that the patient completes prior to the clinician encounter can provide important information when considering allergy testing and making avoidance recommendations. The Asthma APGAR was developed by and within primary care practices and, in a large study, improved patients' asthma outcomes and the practice's guideline-concordant care.[26]

Available materials

Many of the written asthma trigger management materials that are readily available are not culturally appropriate or at the recommended reading level (at or below the 5th-grade level for the general US population).[40,41] Beyond general literacy concerns, materials may also require high health-literacy levels to read and understand. Of the trigger-management materials, many include multiple pages, cannot be tailored to the individual patient's needs, and are often written at a 10th- to 12th-grade reading level. Consequently, patients may never read or understand the materials they receive. Considering the importance of patient literacy levels for written materials, it may be useful to assess literacy using a simple and validated tool called *Quick Assessment of Literacy in Primary Care: The Newest Vital Sign*,[42]* Practices that care for non-English-speaking patients must also consider assessment of materials in other required languages.

*Available at www.ncbi.nlm.nih.gov/pmc/articles/PMC1466931.

Patient education

Patient education will be difficult and likely unsuccessful if primary health care team members are not well versed and comfortable providing evidence-based recommendations for trigger avoidance. Straightforward, concise educational modules on avoidance counseling should be available, including "user-friendly, systematic and step-wise techniques and tools for evaluation of a patient's environmental exposures."[43] **FIGURE 7** presents a sample of environmental control recommendations for dust mites that can be reviewed with the patient and taken home. This and other examples of patient education materials for allergen environmental control and avoidance can be found in the supplementary material.

New technology: apps and video

The ubiquity of smart phones and apps has provided mobile health with platforms to access patients and monitor patient data in real-time. These platforms might also be useful for asthma education, and to help patients identify triggers or be aware of real-time environmental changes (eg, with air quality or air pollution). Regrettably, a review of over 100 asthma apps noted that none "combined reliable, comprehensive information about the condition with supportive tools for self-management."[44] In addition, another review noted that "apps for asthma lack clinical evaluation and are often not based on medical guidelines."[45] Further work is needed to understand how these technologies could improve allergen control and asthma outcomes.

FIGURE 7 **Sample of practical environmental control measures***

Your child [_____] is allergic to the checked items. Taking the recommended steps listed below will help reduce his/her allergy and asthma symptoms.

Date tested:_____ Date reviewed_____ by_____

☐ Dust Mites—Present All Year

- Dust mites are sensitive to light and can pull their water out of humid air. They like to burrow down into upholstered furniture, carpeting, mattresses, pillows, and stuffed animals.
- Your child's bedroom should be addressed first, then the rest of the house.
  - —Put dust-proof casings on pillows and mattresses where your child sleeps.
  - —Wash bedding weekly, in hot (130°F) water, if possible.
  - —Avoid heavy drapery and use vinyl blinds or washable curtains.
  - —Reduce dust catchers, especially in the bedroom (books, stuffed animals, etc.).
  - —Vacuum and dust thoroughly when your child is not present. This can be done once a week unless there is a reason to vacuum more often.
  - —Use a vacuum with a HEPA filter or double-layered bag if possible.
  - —If possible, remove carpeting, at least from the bedroom. Floors that can be swept or mopped are best.

*Developed and used in practice by Christine W. Wagner, APRN, MSN, AE-C. Only the dust mite section of the complete handout is shown here.

Video applications that are tailored to a specific practice or group of practices allow physicians or nursing staff to pre-record short messages for patients on a variety of topics, such as use of daily and quick-relief inhalers, inhaler instructions for each of the inhaler types, and messages about triggers. Messages are recorded once and made available to patients via several online formats. This system has several advantages:

- *Messages come from the patient's care team*
- *Messages can be used over and over by patients*
- *Messages are available in the clinic and at home.*

CONCLUSIONS

Asthma continues to be a significant burden for patients, families, health care systems, schools, employers, and health-care insurers and payers. To date, implementation of existing guidelines has been modest and focused on medications, with limited emphasis on identifying triggers or allergens that impede efforts to control asthma symptoms and to decrease the burden for everyone. More than 90% of US households harbor potential asthma triggers.[46] Simplifying the process for clinicians to identify patients who would benefit from allergy testing, using an environmental questionnaire, will increase the number of patients receiving allergy testing. Providing patient-friendly educational materials using only the individual patient's recommendations at an appropriate literacy level will increase the likelihood of the patient taking steps to improve the environment as related to asthma triggers.

Implementation of trigger testing and environmental controls has been successful at Little River Medical Center in South Carolina for several reasons. First, aeroallergen blood testing is simple and can be ordered during routine appointments. Whereas spirometry and trigger testing once required specialist referrals, both can now be done in the primary care setting.

Second, it's a team effort with nursing staff supporting the physicians. Nurses document symptoms, explain and monitor inhaler technique, and educate about positive triggers. Peer chart reviews also track the use of controller medications and asthma action plans.

Third, there is continuity of care. Regular follow-up visits allow therapy to be individualized and adjusted based on current symptoms and asthma control. Rather than seeing patients only during acute crises, the medical team uses regular appointments to educate patients and families so that they can avoid asthma exacerbations. This fosters continued patient engagement and reinforces the recommendations in the asthma action plan. ●

REFERENCES

1. Institute of Medicine Committee on the Assessment of Asthma and Indoor Air. Division of Health Promotion and Disease Prevention. *Clearing the Air: Asthma and Indoor Air Exposures*. Washington, DC: The National Academies Press; 2000.
2. Kanchongkittiphon W, Mendell MJ, Gaffin JM, Wang G, Phipatanakul W. Indoor environmental exposures and exacerbation of asthma: an update to the 2000 review by the Institute of Medicine. *Environ Health Perspect*. 2015;123(1):6-20.
3. National Asthma Education and Prevention Program (NAEPP). Guidelines for the diagnosis and management of asthma (EPR-3). www.nhlbi.nih.gov/health-pro/guidelines/current/asthma-guidelines/full-report. Accessed June 28, 2018: [see pages 169, 187, and 188].
4. Matsui EC, Eggleston PA, Buckley TJ, et al. Household mouse allergen exposure and asthma morbidity in inner-city preschool children. *Ann Allergy Asthma Immunol*. 2006;97(4):514-520.
5. Ahluwalia SK, Peng RD, Breysse PN, et al. Mouse allergen is the major allergen of public health relevance in Baltimore City. *J Allergy Clin Immunol*. 2013;132(4):830-835.e1-e2.
6. Sheehan WJ, Permaul P, Petty CR, et al. Association between allergen exposure in inner-city schools and asthma morbidity among students. *JAMA Pediatr*. 2017;171(1):31-38.
7. Rosenstreich DL, Eggleston P, Kattan M, et al. The role of cockroach allergy and exposure to cockroach allergen in causing morbidity among inner-city children with asthma. *New Engl J Med*. 1997;336(19):1356-1363.
8. Nelson HS, Szefler SJ, Jacobs J, Huss K, Shapiro G, Sternberg AL. The relationships among environmental allergen sensitization, allergen exposure, pulmonary function, and bronchial hyperresponsiveness in the Childhood Asthma Management Program. *J Allergy Clin Immunol*. 1999;104(4 Pt 1):775-785.
9. Perry T, Matsui E, Merriman B, Duong T, Eggleston P. The prevalence of rat allergen in inner-city homes and its relationship to sensitization and asthma morbidity. *J Allergy Clin Immunol*. 2003;112(2):346-352.
10. Yang JJ, Burchard EG, Choudhry S, et al. Differences in allergic sensitization by self-reported race and genetic ancestry. *J Allergy Clin Immunol*. 2008;122(4):820-827.
11. Fishbein AB, Lee TA, Cai M, et al. Sensitization to mouse and cockroach allergens and asthma morbidity in urban minority youth: Genes-environments and admixture in Latino American (GALA-II) and Study of African-Americans, Asthma, Genes, and Environments (SAGE-II). *Ann Allergy Asthma Immunol*. 2016;117(1):43-49.e41.
12. Reid MJ, Moss RB, Hsu YP, Kwasnicki JM, Commerford TM, Nelson BL. Seasonal asthma in northern California: allergic causes and efficacy of immunotherapy. *J Allergy Clin Immunol*. 1986;78(4 Pt 1):590-600.
13. Wark PA, Simpson J, Hensley MJ, Gibson PG. Airway inflammation in thunderstorm asthma. *Clin Exp Allergy*. 2002;32(12):1750-1756.
14. Leas BF, D'Anci KE, Apter AJ, et al. Effectiveness of indoor allergen reduction in management of asthma. Comparative Effectiveness Review No. 201. (Prepared by the ECRI Institute–Penn Medicine Evidence-based Practice Center under Contract No. 290-2015-0005-I.) AHRQ Publication No. 18-EHC002-EF. Rockville, MD: Agency for Healthcare Research and Quality; February 2018. https://effectivehealthcare.ahrq.gov/topics/asthma-nonpharmacologic-treatment/final-report-indoor-allergen-reduction. Accessed June 29, 2018.
15. Parikh K, Hall M, Kenyon CC, et al. Impact of discharge components on readmission rates for children hospitalized with asthma. *J Pediatr*. 2018;195:175-182.e2.
16. Murray CS, Foden P, Sumner H, Shepley E, Custovic A, Simpson A. Preventing severe asthma exacerbations in children: a randomized trial of mite-impermeable bedcovers. *Am J Respir Crit Care Med*. 2017;196(20:150-158.
17. Rabito FA, Carlson JC, He H, Werthmann D, Schal C. A single intervention for cockroach control reduces cockroach exposure and asthma morbidity in children. *J Allergy Clin Immunol*. 2017;140(2):565-570.
18. Kercsmar CM, Dearborn DG, Schluchter M, et al. Reduction in asthma morbidity in children as a result of home remediation aimed at moisture sources. *Environ Health Perspect*. 2006;114(10):1574-1580.
19. Shirai T, Matsui T, Suzuki K, Chida K. Effect of pet removal on pet allergic asthma. *Chest*. 2005;127(5):1565-1571.
20. Morgan WJ, Crain EF, Gruchalla RS, et al. Results of a home-based environmental intervention among urban children with asthma. *N Engl J Med*. 2004;351(11):1068-1080.
21. Stingone JA, Claudio L. Disparities in allergy testing and health outcomes among urban children with asthma. *J Allergy Clin Immunol*. 2008;122(4):748-753.
22. Janson SL, McGrath KW, Covington JK, Cheng SC, Boushey HA. Individualized asthma self-management improves medication adherence and markers of asthma control. *J Allergy Clin Immunol*. 2009;123(4):840-846.
23. Lin SY, Azar A, Suarez-Cuervo C, Diette GB, et al. Role of immunotherapy in the treatment of asthma. Comparative Effectiveness Review No. 196 (Prepared by the Johns Hopkins University Evidence-based Practice Center under Contract No.290-2015-00006-I). AHRQ Publication No. 17(18)-EHC029-EF. Rockville, MD: Agency for Healthcare Research and Quality. March 2018. https://effectivehealthcare.ahrq.gov/topics/asthma-immunotherapy/research. Accessed June 29, 2018.
24. Williams PB, Ahlstedt S, Barnes JH, Söderstrom L, Portnoy J. Are our impressions of allergy test performances correct? *Ann Allergy Asthma Immunol*. 2003;91(1):26-33.
25. Smith HE, Hogger C, Lallemant C, Crook D, Frew AJ. Is structured allergy history sufficient when assessing patients with asthma and rhinitis in general practice? *J Allergy Clin Immunol*. 2009;123(3):646-650.
26. Yawn BP, Wollan PC, Rank MA, Bertram SL, Juhn Y, Pace W. Use of Asthma APGAR tools in primary care practices: a cluster-randomized controlled trial. *Ann Fam Med*. 2018;16(2):100-110.
27. Cox L, Williams B, Sicherer S, et al; American College of Allergy, Asthma and Immunology Test Task Force; American Academy of Allergy, Asthma and Immunology Specific IgE Test Task Force. Pearls and pitfalls of allergy diagnostic testing: report from the American College of Allergy, Asthma and Immunology/American Academy of Allergy, Asthma and Immunology Specific IgE Test Task Force. *Ann Allergy Asthma Immunol*. 2008;101(6):580-592.
28. Warner JO; ETAC Study Group. Early Treatment of the Atopic Child. A double-blinded, randomized, placebo-controlled trial of cetirizine in preventing the onset of asthma in children with atopic dermatitis: 18 months' treatment and 18 months' posttreatment follow-up. *J Allergy Clin Immunol*. 2001;108(6):929-937.
29. Cabana MD, Rand CS, Becher OJ, Rubin HR. Reasons for pediatrician nonadherence to asthma guidelines. *Arch Pediatr Adolesc Med*. 2001;155(9):1057-1062.
30. National Asthma Educator Certification Board. Find a certified asthma educator. www.naecb.com. Accessed 18 June 2018.
31. Diwakar L, Cummins , Lilford R, Roberts T. Systematic review of pathways for the delivery of allergy services. *BMJ Open*. 2017;7(2):e012647.
32. Cabana MD, Slish KK, Evans D, et al. Impact of physician asthma care education on patient outcomes. *Pediatrics*. 2006;117(6):2149-2157.
33. National Institutes of Health. National Heart, Lung, and Blood Institute. The PACE curriculum. www.nhlbi.nih.gov/health-pro/resources/lung/physician-asthma-care-education/curriculum.htm. Accessed June 29, 2018.
34. Kwong KY, Redjal N, Scott L, Li M, Thobani S, Yang B. Adaptation of an asthma management program to a small clinic. *Am J Manag Care*. 2017;23(7):e231-e237.
35. Ryan D, Gerth van Wijk R, Angier E, et al. Challenges in the implementation of the EAACI AIT guidelines: A situational analysis of current provision of allergen immunotherapy. *Allergy*. 2018;73(4):827-836.
36. Poowuttikul P, Kamat D, Thomas R, Pansare M. Asthma consultations with specialists: what do the pediatricians seek? *Allergy Asthma Proc*. 2011;32(4):307-312.
37. Keely EJ, Archibald D, Tuot DS, Lochnan H, Liddy C. Unique educational opportunities for PCPs and specialists arising from electronic consultation services. *Acad Med*. 2017;92(1):45-51.
38. Liddy C, Afkham A, Drosinis P, Joschko J, Keely E. Impact of and satisfaction with a new eConsult service: a mixed methods study of primary care providers. *J Am Board Fam Med*. 2015;28:394-403.
39. Smith H, Horney D, Goubet S, et al. Pragmatic randomized controlled trial of a structured allergy intervention for adults with asthma and rhinitis in general practice. *Allergy*. 2015;70(2):203-211.
40. The Joint Commission. Advancing Effective Communication, Cultural Competence, and Patient- and Family-Centered Care: A Roadmap for Hospitals. www.jointcommission.org/assets/1/6/ARoadmapforHospitalsfinalversion727.pdf. Oakbrook Terrace, IL: The Joint Commission; 2010. Accessed June 29, 2018.
41. Centers for Disease Control and Prevention. Healthy People 2010. Objective 11-2 data. htpp://wonder.cdc.gov/data2010/focus.htm. Accessed June 29, 2018.
42. Weiss BD, Mays MZ, Martz W, et al. Quick assessment of literacy in primary care: the newest vital sign. *Ann Fam Med*. 2005;3(6):514-522.
43. National Institutes of Health. National Heart, Lung. and Blood Institute. Guidelines Implementation Panel Report for: Expert Panel Report 3—Guidelines for the diagnosis and management of asthma. Washington, DC: U.S. Dept. of Health and Human Services; December 2008:32.
44. Huckvale K, Car M, Morrison C, Car J. Apps for asthma self-management: a systematic assessment of content and tools. *BMC Med*. 2012;10:144.
45. Tinschert P, Jakob R, Barata F, Kramer JN, Kowatsch T. The potential of mobile apps for improving asthma self-management: a review of publicly available and well-adopted asthma apps. *JMIR Mhealth Uhealth*. 2017;5(8):e113.
46. Salo PM, Wilkerson J, Rose KM, et al. Bedroom allergen exposures in US households. *J Allergy Clin Immunol*. 2018;141(5):1870-1879.e14.

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Integrating Allergic Trigger Management into Primary Care Asthma Management: *Step 3: A Significant Opportunity for Payers and Health Systems*

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In the first 2 articles, we presented the evidence for aeroallergen impact on asthma and the need to identify the people most likely to benefit from allergic trigger evaluation (**TABLE 1**). Next, we outlined the available methods to evaluate and confirm aeroallergen sensitization, as well as appropriate evidence-driven prevention and treatment strategies. Despite this knowledge and the available tools, most people with asthma do not receive an allergy assessment as part of their asthma management.[1] Integrating aeroallergen evaluation and trigger management into practice is often met with barriers. This article focuses on innovative ways of overcoming the system-wide barriers to delivering excellent asthma care.

DISCLOSURES

Dr. Brown reports that he is on the Board of Directors for Allergy and Asthma Network; an advisor and speaker for AstraZeneca; a speaker for Circassia Pharmaceuticals plc; a speaker for Integrity Continuing Education Inc.; an advisor for Novartis AG; a speaker for Teva Pharmaceutical Industries Ltd.; and an advisor for Thermo Fisher Scientific.

Dr. Madison has no conflicts to disclose.

Dr. Fromer has been a consultant and speaker for Thermo Fisher Scientific in the recent past.

Dr. Lucas has no conflict to disclose.

Steve Clark has no conflict to disclose.

Dr. Cabana is on the Merck Speakers' Bureau and consults with Novartis AG, Genentech, Inc., and Thermo Fisher Scientific.

Christine W. Wagner has an ongoing relationship with Thermo Fisher Scientific.

Dr. Yawn is a paid consultant and has an ongoing relationship with Thermo Fisher Scientific.

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TABLE 1 Patients in need of an allergy evaluation

Patients of any age experiencing a high asthma burden or high risk despite treatment.
• An asthma-related hospitalization or 2 or more emergency department visits
• Step 4 or higher medication regimen
• Potential candidate for biologics
Young children with recurrent cough/wheeze symptoms to help predict the likelihood of asthma persistence beyond 6 years.
Patients of any age meeting the asthma "Rules of 2"*criteria while on therapy.
• >2 days/week of asthma symptoms or quick relief inhaler use
• >2 nights/month of nighttime asthma symptoms
• ≥2 asthma exacerbations/year (episodes resulting in a burst of oral steroids) or >2 albuterol rescue inhaler fills/refills per year

*Rules of Two® is a registered trademark of Baylor Health Care System. Adapted from: Millard et al. *Proc (Bayl Univ Med Cent)*. 2014;27(2):79-82.

Kim is an African-American woman who has self-identified several possible "allergies" that she admittedly self-treats. On her previous visit, she agreed to confirm her aeroallergen sensitivities and you ordered a panel of "allergy blood tests." You are aware that she is a member of a racial group historically known for being at higher risk of asthma-related morbidity and mortality than non-Hispanic Caucasian adults.

Today, you begin by reviewing Kim's Asthma APGAR score, which has fallen from 6 to 4 with fewer episodes of missed or modified activities that she thinks are a result of using her current medications more regularly. But she still reports both days and nights with asthma symptoms. She is taking her "regular" inhaler and shows you the inhaled corticosteroid/long-acting beta agonist (ICS/LABA) combination,

but says she still needs to use the quick-relief medication (a short-acting beta agonist) several times a week. You also see that the medical assistant reports that Kim's inhaler technique for the dry-powder inhaler ICS/LABA combination is much better—adequate, today.

You and Kim discuss her allergic sensitization results, noting that she has significant levels on at least 4 of the allergens that were tested, including dust mites, cockroaches, grass pollen, and mold. You discuss how exposure to these triggers may be affecting her asthma and, at least in part, may explain her problems with frequent symptoms and "asthma attacks."

Health systems and payers serve large patient populations and patients are generating information that can improve their outcomes and reduce costs. Health care is moving toward an integrated system, in which data are available across stakeholders, including multiple health care systems, patients, pharmacies, and other health care resources, to drive both transparency and performance (**FIGURE 1**). Patient-oriented data can answer key questions: What are the best treatments? What facilitates improved care? How can quality and cost be balanced and managed? Where are there gaps that require innovation? In fact, this publication arose from a gap in asthma care identified by the National Heart Lung and Blood Institute Guideline Implementation Panel: Allergen and irritant exposure control was 1 of 6 priority messages designed to "close the disparity gap for quality asthma care and to promote the principles of patient-centered care."[2]

OPPORTUNITIES FOR IMPROVING POPULATION HEALTH

Learning from improved outcomes in other chronic diseases, the use of "big data" or electronic population health data to identify individual patients most likely to benefit from enhanced asthma care and allergy evaluation is warranted. Population asthma outcomes and health-related data can be produced for most health care clinics or systems. These data may be used to initiate allergy assessment and evaluation in response to the continuing large clinical, family, and cost burden of asthma in the United States. Data

FIGURE 1 **Data can drive both transparency and performance**

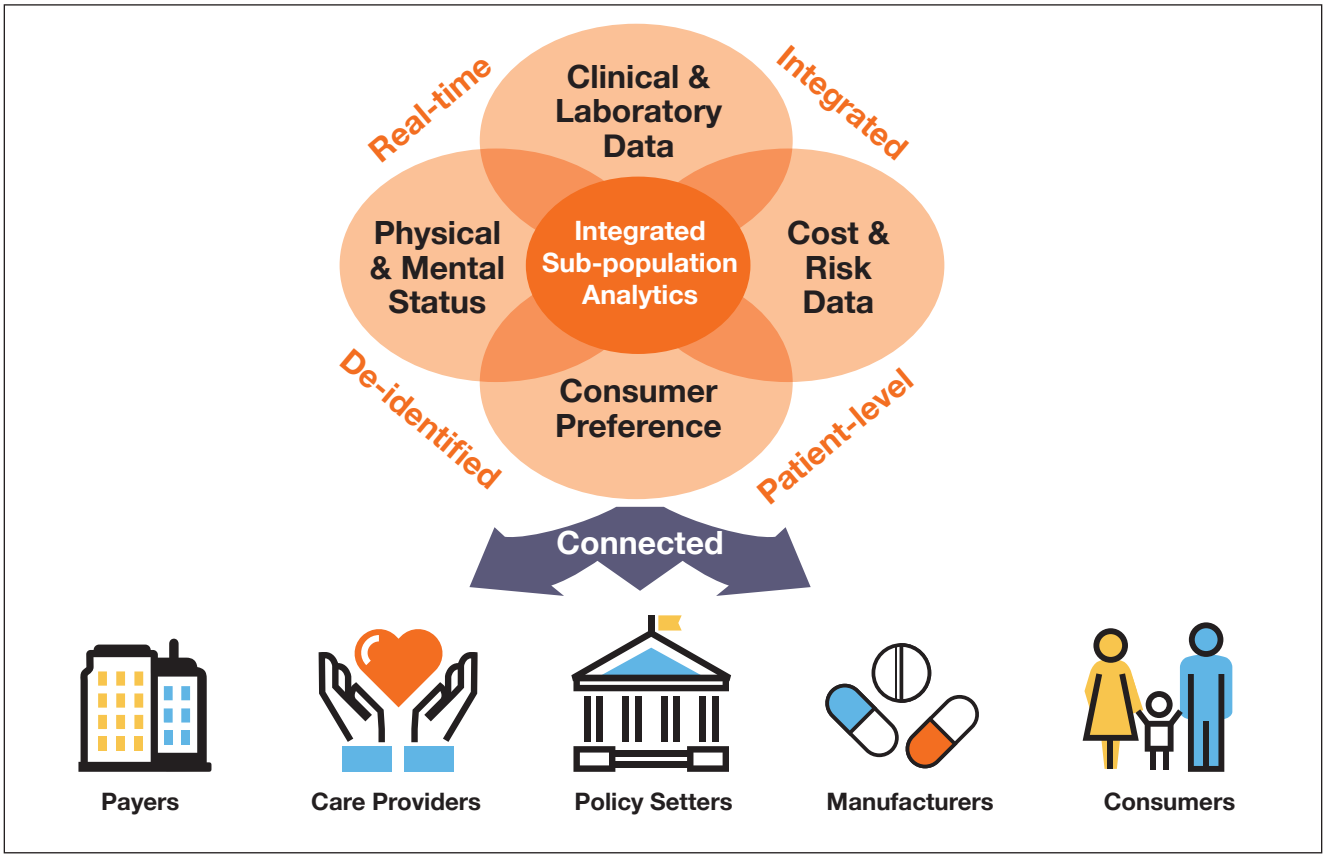
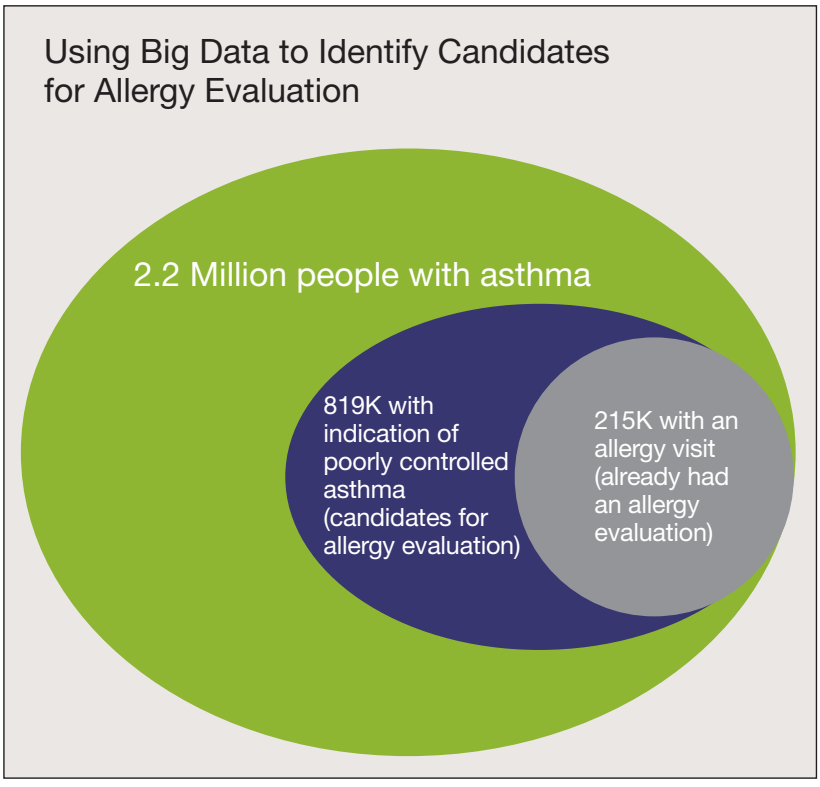


FIGURE 2 **Identifying patients in specific populations**



A database search of patients with asthma can flag those who might benefit from allergy evaluation or more intensive management. The numbers here are based on an exploratory review of data from a large health care system. The 2.2 million people had 2 or more ICD-9 or ICD-10 asthma codes in an 18-month period. The 819,000 had either 2 or more asthma-related ED visits in a year, or an asthma hospitalization, or were on step-4 or step-5 asthma therapy (eg, including a high-dosage ICS in combination with other maintenance drugs).

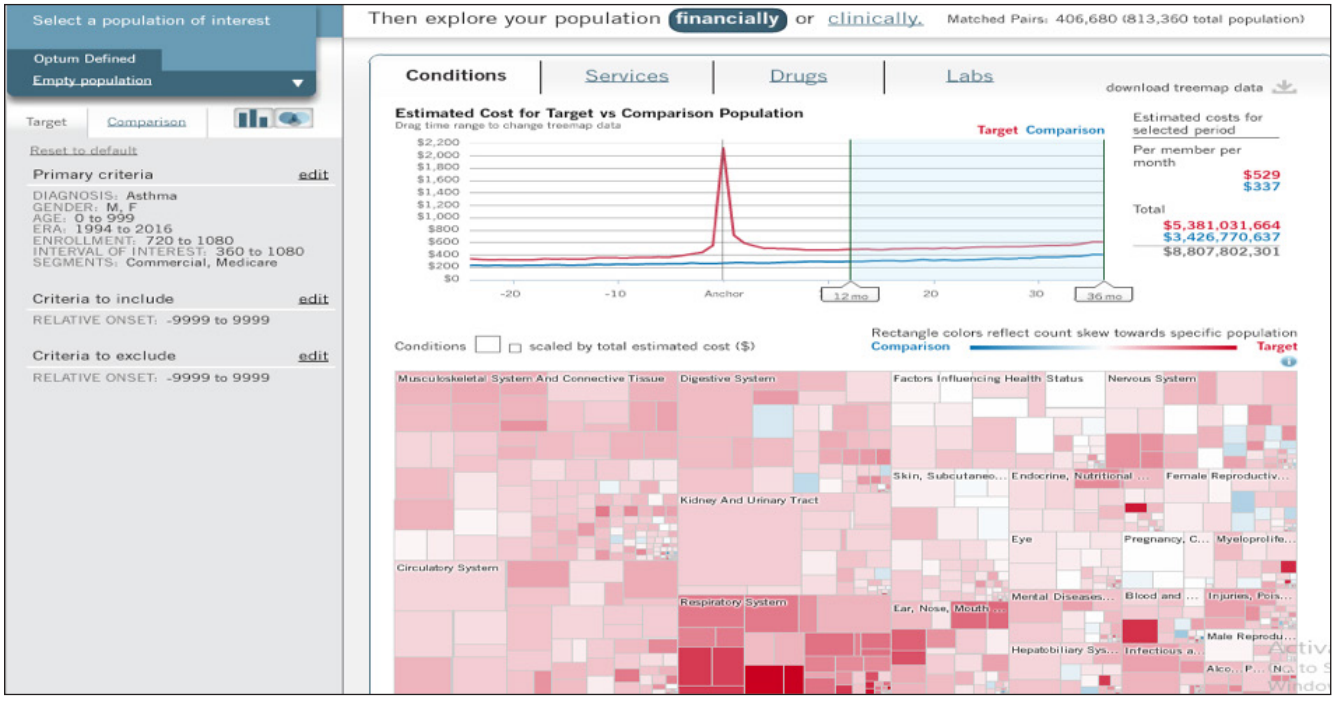
searching does not rely solely on individual clinicians' skills, interest, or available time to determine which patients are candidates for further allergy assessment.

For example, patients with poorly controlled asthma could be selected for allergy evaluation or more intensive management (**FIGURE 2**). Because asthma control scores are not yet widely used, other health care data can be used to identify patients with asthma who have frequent exacerbations, especially those resulting in costly, burdensome, and disruptive visits to the emergency department (ED) or hospitalizations—proxies for poor asthma control. Using billing and ICD-10 (10th Revision of the International Classification of Diseases) codes, everyone with asthma can be identified. Defining those with "asthma" as patients with at least 2 visits in the past 18 months with an asthma code can help limit the group to people most likely to have asthma, and not those who may have had a "rule out" diagnosis or an asthma code to justify short-term inhaler use for a respiratory event or postviral cough. The prescription order system can then be used to identify people with asthma who have been prescribed 3 or more months of daily maintenance therapy with an ICS/LABA combination or, for younger children, a prescription for an ICS at a moderate-to-high dosage or an ICS plus montelukast. These are patients with step-4 and step-5 asthma therapy, according to the 2007 asthma guidelines.[3] In the example in **FIGURE 2**, of the 2.2 million people identified with asthma, 819,000 meet the criteria for high asthma burden and an allergy evaluation. Of that group, 215,000 (26.3%) have already had the evaluation. Using this type of big data allows a focus on the high-risk group (ie, 819,000 – 215,000 = 609,000) who have not had the evaluation, rather than the entire population of 2.2 million people with asthma.

To make asthma care more efficient and effective, some large health care organizations have embedded asthma assessment tools into their electronic health records, making them easily accessible during any asthma visit. This has been done with the Asthma Action Plan[4] and the Asthma APGAR tool.[5] Making these tools available at point of care has the potential to increase their completion, even when the visit may be for another problem, ensuring that asthma care does not get lost in the rush of acute problems or other chronic diseases. Incorporation of the Asthma APGAR tool, including its brief allergy/trigger assessment, into the electronic health record resulted in increased use of control and assessment for people of all ages with asthma.[5] Appropriate standardized queries and data reporting formats, based on control assessments or billing codes for ED or urgent-care visits, can be developed to alert clinicians of at-risk patients as they are seen in the clinic. Care algorithms and, possibly, even standing orders can be considered for assessing, testing, or referring patients with potential allergy-related asthma symptoms.

Using large clinical and population health data[6] and basing identification on adverse outcomes is of interest to health-care professionals and systems and to payers who want to improve compliance with the triple aims of reducing utilization and cost burden, improving outcomes, and enhancing patient and provider satisfaction—focused, in this case, on the greatest use of expensive asthma-related

FIGURE 3 Database searching for care improvement opportunities



The red graph line represents utilization and cost for a group of at-risk patients compared to a reference population (blue line). The bright red squares below identify groups of patients who are not meeting target clinical or utilization goals. Over time, as new management practices are introduced, the impact of those practices can be seen by comparing the 2 groups again.

services. Services such as ED visits and hospitalization are coded within the billing and clinical data in almost all health care facilities (**FIGURE 3**). Therefore, the data can be used to identify a group of patients appropriate for enhanced asthma management, which, in many cases, should include allergy assessment or evaluation. Pharmacy records can also be searched to monitor step-4 and step-5 prescribing, as well as adherence to prescription filling and overall costs.

Over time, information from large databases can also be used to measure progress toward the triple-aim goals. In **FIGURE 3**, the red graph lines represent an at-risk population compared to a reference group (blue line). Using standard search algorithms, these 2 populations can be compared after various interventions to evaluate the effect the interventions had on modifying risk and outcomes.

MAKING ASTHMA PART OF IMPROVED HEALTH CARE

Delivering value

Asthma is a major driver of health care costs and is the most common chronic disease of children and adolescents. The prevalence of asthma has risen steadily over the past 20 years and is projected to continue rising, along with a rise in asthma exacerbations, which may be triggered by aeroallergens.[7,8] The US health care system is rapidly moving toward a value-based structure related to 3 questions—the triple aims:

- *How do we improve outcomes?*
- *What is the patient experience in the care process?*
- *What is the population cost for a defined segment of patients?*

Delivering excellence in value-based asthma care is a function of improving quality while containing cost. This is a continuous process fed by real-world data, which lends insight and helps to shape new, more successful approaches, the results of which can then be measured.

Allergy-trigger testing for people with asthma uses resources, but poorly controlled asthma is expensive in terms of ED visits, hospitalizations (inpatient and intensive care), and extended stays. A single case of uncontrolled asthma can cost $5963 a year—double the cost for a patient whose asthma symptoms are being controlled.[9] The investment in patient education about trigger avoidance is compelling when viewed in light of the savings that could be

achieved. To date, there has not been sufficient belief that asthma exacerbations are not only costly but also a sign of health-system failure. Improved outcomes for patients and populations will come when there is fuller buy-in from payers, accountable-care organizations, and health care systems that allergy evaluation and trigger management offer an opportunity to dramatically improve clinical care and lower costs.

Developing quality metrics

Care systems based on value rely on metrics, transparent and valid measures designed to be used in performance scorecards and compared to benchmarks of excellence. There are 2 types of metrics in assessing asthma care: process and outcomes. Each type is vitally important but must be shown to be clinically important, have evidence of improving outcomes and be easily measured. If significant extra work is needed or care flow is disrupted in collecting the metrics, their use will not be sustained over time.

Currently, the only asthma quality metrics in widespread use are the Healthcare Effectiveness Data and Information Set (HEDIS) measures focused on medication use.[10] One measure is the percentage of patients with persistent asthma who remained on their controller medications for at least 75% of their treatment period. Another measure is the ratio of controller medications to total asthma medications during the measurement year. Although measures of medication use are important, there are other components to asthma care that are important.

Allergy testing in asthma management of high-risk individuals is a good example of a process metric that can be derived from claims data (Current Procedural Terminology codes for skin testing or specific immunoglobulin E) and correlated with outcomes. Aeroallergen assessment in high-risk patients (**TABLE 1**) should be considered for an updated HEDIS or other quality metric to help guide this important but often overlooked aspect of asthma management.

Regular clinician and team feedback can change practice behavior, especially when care teams are empowered to deploy a workflow model that incorporates tools and resources to support the team, utilizing testing results to teach the patient trigger avoidance. Ultimately, when process metrics, such as appropriate trigger-testing rates, are coupled to improvements in outcomes, such as decreased urgent and emergent asthma interventions, and then aligned with payment methodology for improved results, significant quality improvement in practice team care patterns will be sustainable.

Quality metrics could help the clinicians and medical directors who participate in value-based contracting understand how to better align decision-making in clinical practice with the delivery of value to the patient, which emerges clearly in the analysis of when and why to do allergy trigger testing. The cost saving is going to be highest in groups with high utilization of ED and hospital services for asthma, and those with chronically poorly controlled asthma.

Addressing disparities

As with most chronic diseases, insurance coverage for basic components, including allergy testing, is excellent. However, disparity in allergy and asthma care is plentiful in the United States. Allergy and asthma disproportionately affect children, adult women, the poor, African Americans, and Americans of Puerto Rican descent.[11-18] Beyond what disease prevalence would predict, severe asthma morbidity and asthma death are most striking among black and Puerto Rican ethnic populations, in particular.[14,19,20] Given the complexity of disparity sources and the admixture of American society, health care professionals profess incomplete confidence in identifying and tackling these important issues with differing populations in clinical care.[21] However, clinicians can address disparity through awareness and practical clinical approaches to allergen evaluation and asthma management.

Understanding disparity

Disparity is multifactorial. Genetics may define subpopulation susceptibility as well as prevalence of disease, yet most experts agree that, with standard-of-care clinical intervention, allergies and asthma can be effectively diagnosed, managed, and controlled in all patients.[13,22-24] Allergy-associated asthma death rates that are considerably higher among African Americans, Americans of Puerto Rican descent, and other Latino ethnicities and economically disadvantaged populations, therefore, raise considerable disparity concerns.[24-28]

Researchers have described more than 30 evidence-based causes for disparity in asthma and allergy management[25] (**TABLE 2**). Many factors may explain such disparities, including environmental and genetic influences. Urban areas, which often have a predominance of African American patients, are heavily concentrated with asthma risk factors, such as air pollution, mice, cockroaches, dust mites, poor diet, poverty, stress, and violence.[13,15,22,24] African Americans are also less likely to receive National Institutes of Health (NIH) guideline-directed care.[21,29] For example, compared to whites, African Americans visit an asthma specialist less often, and use an ICS for persistent asthma less frequently.[24,26] Clinicians can gain considerable disease-management leverage by understanding the determinants

TABLE 2 Evidence-based determinants of asthma management disparities[25]

Individual and Family	Health Care	Community	Sociocultural and Political
• Cultural beliefs • Depression • Family dysfunction • Genetic polymorphisms • Health literacy • Management of indoor environments • Medication adherence • Nutrition and obesity • Respiratory infections • Social support • Self-management skills • Stress	• Cultural competence • Health care access • Health care financing • Quality of care • Process of care • Provider bias • Provider-client communication	• Community stress • Crowded living conditions • Inadequate housing • Neighborhood disadvantage • Outdoor air pollution • Social capital • Social isolation • Violence/crime	• Discrimination • Employment • Environmental justice • Poverty • Race • Segregation • Socioeconomic position

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of disparity and critically reviewing their own care delivery model.

Working to minimize disparity in the clinical setting

So, how does one approach disparity in the clinical setting? Clearly, change starts with clinical recognition that such disparities exist, an obvious fact that is often missed. Recent data suggest that African-American and some Latino asthma patients who perceive health care discrimination are—*independent of other asthma risk and socioeconomic status*—at greater jeopardy for poor asthma control.[28] Promising patient strategies are on the horizon[30] and, reassuringly, when clinicians are trained in cultural competence in addition to asthma care, their confidence in using better counseling and more effective patient-centered approaches to asthma care are significantly enhanced, compared to standard asthma care training alone.[21] **TABLE 3** summarizes practical approaches to removing disparity when interacting with patients who have allergy or asthma, or both.

THE NEED TO CLOSE THE CARE GAP

At its core, clinical care is about the clinician–patient relationship and the provision of care that will lead to reduced symptoms and costs. Data collected on the delivery of the nonmedication elements of asthma care define a significant care gap (**TABLE 4**).[1] Among 1176 patients with persistent asthma, asthma triggers—specifically, allergens—were assessed and documented in only 32.5% of all patients.[1] Only 2% of patients with persistent asthma had documented allergy test results.

The value of closing the care gap

A large integrated health network in southern California with 250,000 patients realized their asthma results (exacerbations, hospitalizations, ED visits) were fair at best. The network wanted to advance their performance beyond the HEDIS metric of increasing the percentage of patients on a daily controller medication to manage symptoms. The network focused on 3 metrics. Their goal was to have the percentage of patients who had a diagnosis of mild, moderate, or severe persistent asthma, *and* who received the following care components, exceed 90%:

- a controller medication;
- a written asthma plan;
- allergy testing.

The objective was to improve asthma care and realize better patient outcomes as well as recover shared savings bonuses from their value-based payer agreement. The network acted on the evidence that engaging patients is effective when an asthma treatment plan, with a personalized approach to medication use and allergic-trigger avoidance, is used. The Asthma Action Plan from the American Lung Association[4] is one such plan (see supplemental materials).

The network achieved the goal of >90% compliance for all 3 metrics within 6 months. The resulting decrease in ED visits, hospitalizations, and urgent care and walk-in visits resulted in a shared savings bonus that was significantly higher than the cost of trigger testing. This alignment of clinical and financial outcomes was very important because the

TABLE 3 **A clinician's allergy/asthma disparities to-do list**

- Clearly communicate allergy and asthma risk to your patients and family; prudently screen, diagnose, and monitor for disease, especially among high-risk groups
- Seek to understand how patient experience, environment, family, and culture may influence allergy and asthma diagnosis and management
- Plan a strategy with your patients that includes their opinions and concerns about disease, therapy, side effects, activity, and cost
- Regularly aim to improve cultural competence for your practice
- Regularly review samples of your practice's cases of allergy and asthma diagnosis, management and control—especially from populations that face disparity.
- Entertain multidisciplinary approaches to disparity reduction; consider aggressive patient education and supplemental assessment and intervention (including at home, school, and work)

TABLE 4 **Adherence to nonmedication elements of the asthma guidelines[1]**

	Adherence, No. (%)					
Elements of the guidelines assessed and documented	**All (N=1176)**	**Children (5-11 years old) (n=285)**	**Tweens (12-18 years old) (n=211)**	**Adults (19-65 years old) (n=680)**	***P* value for difference across age groups**	***P* value for difference across age groups, adjusting for site using random-effects model**
Asthma control	176 (15)	63 (22.1)	34 (16.1)	79 (11.6)	<.001	.03
Validated tool used	88 (7.50)	32 (11.2)	15 (7.1)	41 (6)		
Asthma medication adherence discussed	390 (33.2)	90 (31.6)	68 (32.2)	232 (34.1)	.71	.18
Inhaler technique						
Taught	89 (7.6)	40 (14)	16 (7.6)	33 (2.8)	<.001	>.002
Observed	15 (1.3)	8 (2.8)	2 (0.9)	5 (0.7)	.20	<.001
Trigger/Irritants						
Allergies discussed	382 (32.5)	123 (43.2)	69 (32.7)	190 (27.9)	<.001	>.002
Allergy testing	24 (2.0)	9 (2.8)	6 (2.8)	9 (1.2)	.12	.19
Patient smoking status	681 (76.3)	NA	115 (54.5)	566 (83.1)	<.001	<.001
Others smoking in home	221 (18.8)	97 (34)	47 (22.3)	77 (11.3)	<.001	<.001
Asthma action plan	37 (3.1)	25 (8.9)	5 (2.4)		<.001	<.001

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predominant network reimbursement was a global capitation rate.

There is growing evidence that the use of acute care resources can be reduced when patients are assessed for specific IgE antibodies to aeroallergens. A recent study demonstrated that IgE testing cut the hazard of another emergency visit and corticosteroid treatment by half in patients with mild persistent asthma ($P<0.05$).[31] Discharge referrals for environmental mitigation have also reduced hospital readmissions.[32] These interventions delivered value to patients through improved quality of life and to health care systems through decreased cost.

CONCLUSIONS

Overall, improved efficiency in allergy testing and management addresses an identified gap in asthma care intended to improve quality of care, patient satisfaction, and value for the health care system, as well as resource utilization. Improved allergen evaluation, appropriateness for testing referral, and follow-up education require system-wide

support. Gathering relevant patient information, quickly assessing environmental issues, and providing counseling are crucial in improving asthma outcomes.

After talking with Kim about her allergy test results, you provide her with written materials that highlight practical methods to avoid dust mite, mold, and cockroach triggers. The materials are brief, have culturally appropriate wording and illustrations, and can be shared with family and friends. You also give her telephone numbers for advocacy groups whose information you know is evidence-based, as well as your office number. Being involved in personalizing the asthma management plan to her life experiences is important to Kim, and plays a critical role in her desire and ability to address the challenges of trigger avoidance necessary to improve the health outcomes that are important to her.

REFERENCES

1. Yawn BP, Rank MA, Cabana MD, Wollan PC, Juhn YJ. Adherence to asthma guidelines in children, tweens, and adults in primary care settings: a practice-based network assessment. *Mayo Clin Proc*. 2016;91(4):411-421.
2. National Institutes of Health, National Heart Lung and Blood Institute. Guidelines implementation panel report for: Expert Panel Report 3—guidelines for the diagnosis and management of asthma: Partners putting guidelines into action. Bethesda, MD: US Department of Health and Human Services; 2008 Dec. NIH Publication Number 09-6147. www.nhlbi.nih.gov/guidelines/asthma/gip_rpt.pdf. Accessed June 28, 2018.
3. National Asthma Education and Prevention Program (NAEPP). Guidelines for the diagnosis and management of asthma (EPR-3). www.nhlbi.nih.gov/health-pro/guidelines/current/asthma-guidelines/full-report. Accessed June 28, 2018.
4. American Lung Association. Asthma action plan. www.lung.org/assets/documents/asthma/asthma-action-plan.pdf. Accessed June 29, 2018.
5. Yawn BP, Wollan PC, Rank MA, Bertram SL, Juhn Y, Pace W. Use of Asthma APGAR tools in primary care practices: a cluster-randomized controlled trial. *Ann Fam Med*. 2018;16(2):100-110.
6. Accordini S, Corsico A, Cerveri I, et al. The socio-economic burden of asthma is substantial in Europe. *Allergy*. 2008;63(1):116-124.
7. Loftus PA, Wise SK. Epidemiology of asthma. *Curr Opin Otolaryngol Head Neck Surg*. 2016;24(3):245-249.
8. Hoch H, Liu A. Predicting and preventing asthma exacerbations. In: *Personalizing Asthma Management for the Clinician*, 1st ed. Szefler SJ, Holguin F, Wechsler ME, eds. Atlanta, GA: Elsevier, Inc.; 2017:129-141.
9. Sullivan SD, Rasouliyan L, Russo PA, Kamath T, Chipps BE; TENOR Study Group. Extent, patterns, and burden of uncontrolled disease in severe or difficult-to-treat asthma. *Allergy*. 2007;62(2):126-133.
10. National Committee for Quality Assurance. Healthcare Effectiveness Data and Information Set (HEDIS): Use of appropriate medications for people with asthma and medication management for people with asthma. www.ncqa.org/report-cards/health-plans/state-of-health-care-quality/2017-table-of-contents/asthma. Accessed June 29, 2018.
11. Akinbami LJ, Moorman JE, Simon AE, Schoendorf KC. Trends in racial disparities for asthma outcomes among children 0 to 17 years, 2001-2010. *J Allergy Clin Immunol*. 2014;134(3):547-553.e5.
12. Centers for Disease Control and Prevention. 2016 National Health Interview Survey (NHIS) data: 2016 Lifetime asthma, current asthma, asthma attacks among those with current asthmas. www.cdc.gov/asthma/nhis/2016/data.htm. Accessed June 29, 2018.
13. Global Initiative for Asthma. 2018 GINA report, global strategy for asthma prevention and management. https://ginasthma.org/2018-gina-report-global-strategy-for-asthma-management-and-prevention/ Accessed June 29, 2018.
14. Zahran HS, Bailey CM, Damon SA, Garbe PL, Breysse PN. Vital signs: asthma in children - United States, 2001-2016. *MMWR Morb Mortal Wkly Rep*. 2018;67(5):149-155.
15. Cardet JC, Louisias M, King TS, et al. Income is an independent risk factor for worse asthma outcomes. *J Allergy Clin Immunol*. 2018;141(2):754-760.e3.
16. Coogan PF, Yu J, O'Connor GT, Brown TA, Cozier YC, Palmer JR, Rosenberg L. Experiences of racism and the incidence of adult-onset asthma in the Black Women's Health Study. *Chest*. 2014;145(3):480-485.
17. Clark NM, Gong ZM, Wang SJ, Lin X, Bria WF, Johnson TR. A randomized trial of a self-regulation intervention for women with asthma. *Chest*. 2007;132(1):88-97.
18. Centers for Disease Control and Prevention. 2015 National Health Interview Survey (NHIS) data: Table 4-1. Current Asthma Prevalence Percents by Age, United States: National Health Interview Survey, 2015. www.cdc.gov/asthma/nhis/2015/table4-1.htm. Accessed June 29, 2018.
19. Mushtaq A. Asthma in the USA: the good, the bad, and the disparity. *Lancet Respir Med*. 2018;6(5):335-336.
20. Dwyer-Lindgren L, Bertozzi-Villa A, Stubbs RW, et al. Trends and patterns of differences in chronic respiratory disease mortality among US counties, 1980-2014. *JAMA*. 2017;318(12):1136-1149.
21. Patel MR, Song PXK, Bruzzese JM, et al. Does cross-cultural communication training for physicians improve pediatric asthma outcomes? A randomized trial. *J Asthma*. 2018:1-12.
22. Brown RW, Cappelletti CS. Reaching beyond disparity: safely improving asthma control in the at-risk African-American population. *J Natl Med Assoc*. 2013;105(2):138-149.
23. Bryant-Stephens T. Asthma disparities in urban environments. *J Allergy Clin Immunol*. 2009;123(6):1199-1206.
24. Forno E, Celedón JC. Health disparities in asthma. *Am J Respir Crit Care Med*. 2012;185(10):1033-1035.
25. Evans-Agnew RA. Asthma disparity photovoice: The discourses of black adolescent and public health policymakers. *Health Promot Pract*. 2018;19(2):213-221.
26. Williams LK, Joseph CL, Peterson EL, et al. Patients with asthma who do not fill their inhaled corticosteroids: a study of primary nonadherence. *J Allergy Clin Immunol*. 2007;120(5):1153-1159.
27. Yang JJ, Burchard EG, Choudhry S, et al. Differences in allergic sensitization by self-reported race and genetic ancestry. *J Allergy Clin Immunol*. 2008;122(4):820-827.
28. Thakur N, Barcelo NE, Borrell LN, et al. Perceived discrimination associated with asthma and related outcomes in minority youth: the GALA II and SAGE II studies. *Chest*. 2017;151(4):804-812.
29. Mitchell SJ, Bilderback AL, Okelo SO. Racial disparities in asthma morbidity among pediatric patients seeking asthma specialist care. *Acad Pediatr*. 2016;16(1):64-67.
30. Baptist AP, Islam N, Joseph CL. Technology-based interventions for asthma-can they help decrease health disparities? *J Allergy Clin Immunol*. 2016;4(6):1135-1142.
31. Brock J. Acute Blood Allergy Testing Associated with Fewer Pediatric Asthma Hospitalizations. P957. Presented at: the American Thoracic Society; May 18-23, 2018; San Diego, CA.
32. Parikh K, Hall M, Kenyon CC, et al. Impact of Discharge Components on Readmission Rates for Children Hospitalized with Asthma. *J Pediatr*. 2018 DOI: https://doi.org/10.1016/j.jpeds.2017.11.062 [Epub ahead of print]

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