ARC
Asthma Regional Council

Investing in Best Practices for Asthma: A BUSINESS CASE

August 2010 Update

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Introduction

An increasingly robust evidence base shows widespread improvements in the health of people with asthma when primary and specialist care are supplemented by non-clinical interventions tailored to the individual. Both the research and practice-based literature show that these interventions—including in-depth asthma education, home environmental assessments, and mitigation of exposures that trigger asthma—can markedly improve patients' quality of life, and often decrease urgent medical encounters. The research literature on the economics of these interventions makes a compelling case, from a business standpoint, for investing in asthma education and in-home environmental interventions as key elements of a comprehensive asthma management program. Yet despite this evidence, people with asthma often do not have access to comprehensive asthma education and in-home environmental interventions, nor are these services adequately paid for by insurance.

This report updates our first Business Case published in 2007.[1] Two primary developments motivated the update. First, the National Asthma Education Prevention Program (NAEPP) Expert Panel, which is responsible for regularly updating the national best practice guidelines for asthma management, and the Centers for Disease Control and Prevention's Task Force on Community Preventive Services (CDC Task Force), each published major reviews—including economic evaluations—of the research on asthma education and environmental interventions.[2,3] Second, programs translating research on comprehensive asthma management into practice have proliferated. Therefore, in addition to summarizing the NAEPP and the CDC Task Force reviews, this update describes six evidence-based programs which are achieving their goals of bringing asthma under control cost-effectively.

This research update and case studies should provide information and inspiration as health payer organizations and policy-makers consider next steps for reducing the burden of asthma at a reasonable cost. Current concern about skyrocketing health care expenditures and the promise of value-based care make the business case for investing in comprehensive asthma management programs—which ensure affordable access to appropriate medications, regular assessment and monitoring, as well as robust asthma education and supplementary in-home environmental interventions—all the more compelling.

Asthma: A Costly Chronic Disease Out of Control

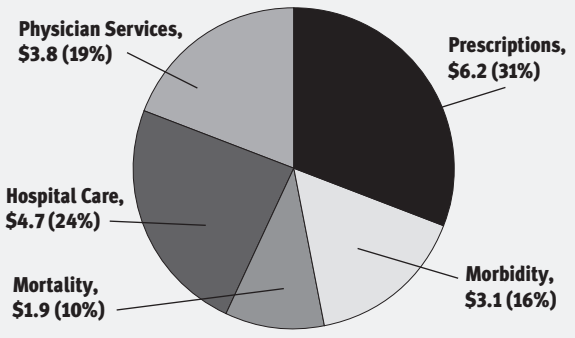
Rates of asthma have nearly doubled in the United States over the last few decades. Over 23 million people, or approximately 9.4% of children, and 7.3% of adults, currently have asthma.[4 5] In New England, rates are even higher.[6 7] Many more people report having had asthma at some point in their lives. The most recent data affirm earlier trends: asthma continues to unnecessarily impede quality of life for people who have the disease, and disproportionately impacts low-income people and racial/ethnic minorities. For example, New England 2006 data demonstrate that:

- asthma symptoms in approximately two-thirds of adults and children are considered to be "not well controlled" or "very poorly controlled," as defined by the national best practice guidelines;[8]
- one in five adults with current asthma reported that their disease limited their usual daily activities to a moderate or great extent. The impact is greater among low-income adults than those in higher income brackets;[9]
- people of color have higher hospitalization rates than non-Hispanic whites;[10]
- among those who reported that their asthma was work-related, 17% had to change jobs because of their asthma, and for those with less than a high school education, the figure was 20%. Adults with low incomes were much more likely than those in higher income households to report changing jobs due to their asthma.[11]

FIGURE 1:

Distribution of Asthma Costs in the U.S. (2007): $19.7 Billion in Total Costs

(costs displayed in $ billions)



Source: American Lung Association. Trends in Asthma Morbidity and Mortality. January 2009

One distinguishing characteristic of asthma is its prevalence across the age spectrum. Most chronic illnesses, including diabetes and heart disease, burden primarily older people. In contrast, asthma strikes both young and old. Interventions to control asthma must prevent exacerbations and minimize disability across the lifespan.

FIGURE 2:

Potentially Preventable Costs for Urgent Asthma Care (2006 Dollars)

Health Care Service	Cost
An emergency department visit for asthma that did not result in admission to the hospital (adults and children)	$691
A hospital stay for asthma (adult)	$9,261
A hospital stay for asthma (child)	$7,987

Source: Agency for Healthcare Research and Quality. Healthcare Cost and Utilization Project (HCUP). Rockville, MD. 2006.

Asthma imposes high costs on insurers, employers, patients and their families, and society at large. In 2007, the US spent an estimated $19.7 billion on asthma in both direct and indirect costs.[12] Yet with proper management, people with asthma can live healthy active lives, unimpeded by persistent breathing difficulties, trips to the emergency department or hospital, and missed school and workdays. In addition to improving the vitality and productivity of individuals and communities, proper asthma management also has the potential to save at least 25% of total asthma costs—or close to $5 billion nation-wide—by controlling symptoms, which in turn reduces usage of urgent care health services (see Figure 1). Among pediatric hospitalizations that could be prevented, asthma is responsible for the highest costs.[13] Above and beyond these savings in direct costs, proper asthma management can reduce "indirect" costs associated with absenteeism and presenteeism (low productivity) at work and at school.[14 15 16]

A Business Case for Asthma Education and Environmental Intervention Services and Supplies

What is a Business Case?

Health care payers consider a number of factors before they invest in a new service. Cost and likely outcomes are among them. In general, there is a business rationale for a health-related service if the expenditure either results in a positive *return on investment (ROI)* and/or is considered to be *cost-effective*. ROI calculates dollars saved, or expenditures avoided, per dollar invested. In contrast, a "cost-effective" intervention is one for which costs of a given health improvement are a good value compared to other standard interventions.[17] For health care payers, a positive ROI and/or evidence of cost-effectiveness are solid business reasons to invest in a new health service. For other sectors, including government and employers, additional economic considerations are important and should be factored into investment calculations, such as potential savings realized from improved productivity, as well as fewer missed school days and associated remedial services (e.g., tutoring). These "indirect" benefits—which accrue to employers and to society at large—tend to strengthen the business case.

The Asthma Return on Investment Calculator

In 2009, a user-friendly on-line tool was developed by Thomson Reuters for the federal Agency for Healthcare Research and Quality (AHRQ). Called the "Asthma Return on Investment Calculator," this tool can help health policy-makers, purchasers and insurers understand the financial implications of investing in asthma quality improvement programs that primarily focus on asthma education. The Calculator is based on evidence from 52 studies and is available free of charge through the AHRQ website:
http://statesnapshots.ahrq.gov/asthma

Best Practices for Improving Asthma Outcomes

The national best practice guidelines for managing asthma (the "NAEPP Guidelines") outline four vital components of effective asthma management.[18] These are:

1) use of objective measures of lung function to assess disease severity and control;
2) comprehensive pharmacologic therapy to reverse and prevent airway inflammation and constriction characteristic of asthma, and to manage asthma exacerbations;
3) patient education that fosters a partnership among the patient, his or her family, and clinicians;
4) environmental control measures to avoid or eliminate factors ("asthma triggers") that contribute to asthma onset and severity.

The NAEPP Guidelines also discuss the importance of managing other conditions that can make asthma worse ("comorbid conditions").

Controlling Asthma and Its Costs: The Evidence for Implementing Best Practices

Knowledge about these four best practice components is an important first step for effectively managing asthma. However, knowledge has not automatically resulted in practice changes. The need for increased implementation of the NAEPP Guidelines deserves additional attention. Historically, the focus of implementation has been almost exclusively on the clinical setting, and on appropriate use of medication as well as assessment and monitoring of lung function (best practices 1 and 2). With population-based surveys documenting poor control of asthma,[19] more and more research has focused on the implementation of cost-effective education and environmental trigger reduction programs and services (best practices 3 and 4) as appropriate interventions to supplement clinical care.

Implementing Best Practices 1 and 2: Measurement of Lung Function and Pharmacotherapy

There is a wealth of evidence showing the importance of regularly assessing lung function and taking proper medications to keep asthma under control and enable people with asthma to lead healthy active lives.[20] Quality improvement initiatives by providers and payers have contributed to wider adoption of these two best practices recommended in the

NAEPP Guidelines. Indeed, increased expenditures on pharmaceuticals have accompanied reductions in expenditures associated with unscheduled or emergency health care utilization, reflecting more consistent and appropriate use of medications to prevent and treat asthma attacks.[21]

Despite these improvements, many patients do not receive proactive assessments of their lung function and symptoms, and do not access or use medications properly. High out-of-pocket costs are important barriers for some patients in consistently obtaining the medications and services they need. For example, 14.0% of adults with asthma reported not filling their asthma medications because of financial considerations.[22] As part of disease management initiatives, some insurers and employers have initiated programs to remove this financial barrier by reducing copayments or otherwise subsidizing medication costs. These initiatives are often grounded in Value-Based Insurance Design, which promotes the use of clinical services when the benefit exceeds the costs.[23]

The manufacturing company Pitney Bowes, for example, attributed an annual decrease of 15% in overall asthma-related costs to a decision to place all asthma medications in the first tier (lowest copayment) of its formulary, requiring a 10% coinsurance payment, rather than 30% or 50%.[24] Several health plans, including Aetna and Humana, have developed similar reduced copay initiatives. Humana's Rx-Plus program lowers copayments for members with diabetes and asthma.[25] ActiveHealth Management, an independent patient-management subsidiary of Aetna, also focuses on prescription medications, lowering copayments for inhaled steroids used to treat asthma and a range of medications for other chronic diseases.[26] Results of a program waiving copayments and providing asthma education—delivered to adults with asthma working for two employers in Asheville, North Carolina—were also impressive: hospitalizations, emergency room visits and indirect costs associated with absenteeism and presenteeism dropped dramatically over the five-year study period.[27]

In sum, though there is not an extensive literature on the cost-benefit of lowering or waiving copays, a number of employers and health plans are experimenting with this approach and finding it financially attractive.

Implementing Best Practices 3 and 4: Asthma Education and Environmental Interventions

Relatively few patients have access to the two remaining components of asthma best practices: patient education and control of environmental triggers. This is a critical gap and opportunity for making improvements in asthma care. An increasingly robust body of evidence shows that these two aspects of effective asthma management not only improve symptoms, but do so at a reasonable cost.

Asthma Education

Asthma is a complicated disease. Many patients require multiple prescriptions, as well as equipment to administer medications, that keep their asthma under control and mitigate symptoms during an asthma attack. People with asthma must make their own decisions about when to use controller and rescue medications, based on their symptoms and lung function. They must also take steps to reduce their exposure to environmental triggers that exacerbate their disease. Because of these complexities, people with asthma need proactive education and follow-up, typically via multiple sessions involving demonstration, practice, and reinforcement of information and proper techniques. Health care providers should develop written Asthma Action Plans with their patients, with multiple copies provided for the school or workplace.

> A 2003 randomized controlled trial calculated a positive return on investment when an Asthma Nurse Specialist provided group education sessions to adults in the clinic, by phone, and at home, as needed. The intervention cost $186 and saved $6,650 per patient in direct and indirect expenditures ($36 saved for every $1 spent).
>
> Source: Castro M, et al. "Asthma Intervention Program Prevents Readmissions in High Health Care Users," American Journal of Respiratory Critical Care. 2003;168:1095-1099.

In dozens of studies, asthma education sessions delivered in the clinic, home or workplace have helped patients overcome key factors in poorly managed asthma, including low expectations for controlling their disease, confusion over using different kinds of medications, and misuse of medical equipment.[28] Demonstrated benefits of asthma education include reduced asthma symptoms, enhanced quality of life, improved medication adherence, fewer activity limitations/restrictions and, often, reduced medical costs.[29]

In their 2007 update, the NAEPP Expert Panel found "abundant" scientific evidence that asthma self-management education programs reduce urgent care visits and hospitalizations, and improve overall health status for both children and adults.[30] Delivered by a variety of professionals in a variety of settings, these programs include information about (a) basic facts about asthma; (b) proper use of medications; (c) self-management techniques/self-monitoring skills; and (d) actions to mitigate or control environmental exposures that exacerbate symptoms.

Cost Implications of Asthma Education Programs

Our original business case (2007) focused on the subset of research studies that examined costs of asthma education programs.[31] It concluded that programs delivered to the highest utilizers of urgent health care services generated net cost savings, or a positive return on investment. Education

services delivered to people whose asthma was under better control—not requiring frequent use of urgent care—were also determined to be cost-effective.[32] On the basis of a similar review of the literature on the cost-effectiveness of asthma education programs, the NAEPP Expert Panel recommended "that asthma self-management education delivered by trained health professionals be considered for policies and reimbursements as an integral part of effective asthma care."[33] For details on studies demonstrating net cost savings of asthma education, see Appendix 1, Table 2.

Home-Based Environmental Interventions

A distinguishing characteristic of asthma is the importance of environmental exposures in exacerbating symptoms and, in some cases, contributing to the initial onset of the disease. Reducing exposure to environmental triggers can often make the difference between living productively with asthma and being severely impeded by symptoms. A variety of environmental factors associated with asthma are commonly found in homes of people from all socio-economic backgrounds (Figure 3), but sub-standard home environments—typically occupied by low-income people—are particularly problematic. Typically, dust mites, cockroaches, mold, as well as dog and cat dander are the environmental allergens of most concern.[34] Specific irritants also can exacerbate symptoms, including environmental tobacco smoke, cleaning chemicals, scents and fragrances, as well as nitrogen oxide from home heating appliances.[35]

FIGURE 3:

Factors Associated with Asthma in Indoor Environments

Common Allergens	Common Irritants
• Cockroaches	• Cleaning chemicals
• Mice/Rats	• Sprays/scents
• Mold/mildew	• Environmental tobacco smoke
• Dust mites	• Indoor/outdoor fumes (gas/wood burning stoves, diesel engines)
• Household pets	
• Outdoor allergens	

A decade of research and demonstration projects have refined models for reducing exposure to environmental factors in home environments. The intensity of interventions to reduce or remediate exposures range from "minor" to "major"– from providing a basic assessment of the home environment with simple equipment, to improvement of building structures and systems (Figure 4). Supplies that reduce levels of allergens and irritants include mattress and pillow covers; integrated pest management (IPM) supplies such as trash cans with lids, caulking to fill cracks, and gel-bait traps; asthma-friendly cleaning products; as well as HEPA vacuums; and air filters. Professional services may include modifying ventilation to control moisture and irritant gases, removal of carpeting in sleeping and high-moisture areas such as kitchens and bathrooms, and assisting with removal of clutter in extreme situations. For homes with active pest infestations, people with asthma who are allergic to pests may need professional pest management services to supplement IPM supplies.

What is Integrated Pest Management?

Integrated Pest Management (IPM) is a prevention-based approach to controlling cockroaches, rodents and other pests known to trigger and/or initiate asthma. IPM represents a safe and effective method for reducing pest allergen levels in homes, which in turn may reduce asthma symptoms. Relative to standard clinical approaches to asthma management, IPM education, services and basic supplies are cost-effective. For certain high-risk patients, professional pest management services are justified. For others, use of basic IPM supplies—without professional services—can cost-effectively reduce allergen levels and improve symptoms. For more details on the business case for investing in IPM, see a report for the Boston Public Health Commission, prepared by the Asthma Regional Council of New England, "The Role of Pest Control in Effective Asthma Management: A Business Case" By Brett and Stillman. Available at:

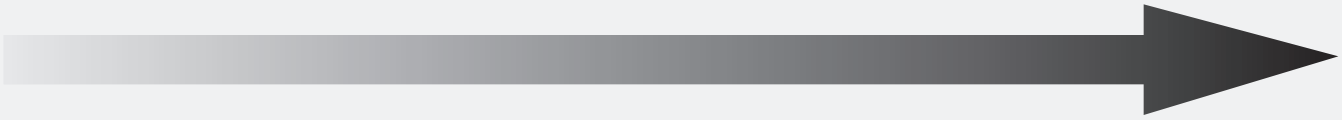
www.asthmaregionalcouncil.org/uploads/IPM/IPM_FINAL_2009.pdf

Home-based environmental interventions have been studied primarily in low-income, urban minority populations. In these studies, residents often have minimal capacity—because they do not own their own homes and have limited incomes—to control poor housing conditions that contribute to high levels of asthma triggers. As a result, these patients and their families may need logistical and financial assistance to access these home environmental interventions.

As part of its regular update of the best practice guidelines, the NAEPP Expert Panel reviewed the growing evidence on home-based environmental interventions. In 2009, the Centers for Disease Control and Prevention (CDC)—via its Task Force on Community Preventive Services—completed its own analysis of the literature.[36] Both federal reviews found strong evidence of effectiveness of environmental interventions, and stress that interventions should be multi-faceted and tailored to the individual. The NAEPP review concluded with the recommendation that "multi-component, multi-trigger environmental interventions [be made available to] children and adolescents with asthma, because of strong evidence of effectiveness in significantly reducing symptom days, improving quality of life or symptom scores, and reducing the number of school days missed."[37]

FIGURE 4:

Home-Based Environmental Interventions – Spectrum of Intensity



Examples of Interventions

Minor	Moderate	Major
• Environmental assessment • Pillow & mattress covers	• IPM supplies and services • Cleaning kits • HEPA furnace filters, vacuums, & air purifiers	• Ventilation/heating retrofits • Re-roofing • Insulation • Removal of water damaged materials

The effectiveness of home-based multi-trigger, multi-component environmental interventions, tailored to the individual, has been established by rigorous research. Examples of home-based environmental interventions above are arrayed along a spectrum of intensity as categorized by the CDC Task Force in their review of 12 studies that have evaluated costs. This figure is one model of the spectrum of intensity of interventions. Programs group interventions in a variety of ways, and some include additional components, such as professional services for carpet removal. Gaps in knowledge still remain about the independent contributions of particular components to the overall effectiveness of a multi-faceted intervention.

Sources: (1) Nurmagambetov T, et al. Economic Evaluation of Home-Based Environmental Interventions to Reduce Asthma Morbidity. CDC presentation on EPA Communities in Action for Asthma Friendly Environment, Economic Evaluation of Home-based Environmental Interventions webinar. December 2, 2009. (2) CDC Task Force on Community Preventive Services. "Asthma Control: Home-based Multi-trigger, Multicomponent Environmental Interventions Summary Evidence Tables – Economic Review." Available at: http://www.thecommunityguide.org/asthma/supportingmaterials/SETEcon.pdf. Accessed March 30, 2010.

Cost Implications of Home-based Environmental Interventions

In addition to examining health outcomes, the CDC Task Force also reviewed the evidence on costs of environmental interventions.[38] Some of the studies reviewed by CDC measured return on investment, or dollars saved per dollar invested. Others used the cost-effectiveness measure of cost per symptom-free day gained, allowing for comparison with other standard interventions. The CDC found that "the combination of minor to moderate environmental remediation with an educational component provides good value for the money invested based on improvements in symptom-free days, savings from averted costs of asthma care, and improvement in productivity."[39]

More specifically the CDC Task Force found evidence of:

- ROIs ranging from $5.30 to $14.00 for every dollar invested;
- cost-effectiveness, as measured by costs per symptom-free day gained ranging from $12.00 to $57.00 (lower if indirect costs were included).[42]

Because there have been few studies on adults, the CDC Task Force limited its conclusions to children and adolescents, although some research has shown improvements in adults resulting from home-based environmental interventions.[40] [41] For examples of studies assessing the cost-effectiveness of environmental interventions, see Appendix 1, Table 3.

The Inner City Asthma Study demonstrated that a moderate intensity home-based environmental intervention program for high-risk children, delivered by an environmental counselor over the course of 5 visits, cost $28 for each symptom-free day gained (total program costs $1469/person.)* These expenditures are well within the range of what payers have determined are "reasonable" costs for medications that achieve similar health outcomes, and far less than Xolair (omalizumab), which costs $523 per symptom-free day for patients with moderate-severe, uncontrolled allergic asthma.**

Sources: *Kattan M, et al. "Cost Effectiveness of a Home-based Environmental Intervention for Inner-city Children with Asthma," Journal of Allergy and Clinical Immunology. 2005; 116(5):1058-1063. **Oba Y and Slazman GA. "Cost-effectiveness Analysis of Omalizumab in Adults and Adolescents with Moderate-to-Severe Allergic Asthma," Journal of Allergy and Clinical Immunology. 2004; 114(2): 265-269.

Combining Asthma Education and Environmental Interventions

The majority of asthma intervention research on these two elements of the NAEPP Guidelines has focused on asthma education, or on home-based environmental interventions, but not both. However, two studies demonstrate the benefits of combining both interventions. In the most recent results from the Seattle-King County Healthy Homes II Project (2009), children who received both in-clinic asthma education (by a nurse) and home-based asthma education, social support, and trigger-remediation materials and services (by a community health worker) demonstrated greater improvements in symptom-free days and other improvements compared to children who received in-clinic asthma education alone (these differences were statistically significant).[43] Similarly, Jowers and colleagues (2000) studied the impact of a comprehensive disease management program combining both environmental interventions and asthma education delivered to children (ages 12 and older) and adults. The study documented statistically significant reductions in the use of costly acute health care services, improved quality of life measures, and fewer work days lost. The financial benefits from improved productivity and reduced health care costs in the Jowers study resulted in a return on investment of $4.64 saved for each $1 invested in the program.[44] Many on-the-ground programs combine asthma education and home-based environmental interventions, and evaluations show results consistent with or better than those of the research studies. The "Model Programs" section below describes six such programs.

Disease Management and Case Management Services

To facilitate access by people with chronic diseases to best practices, some organizations—including payers and employers—are contracting with disease management companies to provide additional support beyond what patients receive from their health care providers. For patients with co-morbidities or with particularly challenging life situations that affect their health, case managers can help patients manage the array of services they need. For such high-risk patients, studies show that one-on-one tailored programs with case management are likely to generate a positive return on investment.[45]

It is worth noting that although disease management programs typically include several of the asthma best practice components, particularly asthma education and medication reinforcement, their services vary widely and they rarely offer home visit services for environmental assessments and interventions—important components of proper asthma management.

Decision-Making on Asthma Education and Environmental Interventions: Who Should Get What Services?

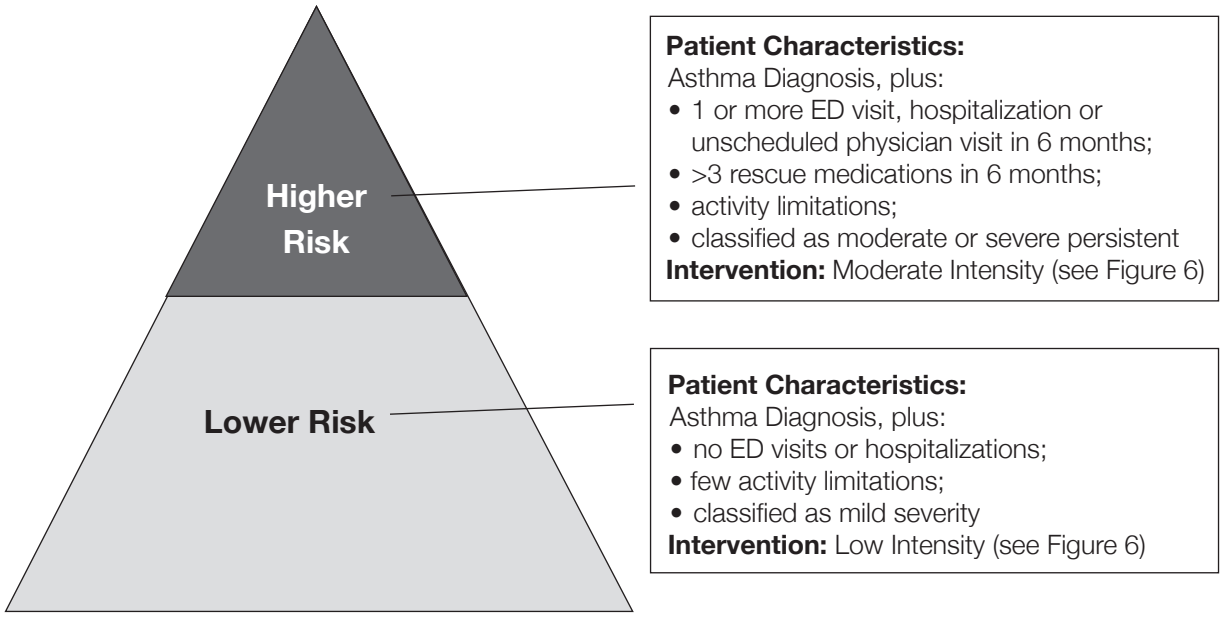
The research evidence on comprehensive asthma management suggests a framework that can help payers and others make decisions about which patients should receive more intensive or less intensive interventions in clinical and home settings. This framework takes into account routine methods for stratifying patients as well as the latest science on the effectiveness and cost-effectiveness of asthma education and environmental interventions. Its purpose is to help guide decision-making, though program design will also be influenced by data systems, staffing, resources and policies particular to a given organization.

For a given patient population (within a specific health plan, health insurer, health delivery organization, etc.), asthma patients can be stratified into risk categories based on clinical diagnostic information (if available) and on other indicators of asthma control, such as rescue medication usage and utilization of urgent health services (Figure 5). These risk profiles help determine the intensity of asthma education, environmental interventions and case management services that should be provided to patients.

Patients classified as lower risk (mild symptoms and/or few activity limitations or low utilizers of medical care (i.e. no recent hospitalizations, emergency department or unscheduled medical visits)) should be offered at least one educational session and a follow-up contact typically by phone, to assess symptoms and reinforce information covered in the diagnostic session, including: (1) the basic physiology of asthma, (2) medications and compliance, (3) asthma triggers and steps to reduce them, and (4) self management techniques. Patients should be provided with assessment and monitoring supplies such as peak flow meters. As needed, patients should also receive allergen-proof mattress and pillow covers as well as smoking cessation services and related pharmacology (Figure 6). Experts strongly encourage allergy testing to better target supplies and interventions to the allergens to which patients are sensitized.[46]

FIGURE 5:

Patient Intervention Stratification Model



Patients classified as higher risk (diagnosed as having persistent moderate or severe asthma, and/or who have had recent unscheduled office or emergency department visits or hospitalizations), should receive basic education in the office and then reinforced in a home visit, basic supplies and smoking cessation services. The home visit should also include an environmental assessment and additional environmental intervention supplies and professional services as needed (Figure 6). Tailoring interventions to patients' allergy profiles and to the conditions of the home is important to ensure effectiveness and to control costs.

For both high and low risk patients, the literature suggests that providers other than physicians—including nurses, mid-level practitioners, respiratory therapists, asthma educators, social workers, community health workers, and environmental counselors—can effectively provide asthma education and environmental interventions, often at a lower cost, given appropriate supervision and training, and depending on the mix of services needed by a given patient.

The Value of Community Health Workers

Community Health Workers (CHWs), or community health advocates and educators who make home visits, can be important members of an asthma team. Not only are CHWs effective, they also cost less than nurses, medical social workers, or respiratory therapists. The recent results from the Seattle-King County Healthy Homes II Project add to the body of evidence regarding the value of using CHWs to deliver home-based environmental intervention programs for asthma as well as to complement clinic-based asthma education programs during the home visit.* CHWs also serve as important clinic liaisons to enhance patient access to health professionals.* Though providers with more training may be needed in certain situations, CHWs have emerged as effective providers of basic health interventions in many cases because of their ability to bridge the gap between community members and health institutions, often due in part to shared cultural backgrounds with program participants. Randomized controlled trials have consistently shown that when appropriately trained and supervised, CHWs can provide home visits for education and environmental allergen reduction that result in positive health outcomes, including fewer asthma symptoms, daytime activity limitations, and emergency and urgent care visits.**

Sources: *Krieger J, et al. "A Randomized Controlled Trial of Asthma Self-Management Support Comparing Clinic-Based Nurses and In-Home Community Health Workers," Archives of Pediatric and Adolescent Medicine. 2009;163(2):141-149. **Postma J, et al. "Community Health Workers and Environmental Interventions for Children with Asthma: A Systematic Review," Journal of Asthma. 2009;46:564-576.

FIGURE 6:

Model Cost-Effective Interventions
Asthma Education and Environmental Interventions

LOW INTENSITY FOR LOWER RISK PATIENTS

SETTING Group or Individual; Clinic or Phone-Based (1+ visits)

STAFFING Examples include: Certified Asthma Educator, Registered Nurse, Mid-level Practitioner, Respiratory Therapist, Licensed Clinical Social Worker, Chronic Disease Educator or others well-trained in asthma care and education.

EDUCATION
Address asthma physiology; medical self-management (use of Asthma Action Plan; & control of environmental triggers)

SERVICES
Smoking cessation; referrals to other specialists, programs & resources

SUPPLIES
Peak flow meters; spacers; mattress/ pillow covers

MODERATE INTENSITY FOR HIGHER RISK PATIENTS*

SETTING Individual; Home-Based (1-5 visits)

STAFFING Same as for lower risk patients, however the home environmental intervention can be conducted by a Community Health Worker or Environmental Counselor.

EDUCATION
Same as low intensity

SERVICES
Same as low intensity as well as case management; in-home environmental assessment; professional IPM or cleaning services if indicated

SUPPLIES
Same as low intensity and other environmental trigger reduction supplies as needed (e.g. basic IPM supplies, HEPA vacuums, air filtration)

*Some patients may benefit from higher intensity interventions not listed here. These include significant structural remediation (e.g. repairing significant leaks, carpet removal, new ventilation systems, removal of water damaged material). While these interventions effectively reduce exposure to environmental triggers associated with asthma, there is not evidence of cost-effectiveness when they are compared to standard asthma interventions/treatments. However, such services should be considered in exceptional circumstances where asthma remains out of control despite adherence to medication and provision of environmental trigger supplies and services.

Learning from Cost-Effective Programs Around the Country

Despite the promise suggested by research studies of programs to cost-effectively reduce the burden of asthma, there is not yet capacity in many places in the U.S. for delivering robust asthma education and home environmental interventions to people with asthma who could benefit. Yet there are a growing number of on-the-ground models that can be drawn upon and replicated. Some health plans are providing these services with in-house personnel or via contracts with other programs. Even without payer involvement, community health centers, local public health departments, hospital outpatient departments, visiting nurse programs, and community based organizations have implemented robust programs, though financial sustainability remains a challenge. These programs, which demonstrate positive impact on health outcomes for a reasonable cost, often generating net cost savings, could proliferate if health insurance more routinely reimbursed for these services and supplies. Seed funding and other incentives for collaborative efforts among payers and providers can help scale-up these model programs so that they are embedded as standard components of comprehensive asthma management, routinely delivered and reimbursed by health payer organizations.

This report highlights six case studies to demonstrate the range of attributes that characterize cost-effective asthma programs. The six case studies are a small sample of dozens of promising programs across the country. Descriptions of other successful programs can be found on the Environmental Protection Agency's (EPA) Community in Action for Asthma Friendly Environments website, http://www.asthmacommunitynetwork.org/. Examples of workplace asthma programs can be found in a 2010 policy and practice report by the Asthma Regional Council and the University of Massachusetts Lowell entitled, "Asthma: A Business Case for Employers and Health Care Purchasers."[47]

The six programs vary in structure and personnel, but they have in common a commitment to supplement quality clinical care with asthma education and environmental interventions in the home, and a track record of positive financial returns. Some health plans (as shown in the case study on Optima Health in Virginia and the Monroe Plan for Medical Care in New York), are designing comprehensive asthma management programs and working directly with provider organizations to implement them. Others, such as Neighborhood Health Plan in Boston and Priority Health in Michigan, are directly reimbursing for services provided by community-based organizations. Still others, such as Alameda Alliance for Health and Blue Cross Anthem in California, are reimbursing for a subset of services provided by public health departments.

1. Optima Health, Virginia Beach, Virginia: A Managed Care System Extends its Asthma Management Services by Partnering with Home Health Care Agencies[48]

Optima Health is a non-profit managed care system (a division of Sentara Health located in Virginia and North Carolina) and offers Medicaid HMO and commercial HMO, PPO and POS plans. In an effort to reduce increasing rates of hospitalizations, the organization launched a one-year pilot asthma management program to improve the self-management skills of members with asthma, including addressing environmental triggers in home visits targeting high-risk children. Impressed by the results of a pilot, which demonstrated dramatic reductions in the use of urgent care services, Optima Health made the home visiting program permanent in 1997. Today, it continues to demonstrate positive returns.

Optima Health members with asthma receive one of three different interventions depending on the severity of their disease. Those considered at low risk receive mailed materials and have access to telephonic asthma education services. Members considered to be at moderate risk receive the mailed information and are contacted by a case manager who provides phone-based support. For those considered at high risk because of recent hospitalizations or excessive use of rescue medications, Optima Health combines asthma education with an average of four home visits provided by nurses or respiratory therapists who are employed by a home healthcare agency. The visits provide environmental assessments of the home as well as additional asthma education.

> The Connecticut Department of Public Health was one of the first state health departments to develop a statewide home visiting asthma program called Putting on Airs. The program provides home-based education and identification and mitigation of environmental triggers. Through a train-the-trainer approach, a majority of communities in the state now have access to these asthma services. However, the Putting on Airs program is an example of the many home-based asthma education and environmental intervention programs whose services run the risk of termination unless more sustainable sources of funding can be identified.

Optima Health has tracked improvements in asthma outcomes among its members, which have translated into substantial cost savings:

- between 1994 and 2004, asthma hospitalizations decreased by 54% among Optima members in commercial plans, and by 32% among members in the Medicaid HMO plan;
- over the same time period, emergency department visits for asthma decreased 18% among commercial plan participants and 33% among members in the Medicaid HMO plan. Overall costs for members considered high-risk and receiving the home-based environmental interventions decreased by 35%.

Optima health estimates that they save $4.40 for every $1 spent on the program.

2. Children's Hospital Boston: A Partnership between a Hospital, a Community-Based Asthma Organization, and a Health Payer Demonstrates Positive Return on Investment[49]

At Children's Hospital Boston, asthma is the leading cause of hospitalizations and one of the top five reasons that children land in their emergency department. Seventy-percent of children hospitalized for asthma live in neighborhoods where hospitalization rates are 4 to 5 times higher than in other neighborhoods in the city, despite comparable prevalence rates. In 2005, Children's Hospital launched its Community Asthma Initiative, targeting children who live in these higher risk neighborhoods and who have used the emergency room or been hospitalized for asthma.

A primary focus of the Community Asthma Initiative is case management services. To implement this element of the

program, Children's provides nurse case management services and home visits. Children's Hospital partners with the Boston Asthma Initiative (BAI), which is a program of ESAC Boston, a community-based non-profit organization. BAI employs community health workers with language and cultural competencies, as well as special training in asthma. The nurse case manager assesses the child's history, needs, and barriers to good asthma control, and communicates with the child's primary care provider to develop a care plan. Working closely with the nurse case manager, the BAI home visitor conducts an environmental assessment to identify asthma triggers, and reinforces information both on medications and on steps to reduce asthma triggers. All families receive supplies such as mattress covers, pest management kits and vacuum cleaners with HEPA filters. Where needed, the program provides families with additional supplies and services to help maintain an asthma-friendly environment, including professional pest management services.

Currently, most of the costs of the program are covered by grants, but for patients that are members of Neighborhood Health Plan, a Medicaid Managed Care Organization, costs of home visiting services and some environmental intervention supplies are reimbursed.

As of March 2010, the program had achieved impressive results for the 441 children with asthma participating in the program. Compared with rates prior to enrollment, the study population:

- reduced emergency department visits by 65%;
- reduced hospitalizations by 81%;
- reduced school days missed by 39%;
- reduced parents' work days missed by 49%;
- increased the use of written Asthma Action Plans by 71%.

For all patients with two years of follow-up, Children's has demonstrated a return on investment of $1.50 saved in hospital costs for every $1 invested in the program. Seventy-one percent of patients served by the program are covered by Medicaid (MassHealth).

The partners in the Children's program are actively engaged in an Asthma Home Visit Collaborative, led by the Boston Public Health Commission (Boston's health department), which seeks to standardize home visits provided by community-based and other organizations in the city and facilitate feedback to providers, as well as to centralize the referral and reimbursement processes. Participants include hospitals, health plans, city officials, and community-based organizations.

3. Monroe Plan for Medical Care: A Medicaid Managed Care Organization Makes the Business Case for Sustaining and Expanding its Pilot Asthma Program[50 51]

In 2002, the Monroe Plan for Medical Care—a Medicaid MCO plan located in the Rochester, NY area—launched a pilot of its Improving Asthma Care for Children Initiative program to address disproportionately high hospital admission rates among minority children. In an effort to shift care away from emergency services to patient self-management, Monroe Plan worked with ViaHealth, an integrated health delivery system, to enroll children in the program. Participants received specialty care including lung function testing and allergy skin testing, as well as asthma education. Children also received case management services, home environmental assessments, and supplies for reducing exposure to dust-mites, cockroaches and other environmental triggers—all of which were tailored to individual patient needs.

Data collected in 2004 compared to pre-pilot 2001 data showed the effectiveness of the program:

- hospitalization admission rates decreased by 60%;
- emergency department rates decreased by 78%.

The program has demonstrated a positive ROI: for every $1 spent on the program, $1.48 was saved in direct medical costs. While the pilot was initially funded through a grant from the Robert Wood Johnson Foundation, its results established a business case for sustaining the program. The Monroe Plan Board agreed to continue the program in-house, which has since been expanded to Monroe Plan's population of moderate to severe asthmatic patients throughout 13 counties in New York.

4. The Asthma Network of West Michigan: An Asthma Coalition Provides Services to Children and Adults, Financed Primarily by Health Payers[52]

When it was established in 1994, the Asthma Network of West Michigan (ANWM) consisted of three acute care hospitals in Grand Rapids, the American Lung Association of Michigan, the Kent County Health Department, Grand Valley State University, Priority Health (a regional health plan offering both Medicaid and commercial plans), Community Care Plan, private practices, and Visiting Nurse Services, among others. One of ANWM's primary goals is to provide intensive home-based case management to low-income children and adults with moderate to severe asthma. During 12 months of home visits, ANWM's case managers—certified asthma educators who are either respiratory therapists or registered nurses—perform environmental assessments and educate patients and caregivers about

asthma management practices, including trigger avoidance. These case managers also work with the patient's providers to develop tailored asthma action plans, and ensure proper use of medications. Additionally, case managers and medical social workers work with patients and their caregivers to address barriers to optimal asthma care by providing referrals for counseling, financial assistance and access to other social services.

Since April 1999, ANWM has provided home-based case management services to Priority Health's Medicaid pediatric population on a fee-for-service basis. Priority Health has extended its partnership to include select commercial patients as well as adults with asthma. In addition to Priority Health, ANWM has contracts with four other health plans. Reimbursement by the plans is the primary source of funding for the program, helping to ensure long-term sustainability, though it does not cover the full costs of the program.

ANWM's comprehensive care has led to:

- 64% reduction in hospitalizations;
- 60% reduction in emergency department visits.

ANWM estimates that the program results in approximately $800 in net health care cost savings per child per year.

5. Cambridge Health Alliance, Massachusetts: An Integrated Health System Featuring an Asthma Registry, Partnerships with a Local Health Department and Schools, and Payer Reimbursement.[53]

The Cambridge Health Alliance (CHA) is an integrated health delivery system which includes 2 hospitals, more than 12 primary care practices, the Cambridge Public Health Department, and a statewide Medicaid managed care organization (Network Health). CHA serves residents of Massachusetts in Cambridge, Somerville and Boston's metro-north region. CHA sought to provide more aggressive and proactive care for its pediatric asthma patients to keep them in school and engaged in daily activities, as well as to reduce asthma-related ED visits and hospitalizations. CHA based its program on the Chronic Care Model.[54]

At the core of CHA's asthma program is a secure electronic patient registry, which tracks patient encounters within the health care system, documents outcomes, and delivers performance data to providers/care teams according to evidence-based guidelines. All members of the health care team, including school nurses and home visit providers, have access to the registry to support continuous asthma care. Flags in CHA's electronic registry prompt providers during clinical encounters, generating referrals for home visits if they are needed. Home visits are provided by the Somerville-Cambridge Healthy Homes program, based in the City of Cambridge Health Department. Over the course of three home visits (more can be authorized if needed), the program's registered nurse and community health worker provide families with education about assessment and monitoring, as well as use of medications. They also evaluate the home for asthma triggers and home safety hazards, and provide supplies to help reduce exposures. The program also provides in-clinic asthma education and training for providers.

Evaluations of the impact of CHA's asthma program on 1,200 patients and their families have shown impressive reductions in hospitalizations and ED visits. Over the seven years that the program has been running, CHA estimates a return on investment of $4.29 for every $1 invested in its asthma program. The positive ROI is an important reason that Network Health, a Medicaid Managed Care plan in Massachusetts, has agreed to reimburse providers for home visit services, in addition to standard medical care.

6. Alameda County Health Department, California: A High-Impact County Health Department Program with Medicaid Managed Care Partners[55]

The Asthma Start Program was established in 2001, within the Alameda County Public Health Department's Community Health Services Division (San Francisco Bay Area), with the goal of improving the lives of children with asthma. Over time, the Asthma Start Program has expanded and now provides in-home case management services, asthma education, environmental trigger assessment and supplies (e.g. dust-mite-proof mattress and pillow covers, bleach-free mold cleaner, a HEPA vacuum if the house has carpet, and cockroach traps) for children with asthma up to 18 years of age.

Children are referred to the program by a local hospital, community and county public health clinics, WIC programs, individual physicians, and through self-referrals. The program also works with two Medicaid managed care programs: Alameda Alliance for Health and Blue Cross Anthem. While many of the program costs are covered by public funds and grants, asthma case management services for children are reimbursed by the Alameda Alliance for Health. For high-risk patients not covered by the Alameda Alliance, the program can bill Targeted Case Management (TCM)—a covered benefit through most state Medicaid programs designed to help patients in community settings gain access to needed medical, social, educational, and other services provided during the home visits.

Home visiting services are provided by medical social workers and an outreach worker, each of whom has specialized asthma and case management training. The program con-

sists of three home-visits. Although the content of the visits are standardized, elements are tailored to the child and/or their caregiver. Asthma Start informs the pediatrician about the child's enrollment into the program and provides a discharge summary of accomplishments at its conclusion.

The improvements in self-management skills and reductions in health care utilization achieved under the Asthma Start program are impressive. For example, a target group of 130 children ages 0-5 discharged from the program in 2008/2009 experienced:

- reduced hospital admissions of 90%;
- reduced emergency department visits of 90%.

A high percentage of parents/caregivers demonstrated improvements:

- 81% of parents/caregivers passed an asthma knowledge test with a grade of 80% or better;
- 85% of parents/caregivers implemented one or more of the trigger reduction recommendations.

Expanding Your Health Plan's Asthma Management Program: Three Steps to Get Started

1. Consider a pilot home visiting program. A pilot can help identify the most effective approach given the constraints and resources available to your organization and potential partners. While minimizing the initial costs, a successful pilot program can demonstrate cost-effectiveness and justify larger-scale investment.
2. Leverage the capacity of community partners to provide additional asthma management services. Community-based organizations, health departments, hospitals, and visiting nurse associations, among others, have the capacity to work in partnership to provide additional services to your members. Leverage these organizations' capacities to expand the asthma management services for your members, and jointly establish rigorous mechanisms for accountability and quality improvement.
3. Become a model: track your effectiveness. Before the program begins, calculate baseline rates and have a plan in place to monitor key outcome measures, including cost effectiveness. Be sure to publish and share the news of your program's successes and lessons learned.

The Alameda County program does not track costs. However, it is reasonable to assume that a 90% decline in emergency department visits and hospitalizations will reduce overall health care costs among participants, given that the typical cost of a child's emergency department visit for asthma is $691 and the average cost of a child's hospitalization for asthma is $7,987[56] (Figure 2).

Lessons from Model Programs

These case studies show the health benefits and cost-effectiveness of enhanced asthma management programs that supplement quality clinical care with asthma education and environmental interventions in the home. They demonstrate that various kinds of organizations and staffing models can achieve effective results, often with leadership and financial support from payer organizations. Several of the case studies highlight gaps in insurance reimbursements that must be addressed if comprehensive asthma management is to be embedded in health care delivery systems on a larger scale.

The impressive on-the-ground results of these case studies make a further case, beyond the research, for insurance policies to cover care that is often insufficiently or inconsistently reimbursed by public and private insurers, including:

- longer physician visits or nurse case management services, in the clinic or hospital setting;
- asthma education in the home, workplace or community;
- home-based services and supplies needed for mitigating environmental triggers;
- the full range of providers that can effectively deliver asthma education and home assessments, such as community health workers.

Diversity in insurance offerings—with different coverage applying to members of different plans—makes it difficult for clinical and community providers to consistently offer evidence-based services to those patients who can benefit from them. At a popluation level, it is important to align insurance coverage with recognized best practices, especially when they are proven to promote value-based care.

An excellent guide for health plans that are interested in developing a home visiting program is the U.S. EPA's *Implementing an Asthma Home Visiting Program: 10 Steps to Help Health Plans Get Started.* See:

http://www.epa.gov/asthma/pdfs/implementing_an_asthma_home_visit_program.pdf

Policy Opportunities

As need and opportunity converge, multiple sectors that influence health care decision-making have a role to play in promoting comprehensive asthma management.

Providers, including group practices and hospitals, should undertake the following:

- conduct proactive assessments of asthma patients;
- provide patients with Asthma Management Plans;
- use computerized registries in the office to improve care;
- consider employing asthma educators in their practices;
- make and promote referrals for home visits and environmental assessments;
- participate in community partnerships to increase capacity for delivery and financing of these services. These linkages are likely to improve quality of care, health outcomes and patient satisfaction; reduce disparities, inpatient stays and emergency department use; and may generate net cost savings.

Public and private payers – who stand to benefit from improved quality of care and often from net cost savings – should consider the following opportunities:

- establish incentives for providers to appropriately classify patients, monitor drug usage, and refer patients to clinical and in-home education sessions;
- encourage provider referrals and reimburse providers for asthma education delivered in clinical and home settings;
- pay for supplies and services shown to improve self-management and reduce exposures to environmental triggers, especially targeting higher risk populations. The services and supplies should be tailored to the individual, but may include peak flow meters, mattress and pillow encasements, basic IPM supplies and services, and for higher-risk patients, HEPA filters, vacuums and air purifiers, as well as professional services as needed;
- offer reimbursement mechanisms for the range of non-physician providers of asthma education and environmental services working in both clinical and community settings, including certified asthma educators and community health workers, as well as other qualified providers based in public health departments;
- provide or reimburse for case management and outreach staff that complement quality primary care for high risk patients. Communication among all providers involved on a "care team" is important; payers can play a role in initiating and sustaining this communication;
- remove financial barriers that prevent patients from purchasing needed medications.

Employers also have a role to play, given how many hours people spend at work, and the number of work days missed as a result of asthma symptoms, either in the employee or in a dependent. They can take the following cost-effective steps:

- secure coverage for comprehensive asthma management services and supplies through contract negotiations for health insurance;
- build on worksite health promotion programs to offer asthma education and other services that fill gaps in coverage;

Why Should Insurance Pay for Home-based Asthma Education and Environmental Trigger Services and Supplies

The impetus for national Health Care Reform has been to improve clinical outcomes and to control the unsustainable rise in costs. Caring for chronic diseases comprises 75% of U.S. health care expenditures. Effective system reforms will entail new delivery and payment strategies that are demonstrated to prevent unnecessary expensive urgent care. The health care system needs to acknowledge that certain populations and diseases need new forms of community interventions to enhance value and quality care. For asthma, which has a clear environmental component, reimbursing a range of trained providers and professionals to assess the patient's home for triggers and offering basic environmental and education services can be as cost effective as many medications—and is an evidence-based asthma management strategies for patients with persistent disease symptoms.

- offset expensive medication copayments;
- assess potential associations between work conditions, exposures, and asthma among employees, and take steps to ensure healthy work environments.

(For a more extensive analysis of the implications of this literature for employers, see *Asthma: A Business Case for Employers and Health Care Purchasers* and its companion *Insurance Coverage Checklist* for use by health care purchasers as they negotiate health benefits coverage for employees.[57] These tools can be found on the Asthma Regional Council's website at **www.asthmaregionalcouncil.org**.)

Policymakers and public health departments should consider the following:

- establish guidelines or regulations to incentivize affordable medication and basic insurance coverage;
- ensure efficient access to and capacity for asthma education and appropriate environmental intervention services and supplies;
- public health departments can serve as effective conveners of stakeholders who can collaborate to build capacity for comprehensive asthma management at a local or state level, and monitor quality of care.

Conclusion

Recent published reviews by the NAEPP Expert Panel (2007) and the CDC's Task Force on Community Preventive Services (2008), along with on-the-ground evidence from innovative asthma management programs around the country, affirm and strengthen the conclusion of our 2007 business case: that asthma education and environmental assessment, services and supplies, delivered in the clinical setting and in the home, reduce symptoms and improve quality of life for people with asthma at a reasonable cost. When they are targeted to high-risk patients, they may result in net cost savings to health payers who invest in them. For society at large, when considering lost productivity at work and at school, the business case for these investments is even more convincing. Other benefits include reductions in health disparities, as well as improvements in quality of life and in co-morbidities such as depression, anxiety and obesity. The health and well-being of other family members can benefit as well.[58] Removing financial barriers to needed medications is another critical step increasingly understood to be cost-effective.

The information in this paper dispels arguments that comprehensive programs to manage asthma are too expensive or unproven, and it provides guidance about how to classify patients and target interventions appropriately. The information should prompt us to ask: how can we afford not to give people with asthma access to programs shown to improve quality of life and control costs? The Asthma Regional Council, the Lowell Center for Sustainable Production at the University of Massachusetts Lowell, and our partners look forward to working with decision-makers in multiple sectors to support implementation of comprehensive asthma management programs. We are especially interested in promoting asthma education and environmental trigger reduction, two highly promising yet often neglected elements of the NAEPP asthma management guidelines.

Appendix 1
Examples of Net Cost-Savings or Cost-Effectiveness: Evidence from the Research Literature

Table 1: Combining Asthma Education and Home-Based Environmental Interventions in Disease Management Program: Example Evidence of Return on Investment

Source	Study Type	Program Description	Program Cost per Patient*	Health Improvement Results	Savings*
Jowers JR, et. al 2000[59]	Pre-Post Intervention	Targeted medium to high-risk children (over 12 years) and adults with asthma. Provided 4-6 phone-based case management and education calls delivered by Respiratory Nurse and 2 home-based education/ environmental intervention visits delivered by a home health care agency	$303	12 months after baseline: fewer hospital days (37%); fewer ER visits (76%); fewer ICU admissions (66%); fewer unscheduled Dr. visits (66%); reduced use of rescue medications (50%); fewer missed work days (99%); fewer missed school days (77%)	Saved $4.64 in health care costs and lost work days/school days (additional care taker lost work days) for every $1 spent on the program

*Costs/savings are not adjusted to today's dollars; they are as reported in each study at the time of publication.

Table 2: Asthma Education: Example Evidence of Return on Investment

Source	Study Type	Program Description	Program Cost per Patient*	Health Improvement Results	Savings*
Bolton MB et al. 1991[60]	Randomized Controlled Trial	Delivered by a Registered Nurse (with specialized asthma training) to high risk adult asthma patients during 3, 1-hour group sessions in the clinic	$85	59% fewer ED visits	Saved $22.50 in health care costs for every $1 spent on the program
Castro M, et al. 2003[61]	Randomized Controlled Trial	Delivered by an Asthma Nurse Specialist to high-risk adult asthma patients in the clinic, by phone & at home as needed	$186	54% fewer hospital readmissions; 34% fewer ED visits; 8% greater improvement in overall Quality of Life; 76% fewer lost work/school days	Saved $36 in health care costs and lost work days for every $1 spent on the program
Clark NM et al. 1986[62]	Randomized Controlled Trial	Delivered by a health educator to high risk children with asthma during 6, 1- hour individual sessions in the clinic	$1558	58% fewer hospitalizations and 59% fewer ED visits among cases with 1 or more baseline hospitalizations	Saved $11.22 in health care costs for every $1 spent on the program for children hospitalized the previous year for asthma
Greineder DK, et al. 1999[63]	Randomized Controlled Trial	Comprehensive asthma case management services for high-risk children with asthma, including education delivered by an asthma Case Manager	$190	57% fewer ED visits; 75% fewer hospitalizations	Saved $7.69-$11.67 for every $1 spent on a case-manager's salary
Trautner C, et al. 1993[64]	Pre-Post Intervention	Delivered by a Specialized Nurse Educator to high-risk adult asthma patients while in the hospital	$233	Average reduction 3-yrs after intervention in: hospital days (51%); missed work days (44%); physician visits (70%); asthma attacks (79%). 8.5% average improvements in lung function	Saved $3 in health care costs and lost work days for every $1 spent on the program

*Costs/savings are not adjusted to today's dollars; they are as reported in each study at the time of publication.

Table 3: Home-based Environmental Interventions for Asthma: Example Evidence of Cost- Effectiveness

Source	Study Type	Program Description	Program Cost per Patient*	Health Improvement Results	Cost-Effectiveness*
Kattan M, et al. 2005[65]	Randomized Controlled Trial	5 home-visits targeting high-risk children with asthma delivered by two Environmental Counselors	$1469	19% reduction in unscheduled Dr. visits per year; 13% reduction in B-agonist inhaler use per year; 37.8 (7%) additional symptom free days	Cost $28 for each symptom-free day gained ($16 per symptom-free day gained if just 1 Environmental Counselor administers the intervention)
Krieger J, et al. 2005[66]	Randomized Controlled Trial	5-9 home visits targeting medium to high-risk children with asthma delivered by a Community Health Worker	$1124	10% reduction in days with symptoms/2wks; 17% improvement in care giver quality of life; 45% reduction in urgent health service use/2mo; 13% fewer days with limited activity/2wks	Cost $23 for each symptom-free day gained.[67]

*Costs/savings are not adjusted to today's dollars; they are as reported in each study at the time of publication.

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